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Bulletin No. 34. February, 1895.

HORTICULTURE.

FRUITS AND VEGETABLES.

Notes on the Comparative date of Blooming,
and Pollen production of varieties of
Apples, Pears, Plums, and
Cherries.

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of Oregon who request them.

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FRUITS.

POLLINATION.

GEORGE COOTE.

The first step towards successful fruit culture is an orchard wisely planted. The several varieties must be so located that each may assist in the pollination of one another. This can only be done by a careful study of the different varieties as to their time of blooming and amount of pollen produced by each variety.

Very careful observations and notes were taken on all varieties on the college farm. It will be understood that all varieties of fruit trees do not have the same power of producing pollen. If a large number of trees of a single variety be planted which are shy pollen producers the lack of pollen will undoubtedly cause a failure in the crop of fruit; and this danger of failure will be greatly increased if the weather is damp at the time of blooming.

The pollen is conveyed from flower to flower by bees and other insects. Their object is the discovery of honey; and whilst searching the recesses of the flower they unintentionally cover their bodies with pollen which they convey to the next flower and unavoidably deposit it on its stigma. If the amount of pollen produced be small there will be but a small amount to be distributed and the fertilization of each flower would be either a failure or imperfect. This shows the necessity of planting trees which are shy producers of pollen along with those rich in pollen. Hence to arrange the trees in an orchard it is necessary to know the pollen producing powers of each variety.

It will be seen that the list of varieties in the following tables is comparatively small. But it must be remembered that this is but a beginning of a work which must be continued through a series of years. We have many other varieties on the college grounds which have not yet come into bearing, and hence are not reported.

As soon as a report of all varieties can be made, a classification will be made and published for the benefit of all interested in such work. The following table shows the date of blooming and pollen producing power of each variety.

Comparative Notes on the Date of Blooming, and Pollen Production of Varieties of Fruit.

CHERRIES.

No.	NAME.	Date of first bloom.	Date of full bloom.	Date of Pol- len maturing	Date of stig- ma receptive
1	*Black Republican.....	4.13	4.18	4.20	4.20
2	†Bigarreau (Rockport).....	4.17	4.20	4.21	4.21
3	†Bing.....	4.18	4.21	4.21	4.21
4	*Black Tartarian.....	4.19	4.23	4.24	4.24
5	*Coe's Transparent.....	4.19	4.27	4.28	4.28
6	*Centennial.....	4.13	4.19	4.20	4.20
7	*Early Purple Guigne.....	4.22	4.24	4.25	4.25
8	*Elton.....	4.11	4.20	4.21	4.21
9	*Governor Wood.....	4.16	4.19	4.20	4.20
10	*Great Bigarreau.....	4.14	4.18	4.20	4.20
11	†Kentish.....	4.21	5.05	5.06	5.06
12	†Knights Early Black.....	4.19	4.25	4.26	4.26
13	*Lincoln.....	4.18	4.24	4.25	4.25
14	†Late Duke.....	4.20	5.07	5.08	5.08
15	†Lewelling.....	4.14	4.23	4.23	4.23
16	*Leibe.....	4.16	4.19	4.20	4.20
17	*Major Francis.....	4.18	4.24	4.20	4.20
18	‡May Duke.....	4.20	5.03	5.04	5.04
19	*Royal Ann, Napoleon Bigarreau.....	4.17	4.23	4.23	4.23
20	*Williamette.....	4.18	4.21	4.21	4.21
21	†Yellow Spanish.....	4.14	4.18	4.21	4.21

PLUMS.

1	*Chabot	3.31	4.02	4.02	4.04
2	†Coe's Golden Drop..	4.08	4.10	4.12	4.12
3	*Columbia.....	4.14	4.24	4.24	4.24
4	‡Botan or Abundance.....	4.10	4.19	4.21	4.21
5	‡Myrobalan.....	3.23	3.31	4.02	4.02
6	*Jefferson.....	4.06	4.09	4.10	4.10
7	*Goliath.....	4.06	4.10	4.11	4.11
8	‡Satsuma or Blood.....	3.25	4.16	4.26	4.26
9	†McLaughlin.....	4.06	4.10	4.11	4.11
10	†Imperial Gage.....	4.09	4.11	4.18	4.18
11	†Washington.....	4.09	4.13	4.15	4.15
12	‡Ickworth.....	4.11	4.19	4.20	4.20
13	†Quackenboss.....	4.11	4.19	4.20	4.20
14	*Peach Plum.....	4.13	4.20	4.21	4.21
15	†Sherman.....	4.13	4.21	4.22	4.22
16	†Walling.....	4.12	4.16	4.17	4.17
17	‡Yellow Gage..	4.08	4.11	4.12	4.13
18	*Rhine Claud.....	4.07	4.12	4.14	4.14
19	*Smith's Orleans.....	4.07	4.18	4.19	4.19
20	†Masu.....	4.14	4.20	4.21	4.21
21	†St. Julian.....	4.19	4.23	4.24	4.24
22	‡Orange	4.07	4.10	4.12	4.12
23	†Yellow Jap.....	4.09	4.16	4.17	4.17
24	‡Royal Hative.....	4.06	4.18	4.25	4.25
25	†Simon Plum.....	3.22	4.04	4.06	4.06
26	*Petite Prune.....	4.11	4.19	4.20	4.20
27	†German Prune.....	4.13	4.19	4.19	4.19
28	†Italian.....	4.19	4.25	4.28	4.28

PEACHES.

No.	NAME.	Date of first bloom.	Date of full bloom.	Date of Pollen maturing	Date of stigma receptive
1	*Clements.....	4.02	4.09	4.10	4.10
2	‡Austin Cling.....	4.08	4.15	4.16	4.16
3	†Alexander.....	4.10	4.20	4.21	4.21
4	†Bishop's Early.....	4.07	4.13	4.15	4.15
5	†Corvet.	4.05	4.09	4.10	4.11
6	*Ellson.....	4.07	4.12	4.14	4.14
7	†Elberta.....	4.07	4.12	4.14	4.14
8	*Miss Lola.....	4.06	4.09	4.10	4.10
9	*Ulates.....	4.02	4.09	4.10	4.10
10	‡Late Crawford.....	4.03	4.11	4.12	4.12
11	*Mother Porter.....	4.06	4.09	4.10	4.10

PEARS.

1	*Bartlett.....	4.20	4.25	4.26	4.26
2	*Beurre Gifford.....	4.12	4.18	4.19	4.19
3	†Beurre 'd Anjou.....	4.13	4.17	4.19	4.19
4	†Duchess 'd Angouleme.....	4.10	4.19	4.20	4.20
5	‡Keiffer's Hybrid.....	3.29	4.04	4.05	4.05
6	†Pound.....	4.16	4.23	4.24	4.24
7	‡Idaho.....	4.13	4.17	4.18	4.18
8	†Barry P.....	4.14	4.24	4.24	4.24
9	*Beurre Clairgeau	4.16	4.23	4.24	4.24
10	†Seckel.....	4.18	4.22	4.22	4.22
11	*Winter Nellis.....	4.18	4.24	4.25	4.25
12	*Summer Doyenne.....	4.09	4.17	4.19	4.19
13	‡Osborn's Summer.....	4.19	4.22	4.23	4.23
14	*Le conte.....	3.31	4.06	4.10	4.10

APPLES.

1	*Baldwin.....	4.24	5.04	5.05	5.05
2	†Charlotenthaler.....	4.24	5.03	5.03	5.03
3	*Domini.....	4.24	5.01	5.01	5.01
4	†Early Harvest.....	4.23	5.07	5.08	5.08
5	*Fall Pippin.....	4.26	5.07	5.08	5.08
9	†Grimes Golden.....	5.01	5.09	5.10	5.10
7	†L. Romanite.....	5.11	5.22	5.23	5.23
8	†Missouri Pippin.....	5.01	5.06	5.07	5.07
9	†May of Myers.....	5.07	5.11	5.12	5.12
10	†Oldenburgh.....	4.30	5.06	5.07	5.07
11	*Pumpkin Russet.....	5.03	5.07	5.07	5.07
12	*Oregon Crab, (Lewelling).....	4.19	4.25	4.26	4.26
13	‡Rambo.....	4.26	5.08	5.09	5.09
14	†Rome Beauty.....	5.13	5.22	5.23	5.23
15	*Tetofsky.....	4.24	5.07	5.08	5.08
16	†Transcendent, Crab.....	4.20	5.02	5.03	5.03
17	‡Winesap.....	4.28	5.10	5.11	5.11
18	†Waxen.....	4.21	4.30	4.30	4.30
19	*Whitney No. 20, Crab.....	4.26	5.06	5.06	5.06
20	†Martha, Crab.....	5.03	5.11	5.11	5.11
21	*Hyslop, Crab.....	4.25	5.04	5.05	5.05
22	*Yellow Siberian, Crab.....	4.23	4.30	4.30	4.30

N. B.—Varieties marked with a * are abundant in pollen; those marked with a † are medium; those marked thus ‡ are scant of pollen.

Experiments in Pollination of the Peach.

When the peach is grown in glass houses, and forced by artificial heat out of its season, it is necessary to pollenize the stigma of each flower by artificial means either by a small brush or some other process. The use of the brush is expensive and tedious and is not always successful; much of the fruit dropping at the stoning period.

To save labor in transferring the pollen some trees were sprayed when in full bloom with warm, and others with cold water. This proved very unsatisfactory, more fruit dropping at the stoning period than in the case of trees pollenized with the brush.

As a further experiment a hive of bees was placed in the house when the trees commenced to bloom. This was in November, and a heavy fog prevailed for fifteen days, and although the flowers were constantly opening not a bee showed itself. During the night of the fifteenth the fog lifted and the next morning was bright and clear, causing the pollen to burst. Then the bees came from the hive and kept up their work for eight or nine days. The result was that not a single peach was observed to drop at the stoning season. So great was the amount of fruit on the trees that it was necessary to thin it. One tree in the house was securely protected, so that bees could not gain access to it, and all of the fruit dropped at the stoning period.

These facts show the value of bees to the horticulturist, and no fruit grower should be without them.

Varieties of Apples Tested.

The experimental orchard was planted in the spring of 1891. The soil is a basaltic loam. It had been in wheat and oats for many years without the application of fertilizers of any kind. Before planting the trees the soil was plowed and subsoiled. Cultivation of the soil has been kept up all through the growing season; under this treatment the trees are making rapid growth. So far but few have fruited. There are now one hundred and thirty varieties of apples, and nine of crabs growing on the ground and others will be added as fast as means will permit.

NOTES ON VARIETIES OF APPLES AND CRABS PLANTED 1891, (ONE YEAR FROM THE GRAFT, WHEN SET.)

HYSLOP CRAB.—Fruit large, borne in clusters of three to four, roundish to egged shaped; color a dark, rich red; covered with a thick blue bloom. Flesh yellowish, good for cooking. Tree, a strong grower; spreading. A long keeper. Productive.

WHITNEY NO. 20 CRAB.—Fruit light yellow; skin glossy, streaked with carmine; flesh tender, juicy, pleasant flavor. Matured the 26th of Aug. Leaves dark green, glossy. Tree of uniform growth. Very productive. Not a long keeper.

MARTHA CRAB: Fruit large, yellow shaded and streaked with light red, good quality; good for eating out of hand. Ripened Sept. 28th. Tree makes a medium growth.

YELLOW SIBERIAN CRAB—Color, bright yellow. Fruit inclined to oval in shape, somewhat larger than the common Siberian; good for preserves and jellies. Matured Sept. 6th.

YELLOW TRANSPARENT CRAB.—Pale yellow, medium to large, flatten-

ed, slightly conical. Flesh white, tender, juicy; slightly sub-acid. Matured Aug. 15th. Tree an upright grower; vigorous and productive. Will keep but a few days.

TETOSKY.—A Russian variety; early, productive. Tree spreading, forming an open head. Trees are susceptible to injury by frost. Fruit of medium size; oblate, conical, often nearly round; yellow, striped with red and covered with a whitish bloom. Flesh white, juicy; slightly acid. Matured Aug. 15th.

OLDENBURGH.—Origin, Russia. Tree a vigorous grower; upright spreading head; producing when quite young. Fruit valuable for cooking, large, regular in form; roundish, oblate. Skin smooth, faintly splashed and streaked with red on a golden yellow ground. Calyx rather large, nearly closed, set in a wide, even basin. It has a faint blue bloom on the fruit. Flesh juicy, slightly sub-acid. Matured Aug. 27th

MAY OF MYERS.—Tree of medium growth producing when quite young. Fruit medium size, roundish, conical, pale greenish yellow, streaked with carmine in the sun; flesh white, very fine grained, firm. Not very juicy. Flavor mild sub-acid. Good Feb. to June.

LITTLE ROMANITE.—Tree hardy, vigorous grower; bears quite young. Fruit, medium size, roundish oblong. Skin smooth, streaked with deep red and yellow. Stalk short, deeply inserted; basin deep. Flesh yellow, firm, juicy and rich. Very good. Season: Feb. to May.

Cherries.

BING.—Fruit very large, heart shaped, slightly angular, surface glossy; color, dark crimson to black. Cavity broad, stem rather long, broad suture, slightly depressed at apex. Skin thick; firm, sweet. Flavor good, and of excellent quality. Matured July 6th

LATE DUKE.—Fruit large, roundish, heart shaped; stalk from 1½ to 2 in. in length. Color, bright shining red. Flesh amber, tender, juicy and rich. More acid than May Duke. From its color and softness is apt to be gathered before maturing, which would be for this locality the second week in Sept. The tree makes a vigorous growth, with a spreading habit, while the May Duke is quite the opposite, the latter making an erect growth.

MAY DUKE.—Fruit large, roundish, stalk long and slender. Color, dark red, when fully exposed to the sun. Flesh tender, juicy, rich. The tree may be readily distinguished by its upright growth. Matured June 30.

ELTON.—Fruit large, heart shaped; less obtuse than that of the Bigarreau. It has a longer and more slender stalk, being from 2¼ to 2½ inches in length. Skin of a pale waxy yellow on the shaded side; mottled and streaked with red next to the sun. Flesh whitish, firm, sugary and very rich. Matured July 20th. Tree makes a strong spreading growth, branches dark brown; shoots speckled with a silvery epidermis on a ground of chestnut brown. Leaves very large.

BIGARREAU NAPOLEON, (Royal Ann.)—Fruit large, heart shaped; light yellow, spotted with deep red and dark crimson, flesh firm, juicy, flavor good. Tree makes a vigorous growth. Matured July 15th.

Plums.

BOTAN OR ABUNDANCE.—Medium in size, quite pointed, and in many cases oblique. Color yellow, slightly covered with red on the sunny side; flesh deep yellow, juicy. When fully matured is of good quality. Tree a strong upright grower; leaves narrow. Matured Sept. 5th. Cling.

SATSUMA OR BLOOD.—Size medium to large. Conical and quite pointed.

Deep suture; color dark red; flesh dark blood red. Coarse, slightly acid, of fair quality, clinging to the stone quite firmly. It blooms early, and is often killed by late frost.

GOLIATH.—Fruit large, roundish oblong, a little depressed. Stalk downy; skin purple, covered with a rich bloom. Flesh greenish yellow, firm, coarse; adhering to the stone: only medium in richness. Good for cooking.

ROYAL HATIVE.—Fruit, medium size, roundish, rather widest near the stalk which is about $\frac{1}{2}$ in. in length; but little depression at its insertion. Skin purple, netted with yellowish brown. Flesh yellow, rich and delicious. Productive. Matured Aug. 12th.

ORLEANS.—Fruit, medium to large, depressed at apex. Stalk $\frac{1}{2}$ in. in length. Ground color of the skin is a dark purplish red, with pale red specks; covered with a good bloom giving it a blue color. Flesh, yellowish green, firm; very small free stone. Good for cooking.

Grapes.

CENTENNIAL.—The vine has made a medium growth; berries not large; skin firm; color very light green, shaded with pink; flesh juicy, sweet. Matured fruit Oct. 10.

ROYAL MUSCADINE.—Syn. common Muscadine, White Chasselas.—Bunch medium size, tapering, occasionally shouldered. Berries of medium size, sound; skin thin. When fully matured assuming an amber tint. Flesh tender, rich and sugary. Very productive, sets very evenly. One of the best in cultivation.

TELEGRAPH.—Berries large, round to oval; color dark. Failed to mature; is not adapted to this climate. The vine makes a very strong growth.

WILDER.—Bunches large, shouldered; berry large, somewhat globular; quite dark; flesh tender, juicy and sweet. Matured Sept. 29th. The vine is vigorous and quite healthy.

LADY.—Vine makes a small growth. Foliage resembles Concord. Bunches small, quality good. Color light greenish yellow, covered with a heavy bloom; skin very thin; pulp tender, sweet and rich, slightly vinous.

GOETHE, (Rogers No. 1.)—Vine a vigorous grower. Bunches large, of a loose habit, shouldered; berries large, oblong, yellowish green, small red dots on the sunny side; skin thin. A late variety, did not mature.

PRENTISS.—Vine of medium growth, short jointed; large leaves, downy. Bunches medium, not shouldered. Berry round, somewhat inclined to oval. Skin, thick, firm; color light green to pale yellow when fully ripe with a slight pinkish tint on the sunny side: covered with a weak bloom. Matured Sept 29th.

JESSICA.—Vine makes only a medium growth. Small, compact bunches. Berries, medium size; color, a light green changing to amber when matured; skin thin; pulp, tender, very sweet and sugary. Matured Sept. 20th.

GREEN MOUNTAIN.—This variety was received from Steven Hoyt & Co., New Cannan Conn., for trial. It has been in bearing two years and has proved to be a valuable addition to the list of white grapes. It is very productive; matures early; and so far is quite free from disease. It is one of the most valuable varieties for this coast, especially for the valley districts. Vine a medium grower, close jointed, bunches large sometimes shouldered; compact; skin of medium thickness, rather dark green in color, covered with a whitish bloom. Flesh tender, rich and of excellent quality.

ERIE BLACKBERRY.

SWEET WATER.—Vine short jointed, leaves glossy, and deep green above, pubescent beneath, reddish brown when first beginning to unfold. Bunches quite large, open. Berries large, round; color light green, with a slight brown next the sun; flesh sweet and rich; quite productive. Matured Nov. 2d.

LINDLEY, (Rogers No. 6.)—Vine makes a vigorous growth. Bunches large, shouldered, loose; berries large, round; color brick red; flesh tender, sweet, with a considerable Muscat flavor; fruit drops from the clusters very soon after maturing. Matured Oct. 5th.

WORDEN.—Vine makes a weak growth. Bunch of medium size; shouldered; berry large, black; skin thin; flesh sweet resembling Concord. Matured Oct. 29th

ULSTER'S PROLIFIC.—Vine, a medium grower. Bunches medium; berries large; thin skin; flesh tender, sweet with a slight flavor of the Muscat. Matured Oct. 4th.

CONCORD MUSCAT.—A very strong vine. Bunches of medium length, compact; berries large, oval; skin thin; color, light green with a small amount of bloom; flesh quite tender; flavor rich and sugary with a strong Muscat flavor. Matured Oct. 1st.

HERBERT (Roger's No. 44).—The vine makes a vigorous growth, healthy; producing medium sized bunches, often shouldered; slightly compact; berries of medium size, color black; flesh quite tender and sweet, of excellent quality; matured Oct. 29th.

Blackberries.

For the purpose of making a comparative test of Blackberries and Raspberries, three plants of each variety were taken, consisting of four canes each. The weight of the fruit was carefully recorded at each gathering.

AGAWAM.—Fruit sweet, melting, medium size; quite black; firm; first bloom opened May 25th, full bloom June 3rd; first picking July 11th, last picking Aug. 27th; three plants producing 7 lbs.; canes are of medium growth.

ERIE.—Fruit quite large; diameter 1 in. circumference $3\frac{1}{2}$; firm, and of excellent flavor; good for shipping. First bloom May 29; full bloom June 6th; first picking July 25; last picking Aug. 27th; three plants producing 16 lb; canes make a very strong growth.

CHILD'S TREE.—Fruit almost round, $\frac{3}{4}$ by $\frac{5}{8}$ inches; flavor good; has not proved productive.

TAYLOR'S PROLIFIC.—Fruit large, and quite glossy; quality good; 1 in. in diameter, 3 in. in circumference. First bloom opened May 26th; full bloom, June 3d; first picking, July 11th, last gathering, Aug. 27th: three plants produced 5 pounds.. Makes a strong growth.

SNYDER.—Fruit, medium size: quality, good; diameter, $\frac{5}{8}$ in.; circumference, $\frac{7}{8}$ in.; firm; first bloom opened May 24th; full bloom, June 2d; first gathering, July 24th; last gathering, Aug. 27th. Three plants produced 5 lbs; canes quite vigorous, producing large leaves.

WILSON JUNIOR.—Fruit large, firm; excellent flavor; diameter $\frac{1}{4}$ to $\frac{5}{8}$ in.; circumference $1\frac{1}{4}$ in. First ripe fruit, July 24th; last gathering, Aug. 8th. Three plants producing 3 lbs.; cane made a small growth.

EARLY HARVEST.—Fruit good quality, firm; medium in size; first bloom May 27th; full bloom, June 4th; first gathering, July 18th; last gathering, August 6th. The canes make a strong growth. Cannot recommend them for

planting for general cultivation. The canes are not hardy. Much damaged by frost; three plants produced $\frac{1}{4}$ lb.

KITTATINNY.—Fruit large; diameter 11-16 inches, circumference $2\frac{3}{4}$; firm, good quality; First bloom, May 28th; full bloom, June 6th; First picking, July 25th; last picking, Aug. 22nd; three plants produced 12 lbs.; canes extra strong, a good market variety.

OREGON EVERGREEN.—*Rubus laciniatus*, Willd.—Fruit large; medium in quality; juicy. If grown without irrigation the seeds are quite hard; is very productive; strong growing; quite hardy. This variety when properly cultivated needs to be irrigated, the fruit will be of better quality and much more productive. The plants in question were grown without water. The first gathering was made Aug. 4th; last gathering Sept. 20th; product of three plants, 120 lb.

Raspberries.

GOLDEN QUEEN (Childs).—Fruit, yellow; large, measuring $1\frac{1}{2}$ to $2\frac{1}{2}$ in. in circumference; of good flavor; firm; good shipper; very attractive when mixed with the red, for desert. First bloom opened May 23d, full bloom, June 4th; first ripe fruit, June 30th, last picking, Aug. 1st; three plants produced 5 lb; canes made a vigorous growth; long jointed. Produce suckers very freely.

CHILDS ALL SUMMER (Childs).—Fruit dark red; large; circumference of fruit, $2\frac{1}{2}$ to $2\frac{3}{4}$ in; quality good; an excellent berry for market. First bloom, May 1; full bloom, May 24; first ripe fruit, June 30; last picking, Sept. 8; three plants producing 10 lbs. canes vigorous, short jointed; leaves large, quite dark in color.

CUTHBERT—Fruit, bright red; moderately firm; of good quality; circumference of fruit, $2\frac{1}{2}$ to $3\frac{1}{2}$ in.; flavor sweet and luscious; a good shipper. First bloom opened May 11th, full bloom, June 2d.; first ripe fruit, June 29th; three plants producing 12 lb; last picking, Aug. 17th; the best red raspberry for all purposes tested here. Canes make a medium growth; quite healthy.

TURNER.—Fruit red; above medium size; circumference $1\frac{1}{2}$ to $2\frac{1}{2}$ in.; flavor not of the best; good shipper; first bloom opened May 14th; full bloom, June 3d.; first picking, 23d.; canes not strong; 3 plants produced $5\frac{1}{2}$ lbs; last picking, July 27th.

CRIMSON BEAUTY.—Fruit red, small; does not adhere to the stem well. Not a success this season. First bloom May 20, full bloom June 1; first picking June 27; three plants producing 3 lbs. Canes quite short; leaves small, turning yellow by June 30th.

MARLBORO.—Fruit red; medium in size, $2\frac{1}{2}$ in. in circumference quality good; firm; first bloom opened, May 27; full bloom, June 6th; first picking July 2; three plants produced 5 lbs.; last picking, July 31. Canes strong, long jointed.

SHAFFERS COLOSSAL;—Fruit, dull purple; large, $2\frac{1}{4}$ in. in circumference, $\frac{5}{8}$ in. in diameter; flavor good. First bloom opened, May 21; full bloom, June 5; first picking, July 2; last, July 27; one plant produced 1 lb. 1 oz; canes small, not in good condition for bearing.

EARLY PROLIFIC.—Fruit red; firm; $2\frac{1}{2}$ in. in circumference, $\frac{5}{8}$ in. in diameter; flavor good; first bloom, May 21, full bloom, June 2; first picking, June 26, last picking, June 25; three plants produced $4\frac{1}{2}$ lbs. Canes of medium growth.

HANSELL.—Fruit very red, firm; $2\frac{1}{2}$ in. in circumference, $\frac{5}{8}$ in. diameter; quality fair; first bloom, May 12, full bloom, May 29; first picking, June 26, last picking, June 27; three plants producing five lbs. Canes not over strong.

EVERGREEN BLACKBERRY.—(*Rubus laciniatus*,) Willd.

Black Caps.

DOOLITTLE.—Fruit a dark purple; 2 in. in circumference, 9-16 in. diameter; flavor sub-acid; much esteemed for cooking. First bloom, May 22; full bloom, June 3d; first picking, June 30; last picking, July 27; three plants producing 6 lbs 3 oz. Canes quite strong.

NATIVE VARIETY (*Rubus lucodermus*.)—Fruit, quite large; diameter $\frac{5}{8}$ in., circumference $2\frac{1}{2}$ in.; flavor excellent; first picking, July 9th; three plants producing 5 lbs. 3 oz. Canes very strong growing.

SOUHEGAN.—Fruit, quite dark, having a large amount of bloom; diameter, $\frac{5}{8}$ in., circumference, $2\frac{1}{2}$ in.; quite a pleasant flavor; firm; first bloom, May 23; full bloom, June 2; first ripe fruit, June 26; last picking, July 25; three plants producing 10 lbs. Canes very strong.

JAPAN WINEBERRY.—Fruit dark red; diameter $\frac{5}{8}$ in.; circumference $2\frac{1}{8}$ in.; first bloom, July 16; first picking, July 30; last picking, Aug. 22; three plants producing 7 lbs.; the calyx is covered with a glutinous substance. Canes are set very thickly with small dark red spines.

Cherry or Pear Slug, (*Selandria cerasi*.—Peck.)

On July 4th, the slug commenced to attack the Pear and Cherry trees. They were found in greater numbers on the latter. The trees were liberally dusted with air-slacked lime. It was thrown from the hand into the trees, the operator taking care to stand to the windward side, so that the lime might be better distributed among the branches.

The slugs being naturally moist the lime readily adheres to them, and the smallest particle seemed to make them commence to curl up, and to cause them to fall to the ground.

As an experiment, earth dust was used on a few trees. Two days after these applications, the orchard was inspected. It was found that trees that were treated with the lime were comparatively free from the slugs, while those receiving the application of earth dust were badly infested.

The lime should be applied early in the morning before the dew is off. After the treatment the trees put on a very healthy appearance.

NOTES ON VEGETABLES.

A number of novelties, and standard varieties of vegetable seed were received from Atlee, Burpee & Co.; also from Posson & Son, for the purpose of comparing them upon our Experiment ground. These plats have been heavily fertilized with stable manure so that the soil has become better suited to this work.

Peas.

RENOWN (Burpee.)—Vine, medium strength; 2 to $2\frac{1}{2}$ feet high; slightly branched; color, dark green; leaflets 4 to 6; good quality; evenly filled. Pods $3\frac{1}{4} \times \frac{5}{8}$.

ECHO (Burpee.)—Vines of medium growth, 2 to $2\frac{1}{2}$ feet high; 4 leaflets; color, dark green; paired; pod $3\frac{3}{4} \times \frac{7}{8}$; number of peas in pod, 5 to 6, well filled and of excellent quality.

VICK'S PERFECTION (Bowen.)—Vines strong, 2 to $2\frac{1}{2}$ feet high; not

branching; color dark green; leaflets 4 to 6. Pods paired; 5 to 8 peas in a pod; $2\frac{1}{2} \times \frac{1}{2}$ in.

BLUE PETER (Posson.)—Vines 10 to 12 in. high; strong growth; early, prolific; color dark green. Pods $3 \times \frac{5}{8}$ in.

EARLIEST OF ALL (Bowen.)—Vines make a slender growth, 16 to 24 in. high; Color light green; leaflets 4; 3 to 6 peas in a pod, $2\frac{1}{2} \times \frac{1}{2}$. An early variety.

Radishes.

GOLDEN DRESDEN.—A new variety, introduced by Atlee, Burpee, & Co. Philadelphia. Seed was sown in open ground April 23d.; marketable maturity, May 24; thirty-two days from time of sowing; producing large well formed roots; color, light golden brown; flesh quite white and crisp; of good flavor; a valuable addition to the long list of varieties.

NEW IMPERIAL FRENCH BREAKFAST RADISH (Burpee.)—Seed sown in open ground April 23; producing very attractive roots; red tipped with white; olive shape; tender and crisp; an excellent early variety.

Corn.

EARLY FORDHOOK SWEET CORN (Burpee.)—A very early, dwarf growing variety; quite productive; maturing from three to four medium sized ears to the stalk; is of the finest quality; a valuable early variety; maturing five days in advance of Cory; height 3 to 4 feet.

Lettuce.

ICE-BERG (Burpee.)—A quick growing variety, producing large solid heads; crisp and tender; stands a long time before going to seed; good quality.

FERRY'S EARLY PRIZE HEAD (Posson.)—This variety produced well during the summer; head quite large, the tips of the leaves changing to a bronze color; quite tender and crisp; average weight of head 11 oz.

BIG BOSTON (Henderson.)—A variety resembling Boston Market, with the exception that it grows larger in size; six to eight days later in maturing; head weighing from 8 oz. to $1\frac{1}{4}$ lb.; medium quality, good for market purposes

NEW CELERY LETTUCE, Trianon, (Henderson,) Syn; Paris white Cos.—Large pale green leaves which fold over at the top so that they close over and blanch without tying; heart very white and crisp; excellent quality; continued growing longer than any other variety on the grounds. It proved to be one of the best summer varieties grown here the past season.

NEW WHITE GIANT, COS (Burpee.)—Resembling the above; is strong growing; standing a long time before going to seed; produces large white hearts; tender, crisp and of good quality.

WHEELERS TOM THUMB (Burpee.)—Forms a small hard head; produces but few outer leaves; can be planted much closer than other varieties; excellent quality; quite hardy in the Willamette Valley; can be highly recommended for planting out in the fall for early spring use.

EARLY WHITE SELF-FOLDING (Posson) Syn.—Paris white.

PRICKLY SPINACH (Posson.)—A variety for autumn sowing; and may be readily distinguished by its seeds being quite prickly; it is much harder

than the round or summer spinach. If sown the middle of August, the plants will produce frequent gatherings all through the Winter months and early Spring. The soil should be well drained for the production of Winter spinach.

Victoria Spinach (Burpee.)—A strong growing and productive variety; remaining in season a long time, leaves quite large; good quality,

BLOOMSDALE SPINACH (U. S. Dept. Agri.)—Made a good growth; remaining in use but a short time; went to seed early; marketable maturity, July 6th; ripening seed, Aug. 10.

Beans.

EXTRA EARLY REFUGE (Posson.)—Vines 8 to 10 in. high, erect; bushy; pink bloom; pods 3 to 4½ in. long, ⅜ in. wide; color green, with a few purple specks; leaves medium size; two to four beans in a pod, not filled to the end.

GOLDEN WAX (Posson.)—Vines 10 to 12 inches high; strong, erect; dark green; leaves medium in size; flower white; pods yellow; 3 to 4½ in. long, ½ in. broad, flat; 3 to 5 beans in a pod; very prolific.

GOLDEN CHAMPION (Posson.)—Pole; vine of medium strength; leaves light green; flowers pink; pods 4 to 6 in. long, ⅜ in. wide; roundish; string slightly developed; prolific,

SPECKLED WAX (Posson.)—Plant 6 to 10 in. high, erect; leaves small, light green tinged with yellow; flowers pink; pods 3 to 5 in. long, ½ in. broad; yellow, spotted with red; slightly curved; 3 to 5 beans in a pod; first picking July 25th.

BURPEES BUSH LIMA (Burpee.)—Plant, 10 to 14 in. high, of medium strength; leaves medium size; flowers white; pod 3 to 5 in. long, 1 to 1½ in. broad; one to three beans in a pod; of excellent quality.

BURPEE'S NEW STRINGLESS GREEN POD BUSH LIMA (Burpee.)—Plant 10 to 12 in. high, erect, leaves medium size; flower white; Pods 3½ to 5 in. long ½ in. broad; producing from 2 to 5 beans in a pod; color green; without strings; prolific; maturing July 17th.

WILLOW LEAF LIMA (Burpee.)—Vine strong growing, 5 to 7 feet high; flower white; prolific, season late; pods 3 to 3½ in. long, ⅝ wide; producing from 3 to 5 beans in a pod.

HORTICULTURAL LIMA (Posson.)—Pole; leaves large, dark green; flowers white; pods 4 to 5 in. long, ⅝ broad, splashed with red when nearing maturity; 3 to 6 beans in a pod.

EARLY BLACK LIMA (Burpee.)—Pole; 4 to 7 feet high, of medium strength; season late, prolific; flowers white; pods 2½ to 3½ in. long, ¾ wide; 2 to 3 beans in a pod.

SOUTHERN PROLIFIC (Bowen.)—Pole, 6 to 8 feet high; pods borne in clusters; very prolific, valuable late variety; producing pods of the best quality until cut by frost.

Cauliflower.

BURPEE'S EARLY CAULIFLOWER (Burpee.)—Plants make a compact growth; heads are well protected; producing compact solid heads of excellent quality; quite white; stem short; matures early.

VEITCHES AUTUMN GIANT (Henderson.)—Heads large, compact; white,

good quality. It is undoubtedly the best autumn cauliflower yet introduced for this locality for winter use. If sown the last week in April or the first week in May, and planted in well manured ground it will begin to mature the last week in October, and continue to do so through Nov., Dec., and Jan., should the weather permit. It has been grown on the Station grounds six years often producing heads from 8 to 9 lbs. in weight.

Pumpkins.

FORDHOOK (Burpee.)—A strong and rapid growing variety of the best quality; prolific; light lemon yellow; good keeper; excellent flavor; skin very thin; highly esteemed for table use during the winter and late fall.

PUMPKIN SWEET SUGAR (U. S. Dept. Agri.)—Strong growing vines; producing large fruit; when young is mottled over with grey spots; ribbed similar to the musk-melon; of fair quality.

Donations in 1894.

Received of Atlee, Burpee & Co., Philadelphia, 7 pkts. Pansy's, 8 pkts. Sweet Peas, 2 pkts. Mignonette, and one pkt. each of the following: Calliopsis, Dianthus, Coleus sunset strain, Fordhook Balsam, Renown pea, Echo pea, Fordhook squash, Bush Lima bean, Willow-leaf Lima bean, Early Black Lima bean, Early Black Pole bean, Burpee's Bush Lima bean, Burpee's New Stringless bean, New Giant White Cos lettuce, Iceberg lettuce, Wheeler's Tom Thumb lettuce, French Breakfast radish, New Improved French radish, Victoria Spinach, Matchless tomato, White Wonder cucumber, Sure Head cabbage, All Head Early cabbage, Early Fordhook Sweet corn, Burpee's Early Cauliflower, Fordhook Frost Tomato, Early Watermelon.

Received from H. F. French, Corvallis, 1 pkt. each of the following: Victoria onion, Giant White Cos lettuce, New Prizetaker onion.

Received from Northrup, Braslau, Goodwin & Co. 2 pkts. Pansy's, and one pkt. each of the following: Chrysanthemum, Kalamazoo celery, Imperial balsam, Imperial mixed balsam.

Received from J. Briggs, Albany, Linn Co., Or.: collection of Box trees, collection of Roses, 1 doz. Horse-chesnuts, $\frac{1}{2}$ doz. Pyracantha, $\frac{1}{2}$ doz. Cydonia Japonica, 4 doz. Laburnums, Collection of Gladiolus bulbs, Tulip bulbs and Hyacinth.

The following varieties of cions were received from the New York Experiment Station, Geneva N. Y.

APPLES.—Acuba-leaf, Alexander, Buckingham, Chenango Strawberry, Cooper's Market, Count Orloff, Fallawater, Golden Sweet, Grand Sultan, Hubbardston Nonesuch, Jeffries, Ohio, Peck's Pleasant, Pewaukee, Washington Royal, William's Favorite, York Imperial, Longfield, Pumpkin Sweet, Jersey Sweeting.

CRABS.—Blood Red, Chicago, Coral, Lady, Paul's Imperial, Pitca Striata Red Siberian.

CHERRIES.—Aburn Duke, Cleveland Bigarreau, Rostraver, Schmidt, Windsor, Downer late.

PEARS.—Bordeaux, Bose, Boussock, Brandywine, Danas Hovey, Easter Beurre, Gans, Gifford, Hosenschenck, Late Bartlett, Lawson, Superfine.

PLUMS.—Burbank, Early Red, Field, Forest Garden, French Damson, Free Stone Damson, Sweet Damson, King of Damsons, Garfield, General Hand, Guis, Grand Duke, Lincoln, Ogon, Prince of Wales, Wild Goose, Wolf.

April 18, 1935

Oregon Agricultural Experiment Station.

Bulletin No. 35. - March, 1895.

Agricultural Department.

I. FORAGE PLANTS.--(a.) Clover. (b.) Vetches.
(c.) Flat Pea. (d.) Corn.

II. PIG FEEDING.

The Bulletins of this Station are sent free to all residents of Oregon who request them.

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INTRODUCTION.

BY H. T. FRENCH.

As extensive wheat farming gives way to a more intensive system of farming, the attention of farmers will be turned toward better fodder plants, than those found on the farms throughout a large portion of the State.

Stock raising must go along with any system of intensive farming. The coarse products of the farm must be converted into meat and dairy products, and thus returning a large portion of the fertilizing elements to the soil.

At the present time considerable attention is being directed toward the dairy industry, as a source of revenue on the farm. And that a better knowledge of some of the common forage plants may be obtained, the following report is made.

It is an indisputable fact, that many dairy enterprises have met entire failure, because there has not been enough attention given to supplying the stock with suitable food during times of scarcity.

The natural pasture will supply an abundance of food during a portion of the year, although it is many times inferior to the artificial supply, or that which is raised by cultivation. As long as the dairy-men depend upon natural pasturage, they will not make the most of the opportunities that are so richly bestowed throughout a large portion of the state. It is only in the most favored localities that natural pasturage will pay. We hear the early settlers tell of the luxuriant vegetation which covered the hills and valleys during the pioneer days of the State, and some think it strange that the hills can not be induced to renew their verdure, and again be covered with a coat consisting of the native grasses and plants.

The native or wild grasses, which once covered the hills and valleys, have vanished never to appear again. They have gone out with the native red man never to occupy the land again. This fact is proven in the agricultural history of the older portions of this country, and in the countries of the old world. The crops

of to-day, in these localities, are such as have become developed, and domesticated from the wild species found, often in foreign lands. As the imported breeds of stock are superior to native stock, in many cases, so are the grasses and forage plants, coming from foreign soil better adapted to modern agriculture.

It is not our intention to ignore the natural pasture where a variety of nutritious grasses are found. Such a condition is very often a source of profit to the stock raiser, and the dairyman. It becomes too expensive an operation however where land becomes valuable. It requires too much land to support a single animal.

It is not an uncommon sight to see farmers mowing native meadows that do not yield more than one ton of inferior hay per acre. Many of the native pastures do not average a cow to five acres, and some men of authority on the subject put it one cow to ten acres. Oregon has out-grown this method and should take a step upward.

It is the object of this bulletin, to mention some of the forage plants which have been tested on the Experimental grounds, and on the College farm. In all cases, except the flat pea, the plants have been used for several years in a practical way, as well as in certain experiments.

Clover.

The first in the list is clover. Clover is king where it can be grown successfully, and that will include a large portion, if not all of Oregon, west of the Cascade mountains. It has been successfully grown in several parts of Eastern Oregon; but our observations do not cover that portion of the state.

Many native clovers are found widely distributed over the western part of the state, and several of these are valuable for hay and pasturage.

COMMON RED CLOVER, (*Trifolium pratense*.)

This clover needs no description. It is common in several portions of the state, especially in the northern part of the Willamette Valley. It will become much more common, when its merits are more thoroughly known. Clover has been a blessing to many localities in the Eastern States. Without clover, it would be impossible to maintain the fertility of the soil and feed stock

profitably. To remove the clover crop, would be to remove the very foundation of all successful farm operations.

As a fertilizer clover has no equal. It has been termed "the red plumed commander-in-chief of all the manurial forces," but it is not the purpose of this bulletin, to speak of it in this connection, however important it may be.

Red clover has been grown successfully, on the experimental grounds and on the college farm, for the past three years. The raising of clover has ceased to be an experiment with us. The first attempts to get a seeding were not wholly satisfactory, but for the past two years there has been little difficulty in this direction. Several crops of young clover were destroyed by the dry weather of July and August. In these cases the seed was sown in the spring, upon fall wheat. Many farmers are successful in seeding to clover in this way; but our soil is not in sufficient good tilth, to warrant a catch when this plan is followed. Later, after several crops of clover have been grown it may be possible to obtain a stand in this way. When the ground becomes more open and porous the young plants will make sufficient growth to withstand the drouth of the following summer.

The best results have been obtained by sowing in the fall before the rains begin. The land, where clover is to be grown, is plowed in the winter or spring, and thoroughly summer-fallowed by cultivating several times during the summer. In this way the weeds will be destroyed. As the seeding time approaches, the surface is worked as fine as possible, and the seed is sown in September, at the rate of 10 pounds per acre. It is a good plan to mix six pounds each of Orchard grass and Tall Oat grass with the clover. Sometimes we use two quarts of timothy seed in the mixture. The Orchard grass and Oat grass, help to hold the clover up later on, and they mature at the same time as clover making very good hay,

Some experimenters claim that Tall Oat grass is not readily eaten by stock, but we have not had such an experience. Stock are very fond of it, when mixed with clover. Orchard grass is a very valuable grass when cut before it becomes too ripe. Mr. I. A. Cole says of this grass, "After twenty years experience I have settled down upon Orchard grass as possessing greater merits than any other for both the pasture and meadow for fattening animals or for the dairy stock. When cut for hay, just before

its bloom and cured with as little sun as possible, it will make more milk than any other variety known to me."

The timothy does not mature as soon as the clover; but it will add something, and help to make a variety which is an advantage in any hay.

The advantage of sowing the clover in the fall, without a crop of grain is that, if the winter is not too severe, a good crop of hay may be cut the first season; and there is no danger of the plants being killed by the dry weather during the following summer. If the seed is sown at all in the spring, the best plan is to sow a mixture of grasses and clovers, without any other crop. If grain is sown with the grass seed there is danger of the stronger growing grain plants taking all the moisture away from the clover and grass, so that when the grain is cut, the grass and clover will be burned out by the extreme heat to which they are exposed.

GYPSUM AS A FERTILIZER FOR CLOVER.

Gypsum has been found highly beneficial to clover. In experiments carried on for two succeeding years on small plats, the yield was increased, by using gypsum, from 20 per cent to 200 per cent over the yield from plats where no fertilizer was used. The great difference in increase was due to the variations in time of sowing the fertilizer. When sown on clover late in the season, very little effect was noticed. The best results were obtained, when the fertilizer was sown prior to March 15th. There must be plenty of moisture to take it into the soil, and thus render it available for the use of plants. It must be brought in contact with other substances in the soil also, before the best results will be realized.

It is used on the College farm at the rate of 75 to 100 pounds per acre, applied in fall or early winter, after the clover is seeded. The second year it may be applied later in the season, say in January or February.

YIELD OF CLOVER HAY.

The yields of clover hay obtained on the experimental grounds, and on the farm, are very flattering indeed. In 1893, a twenty acre field yielded 69 tons, by actual weight. The same field, in 1894, yielded 60 tons. This is from one cutting. The second crop is usually well filled with seed; but we have never made any attempt to save it, from the fact that there are no machines for cleaning the seed in this part of the state. Threshing ma-

chines are sometimes used, but no one seems to know how to operate them for this purpose.

MAKING CLOVER HAY.

In making clover hay some pains must be taken to prevent a serious loss. The leaves of the clover will dry much quicker than the stems; and if the hay lies spread on the ground until the stem is dry, the leaves will be lost. The best plan is to rake it up just as soon as it is thoroughly wilted, and put it up in not too large piles, where it will cure in good weather, in from 24 to 36 hours. It is not a good plan to let it stand too long before hauling it into the barn. It may be a little tough, and apparently too wet to keep in the mow; but if there is no rain or dew on it, it will suffer no harm if packed closely in the hay mow. Do not throw open the barn doors to let in air. Keep the air away from it, and there will be no white mould or musty hay when removed. The theory of throwing open the barn doors, to admit air to the hay has long since been exploded. It is no longer practiced by modern hay makers. Some farmers salt the hay in the mow. We do not, we prefer to salt the stock by hand as often as desirable.

KIND OF SOIL FOR CLOVER.

While a calcareous soil is best adapted to the growth of clover, it will grow upon a soil which has a comparatively scanty supply of lime. Clay loam seems to favor its best development. There seems to be lime enough, in either the white land or the dark soil of the Willamette valley, for its development. We have grown it on both these soils with great success.

It requires considerable potash; but this is found in most soils in sufficient abundance, especially if gypsum is present to assist in setting the potash free.

The white land, where water does not stand on the surface too long, produces large crops of clover. Better results are obtained however when such land is tile drained.

CLOVER FOR GREEN FEED AND FOR SILAGE.

Clover makes good silage, when properly managed. It can not be handled as easily as corn, from the fact that it will not pack as closely in the silo. It is more difficult to exclude the air. It must be very green when cut for silage, and it is better to run it through a feed cutter the same as corn. We have had a very good sample of clover silage made from whole clover; but there

was considerable loss about the walls, and in the corners of the silo. Water is sometimes put into the silo with the clover, so that it will pack more closely and keep more moist. Our silo was filled during rainy weather, hence there was no need of adding more water. The water ran from the loads as they were drawn into the barn. There is one advantage in placing it in the silo and that is, the rainy weather does not interfere with the work. Sometimes the wet weather continues so late, that the clover gets too ripe to make good hay. If you have a silo it can be cut any time you wish.

As a soiling crop, or cutting for green feed, clover is one of the most valuable crops grown. It is ready to cut May 1st., and will keep green, in favorable seasons, until July. The crop keeps green much longer here than in the Eastern states, where there is more dry weather at this season of the year.

INSECT PESTS.

Only a few reports of insect pests attacking clover have been reported to the Station. The clover root borer has done some damage in some portions of the Willamette Valley; but its depredations have not been serious. The clover mite is also here, but has not done any special damage as far as known.

The pocket gopher is the most annoying pest we have to contend with. In two or three years, they will establish themselves very thoroughly in a clover field, and do considerable damage. Besides eating the roots of the plants, they throw up mounds of earth which hinder the mowing machine. These pests can be poisoned in the winter by placing in their burrows pieces of potato, which have been charged with strychnine. The most efficient remedy tried so far however, is a shovel. small dog and man, when the ground is full of water as it is many times in the winter. The high water table drives the gophers near the surface, the dog will scent them, and with a little help will soon bring them to the surface. In this way over sixty were destroyed in one field in a few hours. This will only work in localities where the soil fills with water.

ALSIKE CLOVER (*Trifolium hybridum*.)

Many questions have been asked regarding this clover, hence we will make a few remarks upon its growth, as noted on our experimental grounds and on the farm.

This clover is intermediate between the red and white in

appearance. It matures later than the red, and, in this locality, this feature is a marked advantage. The first crop is so late, in maturing that it will not make a second growth. It is better adapted to low lands than the red clover. In our experiments it has done well on the white land. We would not recommend its use, except in mixtures with other clovers and grasses.

MAMMOTH CLOVER (*Trifolium medium*).

The same objection to alsike clover, will hold good with this. The clover resembles the common red except it is later to mature, and its leaves and stems are covered with a woolly substance which makes the hay too dusty for horses. For pasturage the plant has some advantages, making a stronger growth than the common red. This fact is not so important in the clay loam soil of the valley; for such soil will produce sufficient growth of the smaller varieties. For a light sandy soil the mammoth has some advantages over the less vigorous varieties.

WHITE CLOVER (*Trifolium repens*.)

This is valuable for pasturage, and is found in most localities of the state in considerable abundance. It is a good plan to sow white clover in a mixture for pasture, especially on new land or low wet lands. It makes a good sod, and furnishes considerable forage.

CRIMSON CLOVER (*Trifolium incarnatum*.)

Much interest is manifested in regard to this clover, and from plat experiments the writer is led to believe that it will be a success in a large portion of the Willamette valley, and along the coast where the winters are not so severe. It has been grown in plats two years, making a good yield. This season we have two acres on the farm for a more thorough trial. Our climate is very similar to that of other portions of the United States, where it has been such a marked success.

If sown in September, on carefully prepared land, a full crop of two or three tons of hay per acre, can be cut the following season. It will not last as long as common red clover. One crop is about all that will pay from one seeding. The second crop is very light.

Vetch or Fares.

This is a leguminous plant, which has been used for a long time as green food for stock. It has not been fed as extensively in this country as in the European countries. In France and England, the vetch has been grown for stock food, for many years, and forms an important factor in furnishing forage for stock.

There are several species which are found growing wild in Oregon. Some of these furnish valuable pasturage, and others are considered as pests, especially in grain fields. The question has been asked very often, if this domesticated vetch will not become a pest, and thus do more harm than good. It is the opinion of the writer that it will not, any more than tame clover will become a pest. It is an annual, or in other words grows from the seed every year, hence there is little danger of it becoming troublesome, if the farmer is reasonably careful.

This plant resembles the wild pea, which is found in such abundance in the mountain ranges, especially in the coast range. It does not belong to the same genus however, but is closely related. There is a spring variety which is grown in the Eastern States, and in Canada, with more or less success. The variety that we are discussing is called a winter vetch; but it will mature when sown as late in the spring as April; if sown at that time the crop will mature in August or September. The most common practice is to sow the seed in the fall or winter, and then the crop will be ready to begin cutting for green feed in April or May.

The plant grows best on an open rich soil. It has been grown very successfully on the red hill land of the coast mountains, and it promises to become a very valuable forage plant for such localities. One and one-half bushels of seed is sufficient for one acre. It is a good plan to mix $\frac{1}{4}$ bushel of wheat or rye with the seed to hold up the plant when growing. It will make four or five feet, and often more growth, in one season. If there is no grain with it, the vines will fall over thus making it difficult to harvest.

We have found it valuable for all kinds of stock. It has been fed to horses, cattle, and pigs with the greatest satisfaction. For horses it has been cut and fed green, during the summer, with very flattering results. One farmer, whom we furnished

some seed for trial, said that he had never had his horses do so well, during the working season, as when they were fed the green vetch. Some grain should be fed with it, although in the case mentioned no grain was used. As a green forage for cattle, especially dairy stock, it has given the utmost satisfaction. It is greedily eaten, and furnishes a highly nutritive ration.

It has been used for silage on several farms in the valley, and has given satisfaction, when properly put up. It does not keep in the silo quite as well as corn. It is more difficult to pack it closely enough to exclude the air.

The yield per acre will not ordinarily equal that of corn; yet at the Station, we have secured 19 tons per acre at one cutting. This was on good strong soil; but without any special culture.

As a food for pigs, it has been highly satisfactory. Some experiments were conducted in 1894, to determine its value for this purpose. The results will be found under pig feeding experiments. As a crop for hay, only a partial report can be made. During the summer of 1894 several loads of vetch hay was made for the purpose of testing its value when dry as, compared with clover. The vetch was cut with a mowing machine, when in full bloom, and cured with the same precautions taken, as in curing clover. The hay resembles alfalfa when dry, so much so that several people mistook the material for alfalfa. Experiments are now going on in testing its value as compared with clover. So far we can only say that the dairy stock, and steers which are being fattened are exceedingly fond of the hay. They seem to prefer it to good clover hay. The results of the experiments will be published later.

In procuring seed, we have always let the first crop mature; but if the first cutting is made early, say in April or May, the second crop will produce an abundance of seed. In saving seed, great care should be used to handle the material while damp, for the seed shatters out very easily. If the pods get wet, and the sun dries them again, they will burst open, and the seed will be lost. On this account it is better to let it cure in small piles, and thereby less material will be exposed to the sun and dew. The seed can be threshed with the ordinary threshing machine, although it is rather slow, and some care must be taken not to cut the seed too much.

In conclusion we would say that, from experiments carried out on the Station farm, both in a practical way, and as mere experiments, the vetch is a valuable forage plant for a large

portion of Oregon. The climatic conditions, and the soil seems to be very well adapted to its growth; and the needs of the farmer demand just such a plant as this proves to be.

Flat Pea (*Lathyrus sylvestris*.)

This somewhat noted forage plant is being tested on the experiment grounds, first to determine whether it is adapted to our soil and climate, and later to determine its food value. The first question is pretty well settled; for it found that, after two years trial it grows very luxuriantly. It starts slowly at first making 8 to 10 inches growth the first year, and the second year 4 to 5 feet. It roots very deeply, thus being enabled to withstand the drought with impunity. The dry weather of July and August, serves only to make it grow the faster. The vines will stand considerable frost, and are said to be valuable for food, even after the frost has killed them.

The plant is a perennial, the roots standing an unlimited time when once thoroughly started. The wild plants, from which this was developed have stood, it is said, for 60 years without renewing. The young plants should be cultivated to keep the weeds down during the first year; after that they will take care of themselves. On this account the seed is sown in drills two or three feet apart, and if the soil is rich, the more rapidly the plants will get beyond injury from weeds.

The chemical composition of the flat pea vine is similar to that of clover hay. It can be cut several times during the season, and fed green, or be made into hay. The following report, regarding this plant was made by the Director of the Michigan Experiment Station, in 1893:

July, 1893.—“Those who have walked through the station field since the first of June, cannot fail to have noted the very luxuriant and beautiful plat of more than an acre in extent of the new forage plant *Lathyrus Sylvestris*. It started early in the spring, every root having endured the severe cold of winter without injury. The tops were uninjured last fall by the severe frosts. They did not stop growing until heavy freezing came. Indeed, where there was quite a covering of tops and the snow fell early and remained on the ground, those sprouts on the under side at the surface of the ground were not killed by the freezing of winter, but remained green until the plants began their new growth this spring. The whole field started early and made a green and beautiful appearance. Then came on a long spell of cold and windy weather, which kept everything back,

hence it was not until late that the plants got down to work. Since then it has let itself loose, so to say, and grown in a reckless but determined fashion. Every root sent out numerous shoots that spread away on every side until the ground was covered with a dense mass. Then it began to climb up. The tendrils of one shoot caught on to all the neighboring shoots, and by June there was a deep garment of verdure more than three feet in depth, which yielded at the rate of sixteen tons of green forage per acre. Cured it made at the rate of four tons of choice hay per acre. The forage is eaten eagerly by all kinds of farm stock. Not only does it enrich the soil, but it is able to flourish on very poor soil. Our flat peas were sown on the most sandy soil of our farm. When one sees the freshly dug plant, with its hundreds of tubercles, he feels sure that if any plant can enrich the soil this one can."

Whether the plant will give such flattering results here remains to be seen. We are in hopes, that it will be sufficiently hardy, to maintain itself on the hill land; and thus a large area of now almost barren land will be made productive, for pasturing purposes.

The seed of this plant can be obtained of nearly all seed dealers, and the price is fast coming within the reach of all who wish to give the plant a trial. When first introduced into this country, four or five years ago, the seed sold for ten dollars per pound. We were able to gather our first seed last season, and this we will use in extending the experiments.

Corn.

In discussing corn as a forage plant we shall reaffirm what we have said in former bulletins, regarding the value of this crop to the farmers of Oregon.

There is a quite common expression, often heard at Farmers' Institutes, and in private inquiries, that corn cannot be profitably grown in the Willamette Valley. After five years of trial, during which time the crop has not failed to make a profitable yield, we are fully prepared to recommend the crop, as one which the farmer can at least well afford to test.

That the Willamette valley will ever become a corn country, like Iowa, Kansas, and Missouri, can not be expected, for the climate conditions are not suitable to that extent.

In stepping aside from the subject of corn as a forage plant permit me to say, that the Experiment Station, has been able to grow several varieties which produce as hard, well matured corn, as ever grew in the great corn states. But this is only true of the earliest varieties, such as the King Philip, a yellow flint variety, Minnesota King and Early Mastodon, both of which are yellow dent varieties. There are other varieties, no doubt, that

PLATE I.

will ripen here, but these we have tested and find well adapted to the climatic conditions.

Nearly every farmer could use an acre or two of mature corn in the fall, in feeding pigs at the beginning of the fattening period. These varieties would be valuable also for green food, for the more grain there is with the stalks the better the feed. The later varieties, which will do for silage, are too late for early feeding, if the best results are obtained. Green slushy corn stalks, with no grain formed, does not compare in food value with more mature corn. It has been our practice for the past four years, to grow corn on the summer fallow, and the results are very satisfactory indeed. The larger portion of the corn is placed in the silo, but some of it is cut for stock during the fall. As soon as the corn is removed, the ground is ready for the grain drill, or can be made so by passing over it lightly with the harrow.

After testing some thirty varieties, the Pride of the North seems to give the best satisfaction. It is medium early and produces an ear on every stalk, and a fair yield of stalk and leaf. On the dark land, bordering on the white land, there is no difficulty in securing a yield of ten to twelve tons per acre without the aid of fertilizers. On a clover sod this yield has been increased considerably.

By storing corn in the silo, it can be used nearly, if not quite, the entire year. It has constituted the chief fodder substance at the Station, in several instances from November to July, keeping the animals in a thrifty condition. From accounts which have been kept, it has been ascertained that the corn can be grown, including labor, seed and cost of harvesting, for one dollar per ton. Many claim to have grown it much cheaper than this. It takes three tons of corn silage to equal a ton of the best clover hay, according to its chemical analysis; but in feeding the material, it may be possible to get much better results than the chemist is able to show. It is not our purpose to enter into discussion of silos at this time; but in answer to many inquiries let me say a silo can be built much cheaper here than in the extreme cold climates. Only a single tight wall is needed here, while a double wall is necessary where a zero temperature prevails during a portion of the winter.

The varieties of corn shown in cuts are No. 0, King Philip; No. 1, Forsyth's; No. 2, Bristol's 100 day; No. 3, Minn. King; No. 4, Pride of the North, and No. 5, Huron Pure Yellow Dent. No. 3 and 5 are the earliest. These reached complete maturity making sound corn. No. 4 comes next and is the best corn for silage. No. 1 and 2 do not mature sufficiently to make a good silage corn. No. 2 shows that the name of a variety may be very misleading. This corn will not mature in 100 days in this climate.

PLATE II.

PIG FEEDING.

The experiments in pig feeding reported in this bulletin were carried on with two objects in view, viz: to repeat a former experiment, in testing the value of a mixture, as compared with a single feed; and the other to determine whether it were possible to keep pigs profitably, in pens where they would require a constant ration of grain. In discussing the subject of early maturity, the question is always asked: "does it pay" to force pigs in close quarters during their life-time. In the effort to throw some light upon these questions a litter of eight pigs was selected and the work begun. The pigs were about $\frac{7}{8}$ Berkshire, but not an exceptionally good lot. They were farrowed Feb. 16, 1894. The pigs were weaned May 1st, and up to June 1st, when the weights began, they were fed on shorts and water, with some slop from the boarding hall. They were fed on the food mentioned above while running with the sow. June 1st, the feed was weighed to them, and the pigs were weighed in a group, as seen in the table. At the beginning they weighed 328 lbs., and gained 128 lbs. the first month, or a trifle over $\frac{1}{2}$ lb. each per day. During this period, the pigs were turned on a patch of vetches, and were fed a pound of shorts each per day, and all the water they wanted. The yard contained 17 sq. rods of vetches. They were not given the entire yard at once, but by means of a portable fence. the yard was extended so as to keep the vetches as fresh as possible. During the next period, from July 1st to 28th, the lot gained 190 lbs., or a total gain of 318 lbs. Total amount of grain consumed, 984 lbs., or one pound of gain to 3.1 lbs. of grain. During this latter period, the pigs were fed on vetches which were cut, and given to them twice daily. There is less waste when fed in this way. In the two months, from June 1st to July 28th, the pigs ate the vetches from 30 sq. rods of ground, or a trifle less than one-fifth of an acre. Pigs are very fond of the vetch. They would very often leave their grain for the vetch. July 28th, the vetch became too dry to use, and the pigs were fed from that time till October, on shorts and water. From July 28th to August 24th, the pigs gained 117 $\frac{1}{2}$ lbs., quite a falling off due, no doubt to taking them away from the green feed. From August 24th to October

PLATE III.

1st, the pigs gained $227\frac{1}{2}$ lbs, making a total gain, after taking off the green feed, July 28th, to October 1st, of 345 lbs. They consumed 1253 pounds of shorts, during this period, or a pound of gain was made to every 3.63 pounds of grain. This is $\frac{1}{2}$ lb. more of grain, to make a pound gain, than when fed on vetches. While the pigs did not make such rapid gains on the vetch, they made a good growth. The average daily gain, while feeding on the vetches was .68 of a pound. These figures are not as large as we might expect, but it is much better than to barely keep up animal existence.

From May to August is a critical time with the pigs on the farms where so little clover is grown. The pigs are taken off the wheat pasture in the spring, and as a general thing are compelled to roam over scanty pastures until the stubble fields are ready for them. During this interval, the pig is likely to lose, rather than gain in weight, hence the importance of having some green food suitable for them. A good clover pasture cannot be excelled, but in many portions of Oregon, the farmer has not learned how to grow clover, and, until he does become master of the situation, some other plant must be substituted. No other plant seems to come as near clover as the vetch. We would recommend cutting it, and feeding in pens, rather than to use it for pasturage.

FATTENING PERIOD.

The pigs were divided into two lots, October first, and the second experiment began, viz: that of testing chopped wheat alone as compared with a mixture of grains.

Lot No. 1 was fed clean chopped wheat and water. The feed was weighed and placed in a pail with water, and allowed to stand from one feed to the next. A little salt was added to each feed. The pigs were fed at 8 o'clock in the morning, and five at evening. Charcoal and ashes were kept before the pigs all the time. They were permitted the run of a small yard, connected with the pen, except when it became too muddy. There is nothing gained by compelling, or permitting, pigs to wallow in mud, however much they seem to enjoy it.

The importance of feeding pigs from troughs, needs to be

PLATE IV.

emphasized. It is too often the case that, the pigs are required to pick up the grain out of a perfect slough of mud. The pig may do fairly well; but it is not economy to feed pigs whole grain strewn on the ground, especially wheat or oats. In feeding corn on the cob there is not so much loss, but even then it is not the most economical method. Only a few dollars are necessary to provide troughs and a floor, on which to feed the pigs. The Oregon farmer has not realized the need of barns and pig pens, but as he is compelled to grow more pork, and make more butter, as a source of revenue on the farm, this need will become more apparent.

Lot No. II received the same treatment as lot I, except in the kind of food. This lot was fed on a mixture of two parts chopped wheat, one part shorts, and one part chopped oats, determined by weight. This was continued to Jan. 4th when the oats were withheld.

RESULTS.

By consulting the tables it will be seen that lot II made 752 lbs. or an average daily gain of 1.7 pounds each. Lot I gained 646 lbs or an average daily gain of 1.46 pounds. The pigs fed on the mixture, ate 156 lbs. more of grain than those fed on chopped wheat alone. The shorts fed to lot II was a little cheaper than chopped wheat, hence the cost of producing a pound of pork, was a little less in this lot than in lot I. The 106 pounds of gain over lot I, also assisted in bringing the cost of production down considerably. It will be noted by referring to the table giving the summary, that a bushel of chopped wheat, 60 lbs., produced 12.9 lbs. of gain in lot I. At 4 cents per lb. gross weight for the pork it would give a return of 51.6 cents per bushel for the wheat. In lot II there was a gain of 14 lbs. for every 60 lbs. of grain consumed. During the second period, table No. 2, there was a marked difference in the amount of food to produce a pound of gain, and consequently in the cost. There is one fact, which we have noticed in former reports, and that is the increased use of grain to make a pound of gain as the pigs near the finishing point, or maturity.

Tables showing results by periods of four weeks each.

TABLE 1.—FIRST PERIOD.

No. of Pig.....	Chopped wheat Pen No. 1.				Mixture wheat, oats, and shorts. Pen No. 2.			
	1	2	3	4	1	2	3	4
Date of weighing.....	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
October 1st.....	128	95	112	159	139	111	110	139
October 15th.....	154	115	135	178	172	135	134	166
October 29th.....	173½	137	150	219½	197	161	157	188½
Individual gain.....	45½	42	38	60½	58	50	47	49½
Total gain.....	186 lbs.				204½ lbs.			
Food consumed.....	723¾ lbs.				727½ lbs.			
Food for one lb. of gain.....	3.89				3.55			
Cost of one lb. gain.....	2.53 cents.				2.30 cents.			

TABLE NO. 2.—SECOND PERIOD.

No. of Pig.....								
	1	2	3	4	1	2	3	4
Date of weighing.....	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
October 29th.....	173½	137	150	219½	197	161	157	188½
November 12th.....	197	162	171½	240	223	184	183	203
November 26th.....	216	178	191	270	255	219	212	246
Individual gain.....	42½	41	41	50½	58	58	55	57½
Total gain.....	175 lbs.				228½ lbs.			
Food consumed.....	850 lbs.				905½ lbs.			
Food for one lb. gain.....	4.86				3.96			
Cost of one lb. gain.....	3.17 cents.				2.56 cents.			

TABLE NO. 3.—THIRD PERIOD.

No. of Pig.....								
	1	2	3	4	1	2	3	4
Date of weighing.....	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
November 26th.....	21	178	191	270	255	219	212	246
December 10th.....	233½	193½	211	297	281	241½	236½	274
December 24th.....	257	215½	237½	326	309½	265	260	302½
Individual gain.....	41	37½	46½	56	54½	46	48	56½
Total gain.....	181 lbs.				205 lbs.			
Food consumed.....	857½ lbs.				997½ lbs.			
Food for one lb. gain.....	4.74				4.86			
Cost of one lb. gain.....	3.08 cents.				3.14 cents.			

TABLE NO. 4.—FOURTH PERIOD, OR 25 DAYS.

No. of Pig.....								
	1	2	3	4	1	2	3	4
December 24th.....	257	215½	237½	326	309½	265	260	302½
January 7th.....	280	228	263	351	338	285	275	325
January 18th.....	281	236½	265½	357	340	294	285	332
Individual gain.....	24	21	28	31	30½	29	25	29½
Total gain.....	104 lbs.				114 lbs.			
Food consumed.....	621 lbs.				579½ lbs.			
Food for one lb. gain.....	5.97				5.08			
Cost of one lb. gain.....	3.97 cents.				3.22 cents.			

TABLE NO. 5.—SUMMARY.

	No. of Pig.	Wt. Oct. 1 '94.	Wt. Jan. 18 '95.	Total gain.	Gain per day.	Average daily gain.	Total food consumed.	Amount of food for lb. of gain.	Cost of food for lb. of gain.
		lbs.	lbs.	lbs.	lbs.				
Lot 1 chopped wheat.	1	128	281	153	1.39				
	2	95	236½	141½	1.28				
	3	112	265½	153½	1.39	bs.	lbs.		cents.
	4	159	357	198	1.80	1.46	3052	4.72	3.07*
Lot 2, mixture chopped wheat, oats, & shorts.	1	139	340	201	182				
	2	111	294	183	166				
	3	110	285	175	159				
	4	139	332	193	175	1.70	3210	4.28	2.80*

*Chopped wheat 65 cents per cwt.: Oats 69 cents, and shorts 60 cents.

TABLE NO. 6, SHOWING WEIGHT OF ORGANS, GROSS WEIGHT, DRESSED WEIGHT, AND PER CENT OF SHRINKAGE.

No. of Pig.....	Lot 1, chopped wheat.						Lot 2, mixture chopped wheat, oats, and shorts.					
	1		2		3		1		2		3	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Blood.....	5	4	4	1	4	14	5	5	7	2	5	6
Hair.....	3	4	3	2	3	3	3	8	11	4	11	3
Lungs.....	2	10	1	14	3	1	3	12	3	4	2	14
Heart.....	14		11		11		15		14		12	
Spleen.....	4		3		4		5		6		4	
Liver.....	3	7	3	6	3	4	4	4	7	4	5	5
Kidneys.....		5		8		6		7		7		10
Tongue.....	1		9		12		1	4	13		15	
Intestines.....	22		17		17	8	18	10	17	1	17	19
Fat from Intestines..	7	14	4	6	6	3	9	11	8	13	7	7
Leaf fat.....	12	6	7	4	9	2	13	6	12	12	11	2
Gross weight.....	281		236½		265½		357		340		294	
Dressed weight.....	229½		194¾		219¾		289		284		242	
Per cent shrinkage...	18.5		17.7		17.6		19.		16.4		17.7	
Average per cent shrinkage					18.2						17.2	

If the pigs could have been slaughtered four weeks earlier the results would have been a little more favorable. There is nothing gained by keeping pigs beyond the growing period. When they cease to grow the profitable feeding period has passed. This is a strong point to consider for those who grow the pigs, and then fatten them. From Oct. 1st to 30th, was the most profitable period.

By referring to cuts, page 50, it will be seen that the pigs of lot II were more uniform in size. This was partially true at the beginning, there being one in the lot a few pounds lighter than the others. The pigs fed on wheat alone were much more sluggish in their habits. They did not move about with as much ease as the other lot.

In table showing weight of organs, there is a striking difference in the weight of the livers of the two lots. Lot II ranged from 5 lbs. to 7 lbs 4 oz, while in lot I the range is from 3 lbs. 4 oz, to 4 lbs. 4 oz. The kidneys of pig No. 1, in lot II were abnormally large, weighing 10 oz. They were not healthy, slight wattery tumors being found on them. There was more inside fat, in lot II, than in lot I. Of the intestines there was a greater weight in lot I, than lot II.

The carcasses were weighed, and meat photographed 24 hours after killing. The shrinkage was nearly the same in each lot.

Cuts Nos. 5 and 6 are from lot II, and Nos. 3 and 4 from lot I. The carcasses were cut through the loin, and between the fifth and sixth ribs. Cut No. 1 of carcasses hanging, is from lot I, and No. 2 from lot II.

Credit is due Mr. C. D. Thompson, who had the care of the pigs during the feeding test.

PLATE V.

Oregon Agricultural
Experiment Station.

Bulletin No. 36. - April, 1895.

C H E M I S T R Y .

Composition and Use of Fertilizers

The Bulletins of this Station are sent free to all residents
of Oregon who request them.

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COMPOSITION AND USE OF FERTILIZERS,

BY G. W. SHAW.

In the history of every state there is a time when the soils begin to in licate exhaustion, and this time marks the beginning of the use of commercial fertilizers. This time has now come to Oregon. That this is true is attested by the increasing use of fertilizers by gardeners, orchardists, etc. as well as by the questions sent to the Station, and asked at Institutes. It is always true that these inquiries start with those who are cultivating small plats of land and are working that land intensively. It is also probably true that these people are securing relatively much greater returns from their lands than those who are cultivating a much larger acreage. Until recently it has been the same with Oregon farmers as with those of the older states in years long past. They had little necessity of a knowledge of Agricultural Chemistry to enable them to obtain remunerative crops, but to-day the soil does not always smile when her back is scratched as she did in years agone. The system of farming that obtained in those days, and in most cases still in vogue, might properly be styled "Extensive Farming," and may do well for a time where land is cheap and abundant. The system—if it *is* a system at all—requires large areas, and there is a prominent idea that it is necessary to cultivate more land to obtain a larger crop. In many instances this has been carried to such an extent, without returning any equivalent to the soil for the valuable plant food which has been constantly dipped out, that the farmer has become literally "land poor." It has brought on a condition unsatisfactory to many farmers, a remedy for which condition cannot be obtained in political reform, or legislative enactment, but in a very radical change in the system of farming. The new system requires concentration, and demands more thorough and better cultivation. In short it is "intensive" instead of "extensive." The intensive system does not necessarily require more labor but requires that the labor now employed be more concentrated, and also an intelligent comprehension by the farmer of his entire business, which is probably more multiform than that of any other calling. The manufacturer who refuses to keep abreast of the times and to adopt the modern intensive system is doomed to failure, and this is no truer of the manufacturer than of the farmer who holds to a like principle.

In the "good old times" the soils were quite abundantly supplied with

all the plant food necessary for the crops and the farmer reaped abundant harvests. The time was in the East when it required as little care and thought to raise farm and fruit crops as is now given to such matters by the average farmer of this coast. The farmers in the Eastern States several years ago came to realize the immense robbery they had perpetrated upon their lands, and more recently the horticulturists of the same states have been brought face to face with this fact. An article recently appeared in the "Rural Northwest" from the pen of Prof. W. F. Massey, from which I quote:

"There is no doubt that the many failures in fruit production in the East are largely due to the exhaustion of important elements of plant food in the soil. All farmers realize the importance of keeping up the fertility of the soil for the production of their annual crops of grain and vegetables, but somehow the idea has been prevalent that a tree can take care of itself. Men look at the great trees of the forest and see how they grow and how the soil increases in fertility under their influence, and think that the same should be the result in the growing of fruit trees, while they are carrying off continually, not only the fruit that the orchard produces, but in many cases expect the land also to produce food for their stock. And then when the orchard fails to give the expected fruit, and its decrepit condition makes the trees alike the prey to insects and fungus diseases, they declare that the climate has changed and we can no longer produce crops for that reason. It has really been because they and their fathers have robbed the soil until the needed food for the production of healthy trees and perfect fruit is no longer available."

Recognizing this condition of things it seems important that the farmers of this state should be made acquainted with some of the recognized facts concerning soils and fertilizers, and their relation to plant life and especially the conditions which obtain in our own state. This bulletin aims to give in a brief form some of the more important facts, and will be followed by others dealing with kindred subjects.

FOUNDATION LAWS OF MODERN AGRICULTURE.

(1) "A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants, in the required quantity, and in the proper form."

(2) "With every crop, a portion of these ingredients is removed. A part of this portion is again added from the inexhaustible store of the atmosphere; another part, however, is lost forever, if not replaced."

(3.) The fertility of the soil remains unchanged, if all the ingredients of a crop are given back to the land. Such a restitution is affected by manure."

(4.) "The manure produced in the course of husbandry is not sufficient to maintain permanently the fertility of a farm; it lacks the constituents which are annually exported in the shape of grain, hay, milk and live stock."

It is the science of chemistry which has told us what we know of this subject, and it was not till these facts were determined that agriculture became a science. The improvements that have resulted since the foundation of these principles are marvelous.

SOIL AND PLANT FOOD CONSTITUENTS.

In all nature there are now recognized about 70 elementary substances which are known as

ELEMENTS—*A chemical element is such a substance as cannot be separated into more than one kind of matter.* For example, iron, the smallest conceivable portion of which is just as truly iron as the largest mass.

These elements may be chemically combined in a great variety of ways to form an endless number of *compounds*, which may be defined as *substances consisting of two or more elements chemically combined in definite proportions.* The properties of these compounds differ from those of the elements of which they are composed, and from those of one another. These compounds are called *bases* or *acids* according as they possess certain characteristics.

Of the 70 elements only fourteen are considered essential to plant life. These are divided into two classes according as they do or do not form acids

Acid Forming Elements. (Non-metallic.)

Oxygen,
Hydrogen,
Carbon,
Nitrogen,
Phosphorous,
Sulfur*,
Chlorin*,
Silicon.

Base-Forming Elements. (Metallic.)

Calcium,
Potassium,
Sodium.
Iron,
Magnesium,
Manganese.

ACIDS.—Now if an *acid forming element* unites with oxygen and hydrogen, or sometimes with hydrogen alone, a substance is formed which is known in chemistry as an *acid*. Thus, nitrogen combined with hydrogen and oxygen forms nitric acid; phosphorous, hydrogen and oxygen form phosphoric acid.

BASES—A *metallic* element combined with oxygen and hydrogen forms a *base*, known as a *hydrate* of that metal. Thus, calcium united with oxygen and hydrogen would be calcium hydrate. Sometimes the term base is applied to the compound of a metal and oxygen.

SALTS.—The two classes of compounds above mentioned are very active in a chemical sense, and having opposite properties they always tend to neutralize each other so that neither acids nor bases are found to any great extent free in nature, but rather in the form of compounds resulting from their combination, such compounds being called *salts*. It would be out of place for us to discuss here the relation existing between acids, bases, and salts further than to say that an acid differs from a salt only in having its hydrogen replaced by a metal, and that every acid has a salt corresponding to it. For example phosphoric acid consists of phosphorous, hydrogen and oxygen: now, if the hydrogen be replaced by calcium, the composition would be phosphorous, calcium, and oxygen, and the compound would be a calcium salt of phosphoric acid.

The subject of soil origin and composition was discussed at length in Bulletin No. 21, and therefore I shall only summarize here.

*This spelling is that which is now recognized by the American Chemical Society, and is used in all chemical publications.

THE RELATION OF SOILS TO PLANTS.

First, the soil acts as a mechanical support for plants. *Second*, the soil furnishes ash constituents to the plant. *Third*, the soil aids in developing the plant by modifying and storing the sun's heat, regulating the food supply and securing other important conditions.

THE OBJECT OF FERTILIZERS OR MANURES.

A rich soil contains an abundant supply of the elements above described and supplies all the necessary plant food. A virgin soil is usually rich, but as soon as the land is brought under cultivation the plant begins to draw from the soil and the materials are not all returned. Sooner or later the land becomes infertile and it is necessary to return a part of the ingredients which have been removed by the plants. Experience has shown that there are but three ingredients which need close attention, viz: phosphorus, potash and nitrogen. Therefore it is only these, together with calcium, oxygen, hydrogen and carbon which will be discussed at this time. The reason for including the four substances last mentioned is that the three critical ingredients may be the better understood.

In worn soils or such as do not give good returns (provided the soils be in good physical condition) it will usually be found that one or all of the first three ingredients mentioned are deficient, or if they are present they are not in an available (soluble) form. In all cases care should be taken to have the soil in a proper physical condition. Here in Oregon this matter is too often neglected; large quantities of wheat and other crops being allowed to drown in the water which should be removed by under-drainage.

To prevent the deterioration of soils is the aim of all modern agriculture. Soil exhaustion, however, is rather a relative term than an absolute one, and usually applies to a certain crop, since a change of crops develops latent soil resources, and upon this fact is based the principle of rotation. Any soil will maintain its fertility so long as the annual depletion is returned in an available form either naturally or artificially, the degree of fertility being dependent upon the minimum quantity of any essential plant food. *"The plant can make no substance out of nothing, or without a sufficient supply of each and every one of all the essential ingredients of its composition," It is the object of manures and fertilizers to furnish to any soil a larger supply of the essential food ingredients.*

CLASSIFICATION OF FERTILIZERS.

FERTILIZERS	{	INDIRECT	{	Lime	
				Gypsum	
				Salt	
	{	DIRECT	{	<i>Artificial</i>	{ Complete Special
			{	<i>Natural</i>	{ Stable Manure Refuse Matter Green Manures Ashes Muck, Marl, etc.

EXPLANATION OF TERMS.

A *fertilizer*, in general terms, is any substance which added to the soil tends to produce a better growth of plants.

An *indirect fertilizer* is one, which, while it may not furnish to the soil plant food, so acts upon the matter already in the soil as to change more or less of it from an unavailable to an available form. A substance is said to be *available* when in a soluble form, although it is probable that no actual solution, in the common acceptance of the term, occurs.*

A *direct fertilizer* is one which is in such a condition that the roots of the plants can take it up readily, or the food material is *available*.

Artificial fertilizers are also called *chemical* or *commercial fertilizers*, and are prepared mixtures sold under trade names, the material of which they are composed being largely the waste products of many industries, and substances found in natural deposits.

Complete fertilizers are such as contain all three of the critical ingredients, nitrogen, potash, and phosphoric acid.

Special fertilizers contain only one or two of the above mentioned ingredients. They are also called *incomplete fertilizers*.

THE ELEMENTS AND THEIR RELATION TO FERTILIZERS.

OXYGEN.—Oxygen is by far the most abundant of all the elements. It forms about one-fifth of the atmosphere, where it exists in a free and uncombined state as a *gas*. It is the vital principle of the air we breathe. It constitutes about one-half of the solid crust of the earth, and eight-ninths of all the water. In these latter forms, it exists in a state of chemical combination with other elements. It combines chemically with nearly every known element, and is especially important in building up, and destroying all forms of organic matter. In a free state it is an invisible gas, possessing neither taste nor smell. It is called a supporter of combustion, because wood, and other burning substances, when plunged into it, will burn with increased brilliancy. Chemically considered it is a very active substance. In all forms of burning the oxygen of the air is combining with other elements, the heat being the result of the chemical union.

HYDROGEN is the element, which when chemically combined with oxygen, forms water. It constitutes about one-ninth, by weight, of all water, and enters into the composition of all plant and animals. It is the lightest substance known. Like oxygen, it is an invisible gas, without color, taste, or odor; but unlike oxygen, instead of being a supporter of combustion, it will, itself, burn when brought into contact with a flame. It is seldom, if ever, found in a free, or uncombined state.

HYDROGEN AND OXYGEN AS FERTILIZERS.—These two elements are supplied to plants in the form of water, which is the largest constituent of the growing plant. The plant tissue receives the necessary amount of each element by the separation of the water stored in the plant. There are several ways in which water is related to the fertility of the soil, but as directly related to fertilizers it bears no important part, except that it should be

*Missouri Bulletin No. 19.

present in as small an amount as possible. When irrigation is practiced the water may fulfill an important office as a fertilizer. Usually the water from rain furnishes all the oxygen and hydrogen that is needed, and much more.

I cannot refrain here from calling attention to the fact that too much water may be nearly, if not quite, as bad for a soil as too little, and this is particularly applicable to certain parts of Oregon. There are immense bodies, of so called "white land," which can be made excellent farming lands, equal to any, by ridding them of the superfluous amount of water by means of tile drainage. It is not only that the plant is likely to die from drowning, but the excess of water prevents the formation of available plant food, and also renders the physical condition of the soil unfit for supporting plant life. If the water does not flow off, it must evaporate at the surface, which tends to cool the soil. A proper system of drainage will not only remove the water, but keep the soil warm by preventing a too rapid surface evaporation; and when the ground is dry will allow a more perfect circulation of air and atmospheric moisture, thereby not only nourishing the plant, but also enabling the oxygen to act upon the latent plant food, rendering it available. This matter of tile drainage is a matter of paramount importance to farmers, and we recommend all to secure and read Bulletin No. 26 of this Station.

CARBON.—The element exists quite abundantly in a free state, and occurs under three forms (1) diamond, (2) graphite, (called black-lead,) (3) charcoal, lamp-black, coal, etc. It is the central element of all animal and vegetable material. There is not a thing endowed with life which does not contain this element. In plants it is combined with oxygen and hydrogen forming starch, sugar, wood fibre, etc. Most products of animal life contain these same elements, but united differently, as casein, fats, fibrin, etc. The element also occurs combined with oxygen alone in the form of a gas called carbon di-oxid, or often carbonic acid gas. Analysis shows that carbon constitutes about one-half of the solid portion of plants consequently it must be an important plant food. But extended experiments have shown that notwithstanding the element is so intimately associated with plants it may be left out of consideration in direct fertilizers for the carbon of the plant is taken from the carbon di-oxid of the atmosphere, which furnishes an inexhaustible supply.

NITROGEN.—This is a colorless, invisible gas without taste or color. It composes about four-fifths of the atmosphere. In addition to occurring in the atmosphere, it is found also in plants and animals. Animals cannot exist when left to breathe nitrogen alone, and yet it is not poisonous. Unlike oxygen and hydrogen, this gas will neither burn, nor will it support combustion. Nitrogen, when chemically combined with hydrogen, forms a gas known as *ammonia*, which is a very interesting compound to the farmer, because it constitutes a very important source of nitrogen as a plant food.

Ammonia exists in the atmosphere in small quantities, being formed when animal and vegetable matter containing nitrogen decomposes. With acids ammonia deports itself much like a metal in that it forms *salts*, which

are called *ammonium salts*. Thus, ammonia combines with hydrochloric acid to form *ammonium chlorid*, or *muriate of ammonia*; with sulfuric acid it forms *ammonium sulfate*.

FORMS OF NITROGEN USEFUL TO PLANTS.

There are three forms of nitrogen which are useful to plants:—

(1) Atmospheric nitrogen: (2) nitrogen in ammonium salts: (3) nitrogen in nitrates. Each of these forms is found to be useful to certain kinds of plants. The number of plants that can utilize atmospheric nitrogen is not large. In general terms leguminous plants, such as peas, beans, clover, alfalfa, and the like, can use the uncombined nitrogen. Hence, such plants are frequently spoken of as “nitrogen gatherers.” This is one of the reasons why such crops are often used as green manures.

Although some plants have the power to absorb nitrogen both directly and from ammonium salts through the medium of the soil, yet *by far the largest amount of nitrogen is derived from nitrates in the soil*. The nitrates are formed by a process known as *nitrification*, which is brought about by the oxidation of ammonia compounds and of organic matter in soil through the agency of microscopic organisms, bacteria, which exist every where in enormous numbers. The process is favored by warmth and moisture, no action taking place at a temperature below 40° F., nor in very dry soils, nor below 10 inches.

HUMUS A MEASURE OF NITROGEN.

Humus is a term applied to certain organic matter in soils. It expresses no definite product, but applies rather to the entire product of organic decomposition, or rather an intermediate stage of this decomposition. This process of organic decomposition results in the production of ammonia which combines with certain acids and is absorbed. Thus the humus may be taken as a measure of the nitrogen in a soil.

More or less ammonia escapes into the atmosphere from the organic matter decaying near the surface of the earth. This atmospheric ammonia is brought back to the earth by the rain and dew, which are seldom free from this compound, although the amount is small and variable. The experiments of Sir J. B. Lawes indicate that an average of about 5 lbs. of combined nitrogen per acre is brought to the soil annually by rain and dew, but in ordinary farm districts the supply of nitrogen from this source would probably not amount to a third of the combined nitrogen removed from soil by an average crop of wheat.

Under ordinary agricultural conditions the loss of nitrogen considerably exceeds that of natural supply and finally profitable crops cannot be grown without the use of nitrogenous manure.

REMOVAL OF NITROGEN.

The following table shows the average amount of nitrogen removed from the soil by one ton of several of the leading farm products. In the same table, for the sake of reference, I have inserted the number of pounds of the other critical ingredients removed and also the value of the fertilizing material which would be required to replace this same matter.

TABLE I.

Showing fertilizing material removed by one ton of some leading crops, and its market value.

NAME.	Potash. lbs.	Phosphoric acid lbs.	Nitrogen. lbs.	Value per ton.
Wheat kernels.....	11.4	18.8	36.8	\$ 8.93
Wheat straw.....	12.4	5.0	11.0	3.13
Wheat chaff.....	2.8	3.8	22.0	4.38
Wheat bran.....	34.6	28.4	49.2	13.16
Oat kernels.....	9.8	15.2	38.0	8.90
Oat straw.....	20.2	5.0	16.6	3.88
Oat chaff.....	20.8	4.0	12.8	3.62
Timothy hay.....	25.4	15.2	23.6	6.88
Red clover.....	41.6	11.2	45.4	11.93
Alfalfa.....	42.2	13.4	49.4	12.87
Seradella.....	15.6	13.0	54.0	12.23
Corn stover.....	24.2	0.6	16.6	4.68
Corn kernels.....	7.4	11.8	33.0	6.75
Cabbage.....	34.2	15.0	4.8	3.59
Turnips.....	8.2	2.4	4.4	1.45
Potatoes.....	5.8	1.4	4.2	1.23
Linseed meal.....	23.2	28.4	49.2	24.30
Hops.....	4.0	3.5	50.6	10.52
Hop refuse.....	2.2	4.0	19.6	4.24
Grapes.....	10.0	3.0	3.4	1.38
Apples.....	1.6	0.06	1.2	.33
Pears.....	3.6	1.0	1.2	.49
Plums.....	3.4	8.0	8.4	1.91

In addition to the removal of nitrogen from the soil by plants it may be lost in soil water, provided it is combined in the form of nitrates, since soils have little power of fixing them in insoluble combinations. When the soil is covered with a green crop, however, there is little loss since plants absorb the nitrogen very rapidly. The practice of bare fallowing, then, is one which on this account alone is not to be recommended, and especially is this true in a climate which is very moist.

DIRECT NITROGENOUS FERTILIZER MATERIAL.

NITROGENOUS FERTILIZERS	MINERAL	{ Sodium Nitrate Ammonium Sulfate Guano		
	ORGANIC	(Origin)	{ Dried Blood Meat Scraps Tankage Azotin	
			{ Dried Fish Ground Fish Wool Waste Horn Dust	
		Vegetable	{ Cotton Seed Meal Tobacco	

SODIUM NITRATE (*Chili Saltpetre*) occurs in enormous deposits in Peru. The commercial salt contains about 16 per cent actual nitrogen. It is an excellent fertilizer, quick in action, but easily washed out of the soil, and therefore should be applied while the crop is growing, and in small quantities at a time.

AMMONIUM SULFATE, is a waste or, bye-product, from the manufacture of illuminating gas. It contains about 20 per cent nitrogen and is much used in commercial fertilizers.

GUANOS containing nitrogen are now very limited, and practically out of the market.

ANIMAL MATTERS.—These are sufficiently described by their names, with perhaps the exception of tankage and azotin, the former of which is slaughter house refuse, and the latter a preparation of meat and membrane from which the fat has been extracted. All animal matter comes mainly from the slaughter house and fish oil factories. Some fertilizers contain horn, hair, and leather scraps, as a source of nitrogen, but this is not as valuable as most other forms of animal matter.

VEGETABLE MATTER.—But a limited amount of this is employed in fertilizers. The main form used is cotton seed meal, but this cuts a very limited figure in our markets.

POTASSIUM.

POTASSIUM.—This metallic element is never found free in nature, but is a constituent of many natural and artificial fertilizers. It is a soft metal, lighter than water, and possesses a great affinity for oxygen. Plants consume potash in relatively large amounts, yet in some soils the supply is nearly, if not quite, equal to the demand. The supply is mostly from the decomposition of feldspar which contains from 10 to 16 per cent.

In the feldspars the potash is united with aluminum and silicon and is not immediately available as plant food, but under the combined action of air, water and frost the feldspars are so changed as to render the potash available. There is little loss of potash in drainage water, since soils are found to have the power of removing it from solutions and storing it in insoluble forms.

Plants vary much in the amount of potash they consume, and experiments show that where it is deficient the plants suffer greatly, the woody portion of plants, and the fleshy part of fruit, being dependent upon the influence of potash compounds.

As a fertilizer it is especially useful to the leafy crops as potatoes, beets, clover, etc., while grain is much less benefited.

POTASH FERTILIZING INGREDIENTS.

Patassium Chlorid	Potassium Sulfate
Kainite	Potassium Nitrate
Wood ashes	Cotton seed hull ashes

POTASSIUM CHLORID (*Muriate of Potash*:)—This furnishes the main supply of potash for most commercial fertilizers. It is obtained from the town of Strassfurt, in Northern Germany, where there is an inexhaustible supply of this and other grades of potash salts. Muriate contains about 50 per cent of actual potash, (K_2O) from which it will be seen that it is a concentrated form, and really the cheapest per pound of potash, although a high priced product.

POTASSIUM SULFATE (*Sulfate of Potash*,) comes from the same source as the muriate and as found in the fertilizer market contains from 30 to 35

per cent of actual potash. The price is higher than that of the muriate, but on certain crops it is found to act more favorably,

KAINITE.—This is the most common of the German potash salts, and is a mixture of several compounds, chiefly chlorids and sulfates of potash, sodium and magnesium. It is comparatively of low grade containing from 2 to 15 per cent of potash. It cannot be used with impunity since it contains sulfate of magnesia which is deleterious to some germinating seeds.

POTASSIUM NITRATE (*Saltpetre*), is valuable not only for the potash, but also for the nitrogen it contains. Because of its high price it is very little used for a fertilizer.

WOOD ASHES.—For a cheap potash supply nothing is better than good unleached wood ashes, and it is practically the only American supply for potash. The amount of potash varies with the kind of wood, ranging from 7 to 14 per cent., with a small amount of phosphoric acid in addition. The potash is in the very soluble form of the carbonate. Leached ashes contain much less potash, often not more than 2 per cent. "Good wood ashes which have not been exposed to weather or otherwise wet * * * weigh about 48 lbs. to the bushel and carry about 8 per cent potash besides nearly 2 per cent phosphoric acid." They are worth at least 25 cents per bushel. Our orchardists could use nothing more beneficial for their small fruits and orchards. No farmer should waste the ashes produced on his farm.

PHOSPHOROUS.

PHOSPHOROUS.—In a chemically pure state phosphorous is a soft yellow, waxy solid, and extremely inflammable on account of its great affinity for oxygen. When it burns it simply unites with the oxygen of the air, the compound formed being commonly called *phosphoric acid* and it is this compound which is of such great value to the farmer.

The element never occurs free, but is combined with oxygen and lime. In this form it is known as phosphate of lime. It also occurs as phosphate of magnesia, and also of lime and alumina. These phosphates are only slightly soluble in water, so the quantity in the soil is only removed by the plants as it becomes available.

From a fertilizing standpoint the phosphates are second only to nitrogen in importance, and in particular cases may even exceed that element. The phosphates of fertilizers exist in three forms:—

1st, SOLUBLE PHOSPHATE.

2d., REVERTED "

3d., INSOLUBLE "

THE SOLUBLE FORM does not occur to any extent in nature. It is known under the names *acid phosphate of lime*, and *calcium superphosphate*. The phosphates of this form being soluble in water are of great great value as fertilizers. When a soluble phosphate is added to the soil it gradually changes to a form insoluble in water, which is probably the form known as REVERTED PHOSPHORIC ACID. This is not the ordinary form of insoluble phosphate, for while a reverted phosphate is quite

insoluble in water, it is readily soluble in dilute acids or solution of salts containing ammonia. The roots of plants contain a small amount of acid which renders them quite capable of using this form of phosphate, hence it is considered nearly as valuable as the soluble form. The *two taken together* constitute what is known as *available phosphoric acid*.

INSOLUBLE PHOSPHORIC ACID (*Calcium Phosphate*,) is so-called because it will not dissolve in water. It is the form in which phosphorous exists in most soils, bones, and rocks, and from which it is yielded to the plants with great difficulty. In this form the phosphates in fertilizers are of the least value to the purchaser. Insoluble phosphates may be converted into the soluble forms by treatment with sulfuric acid, which should be handled with extreme care.

Of the three forms the soluble contains the greatest amount of phosphorous; the reverted form the next greatest supply; and the insoluble form the least. As to the removal of phosphates from the soil, the insoluble form is, of course, not carried away by the soil water; the same is true of the reverted phosphates, but were it not for the fact that the soluble form is very quickly changed to the reverted condition it would doubtless be more or less removed by drainage water.

In general it can be said that soils become deficient in phosphoric acid quicker than in any other ingredient. In the case of basaltic soils there is often a very abundant supply of insoluble phosphates in the form of *apatite* crystals (calcium phosphate.)

BONES.—These are used extensively as a source of phosphoric acid. The usual form on the market is ground bone of various degrees of fineness—the finer the better. Bones are of a double value as they contain not only phosphoric acid, but also potash and nitrogen. They also occur in different conditions as stated below.

Raw Bones (of animals) consist of approximately:

Phosphate of lime.....	50.00
Carbonate of lime.....	25.00
Animal matter (containing Nitrogen, 4.00).....	25.00
	<hr/>
	100.00

Steamed Bones (animal bones which have been steamed to extract a part of the animal matter in the manufacture of glue, etc.) containing approximately:

Phosphate of lime.....	65.00
Carbonate of lime.....	20.00
Animal matter (containing nitrogen).....	15.00
	<hr/>
	100.00

Bone Black—known also as Animal Black and Animal Charcoal, made by heating bones in closed vessels—containing approximately:

Phosphate of lime.....	60.00
Carbonate of lime.....	10.00
Charcoal, etc.....	30.00
	<hr/>
	100.00

Bone Ash (made by burning bones) containing approximately:

Phosphate of lime.....	75.00
Carbonate of lime, etc.....	25.00
	<hr/>
	100.00

Of late there has arisen quite a demand for bones for various industrial uses which has brought about a tendency in some instances to adulterate by the use of coal ashes, oyster shells, etc. Bones form valuable material and even those small amounts which occur about a farm should be husbanded by burying them in the orchard near trees where they will decay. Other ways of utilizing them are by burying them in an ash or manure heap and allowing them to become softened before putting them in the earth.

DISSOLVED BONE (*Bone Superphosphate*) is simply raw bone or bone ash which has been treated with sulfuric acid whereby the phosphoric acid is made more soluble. Fertilizers thus prepared are commercially known as "*superphosphates*."

ROCK PHOSPHATE (*South Carolina Rock*) is used quite extensively in making superphosphates by treatment with sulfuric acid. Unless the rock has been so treated the phosphoric acid is mostly in the insoluble form.

BASIC OR THOMAS SLAG is now used to some extent. It is a waste product in the manufacture of iron. It is often sold under the name of '*Odorless phosphate*.' It usually contains about 50 per cent of phosphate of lime.

INDIRECT FERTILIZERS.—The most important substance under this head is *Lime in one or more of its forms*. It is the oxygen compound of calcium, *calcium oxid*, which is commonly known as lime. It is probably true that no other single substance has been so much used on land as lime, with the single exception of stable manure. Lime is made by burning limestone, and it is this burned or calcined form which should be used whenever it is deemed necessary. It has a three-fold action as a fertilizer:

First, as a direct source of plant food.

Second, rendering available inert plant food in the soil.

Third, improving the texture of the soil.

While a certain amount of lime is essential to the growth of plants yet experience has shown that as a direct fertilizer it does not fulfill all that might at first be expected, therefore it is classed as an indirect fertilizer. It is in the second action that lime produces the greatest chemical effect. It is a strong base, and therefore tends to neutralize any acidity of the soil, which occurs especially in wet boggy places, rendering the soil "sour." It facilitates nitrification and decomposing certain insoluble salts in the soil.

In many cases it can be used to advantage in improving the texture of soils. This is especially true of the heavy clays, which it tends to pulverize and lighten. Used on peaty or adobe soils, it will tend to decrease the organic matter by causing it to decompose more rapidly. It is in this office that lime could be used in many instances by the Oregon farmers in improving the clays of the Willamette Valley. Tile draining and lime, I am confident, would furnish to the State a large increase of available land. Care, however, should be taken to supply organic matter to such soils after liming or the last state will be worse than the first, for it is a trite and true saying that "Lime enriches the father but impoverishes the son."

GYPSUM (*Calcium Sulfate*.)—This substance has been a bone of contention, and disputes have waxed warm and loud as to the cause of its beneficial action, for this it certainly possesses. It is largely used in some parts of the country to encourage the growth of clover. One writer speaks of the use of this substance, commonly called "gypsum," as follows: "There is reason to believe that gypsum causes the decomposition of certain compounds containing potash, whereby it, and some other bases, are made available for the use of crops—the lime taking the place of these in the compound decomposed—the sulfuric acid combining with them to form salts soluble in water. Admitting this to be the action, it tends to impoverish the soils to an extent far greater than is brought about by the use of most other manures."* It has been pretty conclusively proven that a portion, if not all of the above reaction take place in the case of *black* "alkali" soils, spots of which are not of unfrequent occurrence in certain parts of Eastern Oregon. The most profitable use of gypsum would doubtless be in such cases. In California it has been conclusively proven that it is a valuable remedy in such "spots," and when followed by active cultivation, will, in a large measure remedy this very undesirable condition. The use of gypsum together with underdrainage and irrigation if this be possible, and a proper selection of crops will cure in a comparatively short time the most of this hated *black alkali*.

Gypsum can also be used with profit to aid in obtaining a good "stand" of clover on the farms of the Willamette Valley to the cultivation of which crop farmers can profitably give their attention.

The great cost of gypsum at present will not permit its coming into general use, but there may be cases in which its use would doubly repay the expense. It is to be hoped that there are deposits in this State which will soon be opened, and for one who is fortunate enough to discover it in workable quantities, there is a rich harvest in store. It has been reported from Eastern Oregon—the very part of the State in which it could be used to great advantage—and samples of excellent quality have been sent to us for analysis, but so far we have not been able to verify "the find."

SALT, (*Sodium Chlorid*.)—Its application is likely to be useful in a limited number of cases, and with certain crops. It is usually best used in a compost. It has a very destructive action on vegetation if applied in excess, and should be used, if at all, with great care.

Fertilizing Material Produced on the Farm.

It is not our purpose to deal particularly with this topic at this time, but to issue a special bulletin on the subject later, yet there is one phase of the matter which I deem of so great importance that I take occasion to touch upon it now. I refer to the unnecessary waste of valuable material, which, with a little care and forethought, might serve as a valuable fertilizing material. While it is probably impossible to utilize *all* the straw produced on the farm without burning, yet it is equally true that every farmer could use much more than he does, and it should be the policy to use as much as possible. It is a wasteful process to burn, and still more suicidal

*Bulletin No. 19, Ark. Experiment Station.

to sell it from the farm without returning anything to replace it. In burning the straw the valuable element nitrogen is dissipated in the air, while it would serve a valuable office in the soil. If the straw *must* be burned *it should be burned in very small piles instead of in large stacks*, as is so often the case, so that the ash material may not be fused and form *insoluble* silicates, but may furnish as much soluble plant food as possible.

Wheat and oat straw remove from the soil the following amounts of fertilizing material per acre, and the last column of the table gives the value of the straw from an acre of land upon this basis.

TABLE II.

RIND.	Potash in pounds.	Phosphoric acid in lbs.	Nitrogen in pounds.	Value.
Wheat straw.....	31.62	12.75	28.05	\$7.29
Oat straw.....	22.22	5.50	13.86	\$3.91

Therefore reckoned at the market price of nitrogen in the commercial forms it would cost to replace the nitrogen lost by burning the straw produced on one acre of ground \$5.61, while it is a frequent occurrence to sell this same amount for not more than \$2.00. Farmers of the east have paid for this by experience dearly bought, and the time is not far distant, when the farmer of this coast will realize its truth. Relative to this same matter I quote from Mo. Experiment Station Bulletin No. 19.

TABLE III.

Showing the value of plant food (phosphoric acid, potash and nitrogen) removed from one acre.

Wheat, kernels.....	\$ 6.00	Timothy.....	\$12.57
“ straw.....	7.29		
	\$13.24	Clover.....	\$26.98
Oats, kernels	\$ 3.81	Alfalfa.....	\$23.17
“ straw.....	3.62		
	\$ 7.73	Potatoes.....	\$ 7.07
Corn. kernels	\$11.94	Carrots.....	\$ 4.52
“ cobs and husks.....	.96		
Stalks.....	\$ 6.40	Cabbage....	\$18.35
	\$19.30		

“To take care, therefore, of straw and other vegetable refuse and return it to the land in a proper manner, is a matter of great importance; to sell timothy, clover, and alfalfa as such, rather than to feed it and sell it as flesh or milk, is bad policy and self-destruction. To value a crop simply by its market price, is crude and unscientific. The price which the farmer pays for it, is not only its cost of production, but in addition to it, its manurial value, which we have often neglected, and which the conditions of the case begin now to force upon us for serious consideration.”

CONDITION OF OUR FERTILIZER MARKET.

While there is not a large consumption of fertilizers in this State, as compared with other states, yet the demand is on the increase and the business will always be an increasing one. The fact that there are large or-

chards planted in our state is one reason why the fertilizer question will be brought forward soon, and will be a question of importance to the state. This is true because the wear to which the soil will be subjected is one-sided and will be continuous. At present there is no law of any force bearing on the sale of fertilizers in this state, and therefore there is no way the farmer may know what he is purchasing, except to rely on the honesty of the dealer. It is also true that there is no material which offers a greater opportunity for adulteration than these same fertilizers. While the Station has made analyses of most of the fertilizers offered for sale in the state yet *it cannot guarantee that the analysis printed in the table below represents each lot sold*, for the samples sent by manufacturers prove little or nothing, except for that individual sample, so that although the analyses are published under the name of the fertilizer, we cannot guarantee that another sample would give the same analysis or even approximating the same.

Still we have no reason to question the integrity of any dealer in this State. *Be it remembered, however, that the figures given in this bulletin are not in any sense to be taken as representing anything beyond the individual sample analysed.*

The State should have enacted an adequate fertilizer law in justice not only to the farmer, but to the manufacturers themselves, which would compel the manufacturers to make their standard, and thereafter hold to that standard. This is done in other states and should be done here.

At present the purchaser should be very careful to deal with reputable firms who are willing to *guarantee* a certain amount of fertilizing ingredients.

We publish below, without comment, a statement of the results of the analysis of certain fertilizers found in the Oregon market.

TABLE IV.

Showing analysis of fertilizers sold in Oregon.

Laboratory No.	NAME OF FERTILIZER.	PHOSPHORIC ACID.						Nitrogen.	Equivalent to Ammonia.	Potash.	Value per ton.
		Moisture.	Soluble.	Reverted.	Insoluble.	Total.	Available.				
431	Complete Fertilizer for light Soil	6.64	2.78	2.65	8.19	13.62	5.43	2.65	3.21	3.49	\$29.80
432	Webfoot Hop Grower.....	8.67	2.15	8.23	2.94	13.32	10.38	2.66	2.50	4.07	33.34
433	Dried Blood.....	12.72						8.90	10.80		35.80
434	Muriate of Potash.....		.50				.50				55.00
435	Webfoot Potato Grower.....	6.03	4.90	3.11	8.11	16.16	8.05	3.25	3.98	2.33	34.10
436	Sodium Nitrate.....							8.08	10.68		35.80
437	Kainite		.19								20.80
438	Fruit and Vine Phosphate.....	6.19	2.70	6.23	7.07	16.00	8.93	2.38	2.90	2.91	32.14
439	Vegetable Fertilizer.....	12.20	3.36	3.61	2.94	9.96	6.97	2.62	3.18	1.80	31.44
440	Fruit Fertilizer.....	15.79	5.60	5.14	4.10	14.84	10.74	2.34	2.84	2.19	32.48
441	Webfoot Potato Grower.....	7.11	2.55	3.73	1.21	7.49	6.28	2.20	2.67	4.65	25.32
442	Webfoot Orange Grower.....	8.05	2.84	2.82	3.61	9.27	5.66	2.46	2.99	6.40	28.66
443	Webfoot Complete Fertilizer.....	8.07	2.20	5.20	5.04	12.74	7.70	2.76	3.55	2.91	31.24
444	Complete Fertilizer for Light Soil	5.88	4.05	3.34	0.75	8.16	7.41	2.31	2.80	7.37	31.88
445	Webfoot Hop Grower.....	4.68	6.99	1.08	4.92	12.99	8.07	3.46	4.20	6.21	39.02
446	Webfoot Vine Grower.....	7.30	4.60	2.43	3.20	10.23	7.03	4.85	5.89	5.24	40.62
448	Mineral Fertilizer.....	.97	5.20	4.02	3.16	12.38	9.22	.65	.79	1.90	18.00
468	Fish Guano.....	9.91	2.41	1.00	2.60	6.01	3.41	5.49	6.65	3.32	32.96
466	Bone Meal Fertilizer.....	7.21	3.15	2.09	2.91	8.15	5.24	1.79	2.17		17.81
470	Odorless Phosphate.....	9.60	1.86	1.86	12.68	16.40	3.72				13.92
471	Grain Fertilizer.....	7.57	2.03	.84	3.63	6.50	2.87	1.84	2.23	2.34	17.99

THE CHEMICAL VALUE OF A FERTILIZER.

Each of the three essential ingredients of a fertilizer has a commercial value, and the worth of any given ingredient may be stated in dollars and cents. These values are estimated from the essential ingredients in the fertilizer, and they express the *commercial value* based upon what the ingredient would cost in the open market. The values do not pretend to express the agricultural value, which would of course be represented by the profit they would give the user, which would be a very variable quantity. The price upon which these values are based are as follows:

Available Phosphoric acid, per pound.....	8½ cents.
Insoluble " " " "	3 "
Potash from Muriate.....	5½ "
Potash from Sulfate.....	7 "
Nitrogen.....	20 "

The total cost of a ton of fertilizer (to the consumer) is made up of three elements: 1st. the cost of material mixed; 2d. the cost of mixing; 3d. the cost of transportation, storage, etc., but the valuation takes into account only the first of these elements.

To figure the commercial value of a fertilizer, multiply the price of each ingredient by the number representing its per cent in the fertilizer, add together these results and the sum will represent the value in cents of the fertilizing material in 100 lbs. of fertilizer. Multiply the sum by 20 and the product will be the value in cents of one ton of the fertilizer.

Example:—A fertilizer was found to contain 7 per cent available phosphoric acid; 3 per cent nitrogen; and 4 per cent potash.

(1) Phosphoric acid.....	7x8½	59.5
(2) Nitrogen.....	3x20	60.0
(3) Potash.....	4x5½	22.0

(4) Value of 100 pounds.....	141.5
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(5) Value of 2000 lbs, one ton, $141.5 \times 20 = 2830$ cents, or \$28.30, to which should be added about \$3.00 for bagging, etc.

In some cases there is a guaranteed amount of *ammonia* instead of nitrogen, in which case the number representing the ammonia should be multiplied by the decimal, .8235 before applying the above calculation. Again, the amount of *potassium chlorid* (or *muriate*) may be guaranteed instead of actual potash. In such a case the amount of the chlorid should be first multiplied by .6318 to obtain the actual potash. To convert from the sulfate to actual potash it is necessary to multiply by .5404.

The Needs of Oregon Soils.

In the first place let it be remembered that the value of a *mere chemical analysis* of a soil is at most doubtful. An analysis of a soil reveals what and how much of a given ingredient is present in a soil but *it does not show* how much of the plant food is available. There is, however, more or less value attached to investigations of so-called "virgin soil," and an accumulated number of analyses on this class of soils gives very valuable data upon which to base a judgement of probable success or failure. This mat-

ter has been more fully discussed in Bulletin No. 21, to which the reader is referred. In all cases chemical analysis should be followed by careful field tests, and in this way any one may become familiar with the individual needs of his soil. Experiments in the field have been very limited in this State, yet based upon the ordinary methods of judging deficiency of plant food in soils, chemical analysis of a large number of soils seems to indicate a limited amount of potash in the Willamette Valley soils, and this would doubtless be the first ingredient needed on the lowland, and the higher land seems to point toward a need of phosphoric acid. These results must however, be taken as only indicative, although these chemical results have been verified in instances where the experiment has been tried. The loams of Clackamas county have shown a good supply of potash, and a number of Lane county soils have shown a high content of phosphoric acid.

There is a common idea abroad that our soils are deficient in lime, yet the analysis of a large number of soils has not shown that to be true. The soils of the Willamette Valley possesses in nearly all instances a fair amount of lime and on passing into Eastern Oregon the lime content is nearly doubled. In general potash is to be the first element to be suspected as being deficient on the lowlands of the Willamette Valley and phosphoric acid on the uplands. It should also be said that the uplands are not in *all* cases well supplied with nitrogen, which is very essential to fruit production. The red hill lands possess a great power to absorb this element and ammonia and are naturally excellent fruit lands, yet when the fruit begins to shrink in size this element should be supplied. On the lower lands there is a greater supply of humus which is a very fair measure of nitrogen and when these soils are well drained they are likely to possess great capacity for production if potash is supplied. The conditions are so varied however, that, in order for any farmer or gardener to decide *positively* what kind of fertilizer will be best for him to use, it will be necessary for him to do some special experimenting. It is not best in all cases to select a complete fertilizer for often a portion of the material is not needed at all and the farmer may be "*carrying coal to Newcastle.*"

There is one thing that should be said relative to many of the valley lands, viz: that for lasting benefit in increased return and ease of handling careful attention would best be given to the physical condition by proper tile draining before turning attention to fertilizers, for in many instances the improvement of these conditions will be all that is necessary for some time to come.

Of the soils of Eastern Oregon but a limited number of analyses have been made, but acting upon experience in other states having similar climatic conditions and taking into account the origin of the soils of that part of the state we can say that the basaltic rocks would naturally produce a soil well supplied with phosphoric acid, and from this reason it will doubtless be found that when the soils fail it will be rather on the side of potash than phosphoric acid.

We trust that the matters discussed in these pages will prove of benefit to the farmer in not only paving the way for a better understanding of the

principles of agricultural chemistry, but also in calling attention to some sources of waste in the economy of the farm. For reference we insert some tables which will prove of value to those who consult them with an earnest desire to understand the more modern practice of agriculture.

TABLE V.

Compiled Analyses of Commercial Fertilizing Material.

SUBSTANCE	Moisture	Nitrogen	Potash	Phosphoric Acid			Value per ton
				Available	Insoluble	Total	
<i>Materials containing phosphates.</i>							
Apatite.....						36.08	\$14.43
Bone ash.....	7.00					35.89	14.35
Bone black.....	4.60					28.28	11.31
Bone black (dissolved).....				16.70	0.30	17.00	21.84
Bone meal.....	7.47	4.12		8.28	15.22	23.50	40.56
Bone meal (dissolved).....		2.60		13.53	4.07	17.60	30.27
Peruvian guano.....	14.81	7.85	2.61	8.36	6.90	15.26	39.21
S. Carolina rock, ground.....	1.50			0.60	27.43	28.03	11.69
S. “ “ dissolved.. ..				11.60	3.60	15.20	16.52
Basic Slag.....						21.37	8.55
<i>Material containing potassium.</i>							
Carnallite.....			13.68				12.31
Kainite.....	3.20		13.54				29.92
Muriate of potash.....	2.00		52.46				47.20
Nitrate of potash.....	1.93	13.09	45.19				81.25
Spent tan bark ashes.	6.31		2.04			1.61	3.85
Sulfate of potash.....	1.25		38.60				42.46
Wood ashes, unleached.....	12.00		5.50			1.85	7.90
“ “ leached.....			1.10			1.40	2.61
<i>Material containing nitrogen.</i>							
Azotin.....	5.88	11.33				3.43	43.09
Cotton seed meal.....	6.80	6.66	1.62			1.45	25.20
Dried blood.....	12.50	10.52				1.91	38.73
Dried fish.....	12.75	7.25	0.45	3.05	5.20	8.25	34.12
Horn and hoof waste.....	10.17	13.25				1.83	20.38
Meat scrap.....	12.09	10.44				2.07	38.61
Nitrate of soda.....		16.47					51.05
Sulfate of ammonia.....	1.00	20.50					69.70
Tankage.....	13.20	6.82		5.02	6.23	11.25	31.71
Wool waste.....	9.27	5.64	1.30			0.29	9.62

Oregon Agricultural
Experiment Station.

Bulletin No. 37. - - May, 1895.

A G R I C U L T U R E.

Experiments in Cattle Feeding.

The Bulletins of this Station are sent free to all residents
of Oregon who request them.

AGRICULTURAL COLLEGE PRINTING OFFICE
H. R. CLARK, Manager,
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1895.

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CATTLE FEEDING.

BY H. T. FRENCH.

The subject of stall feeding cattle is quite a new one in the live stock industry of this state, and especially in the Willamette valley. Where so little corn is grown, and where such luxuriant pastures prevailed as did at one time exist in this valley, and are found even now in favored locations, it is not strange that little attention was given to this matter. But the conditions have changed in the past few years. Grain no longer pays a large profit when sold in the measure, and the natural pastures are less productive than they once were. Low prices for beef cattle, and little discrimination on the part of the buyer between good and poor beef, have had a marked influence in keeping people from stall feeding cattle. Another very fertile cause is found in the vast ranges of public domain which supported stock in large numbers at little expense. These almost limitless public pastures do not now exist hence there will be a growing demand for a more intensive system of feeding stock. May it not be safely predicted that cattle are entering upon an era of greater demand and consequently better prices? Every thing seems to point in this direction.

It was with a view of throwing some light upon the subject of cattle feeding that the following experiments were undertaken. The results are not wholly satisfactory, yet they will suggest some valuable points perhaps, and serve as a guide to future work along this line.

The objects of the experiment were: first, to test the value of grain and coarse products which can be grown upon the farms of a large portion of Oregon; second, to show if possible that it

is not profitable to sell animals only partially prepared for the market, and at a time when the market is over run with stock from the range.

It has been our observation during the past six years that cattle are very low in the fall and early winter, consequently this is not the time to sell, if we can keep the animals two or three months longer and not lose money by the operation.

With these two objects in view six grade Polled Angus cattle were purchased, five steers and a spayed heifer. Four of the steers were used in the experimental feeding here recorded.

The cattle were very wild when purchased, and it required a month or six weeks to get them accustomed to their surroundings. They were put with the herd the first of October, and driven to the barn every night for a month before any attempt was made to place them in stalls. No grain was fed during this time. November first the animals were secured by a chain tie about the neck. This is called the German tie. The chain is secured by a rod which passes through a ring at the end of the chain, and is bolted to the side of the stall. By this means the animal is securely tied and yet has more freedom than the stallion gives.

The animals were kept here for a few days, and water and food carried to them three times a day. They were then released during the day and again tied at night. This was continued until the feeding experiments began December 6th, when the animals were kept up all the time and only led out to be weighed every two weeks.

The feed was weighed out to them three times daily and water was given to them in the stall.

I have written this in detail to show how much care must be taken if the animals are induced to take on flesh rapidly. The first, last and all the time object, must be to make the animals contented and quiet. Before a month had past nearly every animal would eat from the hand of the one who fed them.

Would it not have been better to have given the cattle more exercise? This question is often asked, and we will say that there is more danger of such cattle taking too much exercise, if given an opportunity, than there is of not getting enough. If properly fed and watered there is no injury from keeping them

in close quarters. The animals were about two years and nine months old when the feeding began.

In the case of the first two, Tommy and Tobe, the feeding began Dec. 6th. These two were fed chopped wheat for a grain ration, and clover hay and corn silage for coarse feed. The grain was divided into three feeds, and fed with clover hay in the morning, with silage at noon and, with clover hay at evening. The grain was mixed with the coarse feed. Much stress was placed upon feeding the animals regularly. The benefits of this are well understood and need no further discussion.

The first two steers, Tommy and Tobe, were fed chopped wheat alone, except during the last two weeks they were given a little oil meal. On the whole, I do not think that chopped wheat is as good a ration as a mixture of wheat, oats, and bran.

The second two steers were fed a mixture of equal parts by weight, of these grains, and the results are a little more satisfactory. The animals appeared to relish their feed better. It is quite as important to know what is *not* a profitable grain ration, as to know the best, hence the results of feeding wheat alone are not without some value.

The feeding of the second two steers was not begun until a month later than the first two, owing to the fact that they were not fully reconciled to their quarters. The coarse feed consisted of clover hay, cut with a feed cutter, corn silage and vetch hay. The vetch hay was fed only to Silas one of the steers in lot 2. This was substituted in the place of the clover, for the purpose of comparing the two substances for feeding purposes. The vetch hay was made from the winter variety cut during July, and carefully cured the same as clover hay. This part of the experiment will be interesting to many who are now experimenting in raising this plant. Our experiments do not prove it to be superior to clover; but it is eaten very readily and gives satisfactory results. It is certainly worthy of a place among the hay crops for Western Oregon. The corn silage was a very good sample, made from yellow dent corn just past the roasting stage. The corn was grown on summer fallow. It was stored in the silo the first of October.

This method has an important bearing upon the feeding of

stock. If the summer fallows of Oregon could be made to produce a crop, and thereby pay for the cultivation which they ought to receive, it would be a very economical method of producing food for stock. Not only is it better for the half starved cattle, but it will assist in increasing the production of grain as well. The constant cultivation which the corn needs, together with the shading of the ground, has a very beneficial effect upon the fertility of the soil.

RESULTS.

By consulting the table in the summary it will be seen that the steers, Tommy and Tobe, ate $2308\frac{1}{2}$ pounds of chopped wheat which at \$13.00 per ton amounts to \$15.00. They also consumed 1737 pounds of hay valued at \$5.00 per ton or \$4.34; corn silage, 4076 lbs. at \$1.50 per ton, cost of raising and placing in the silo or \$3.00; 100 pounds of roots at 25 cents per cwt.; and 19 pounds of oil meal at $1\frac{1}{4}$ cents per pound. This makes the total cost of feed from December 6th to March 28th, \$22.83. Total gain, live weight, during this time was 435 pounds or an average cost per pound of gain of 5.25 cents. This at first thought would preclude any chance for profit, but there is another side to the question. The steers cost \$30.00 or $1\frac{3}{4}$ cents per pound. If we charge the steers up with first cost \$30.00, plus \$22.83 for feed, we have \$52.83. The steers were sold to a local butcher for $2\frac{3}{4}$ cents per pound live weight, or \$58.57. This leaves a net profit of \$5.74, not counting the labor which is fully balanced by the value of the manure. The matter of keeping the fertilizing material upon the farm is a very important consideration. In feeding animals very little of the fertilizing elements are lost from the farm; for only a small amount is required in the production of the animal product.

If there is realized enough to pay for the food consumed, the manure will balance the labor account, and leave the farm more productive than before. This problem of furnishing farm-yard manure has not received as much attention throughout our state, as it should, and in fact, must receive, before the farms will again bring the bountiful harvests they once yielded.

There is another consideration which is an important one, and that is, the stock raiser sells his stock in the fall at a sacrifice, because the food supply on his farm will not warrant stall feeding. The price of beef has been so low, there has not been

much inducement, but beef will invariably sell for $1\frac{1}{2}$ to 2 cents per pound more in the spring than in the fall, hence, if the animals will pay for their feed, which they will, with beef at $3\frac{1}{2}$ cents per pound, counting the profits which arise from the increased price per pound for the original weight of the cattle.

In the experiments with the steers fed on the mixture of grain the results are a little more favorable. These steers were fed on equal parts by weight of chopped wheat, oats and bran. Vetch hay was fed from January 3d. to February 14th to Silas and clover was fed the remainder of the period, and the vetch was fed to Beecher in place of the clover hay. Corn silage was fed to both the whole time. Other conditions were the same as in the first two animals. Silas consumed 1158 lbs. of grain, worth \$5.57; 710 lbs. of hay, worth \$1.77; 1596 lbs. of corn silage, worth \$1.12, and $9\frac{1}{2}$ lbs. of oil meal worth 12 cents. Total cost of food \$8.58.

Gain in live weight, 180 lbs. at $2\frac{3}{4}$ cents, \$4.95. Add to this the increased value of the original weight one cent per pound, or \$9.65 gives \$14.60. Subtract the value of food consumed leaves \$5.02 profit over cost price and expense. Average gain per day was 2.22 lbs.

Beecher consumed $888\frac{1}{2}$ lbs. of grain costing \$5.17, 480 lbs. hay, worth \$1.20, 1886 lbs. silage worth \$1.41, and oil meal 12 cents. Total cost of food \$6.90.

Gain in live weight 195 lbs. at $2\frac{3}{4}$ cents per pound \$5.36 add the increased value of the original weight at one cent per pound \$9.40 gives \$14.76. Subtract the value of food consumed leaves \$7.86 net profit. Gain per day 2.40 lbs.

There was no perceptible difference in the results between feeding the vetch and clover, except in the fact that the second steer Beecher did not relish the vetch as well as Silas.

The animals were sold to a local butcher who weighed the carcasses carefully, showing a dressed weight of 59 per cent. While this is not high it speaks well for the breed and shows that the animals were fairly well matured.

The beef was nicely marbled and of excellent color.

CONCLUSIONS.

1. While the results are not wholly satisfactory, they will assist in determining the line of future work.

2. The gains per day will compare favorably with those made by feeding corn meal.

3. That animals can be well matured at three years of age by feeding such grains as wheat, oats, and bran.

4. That it is not economy to sell steers in the fall at a reduced price, even at the present low price for stall fed beef.

5. With a reasonable price for stall fed beef, the results indicate that there may be as good returns realized here as in localities where corn is used as a principle grain food.

It is the intention of the Agricultural department to continue these experiments, believing that the matter of stall feeding is a very important one, both in its relations to the dairy, and in the production of beef.

The cut of beef shown on page 82, is one taken from a Polled Angus heifer sold off the farm at three years of age, and whose gross weight was 1637 pounds.

Mr. C. D. Thompson, farm foreman, had charge of the feeding.

SUMMARY.

	Tommy. lbs.	Tobe. lbs.	Silas. lbs.	Beecher. lbs.
Weight December 6.....	840	Dec. 6 855	Jan. 3 965	Jan. 3 940
“ March 28.....	1070	1060	1145	1135
Total gain.....	230	205	180	195
Total grain.....	1150 $\frac{1}{4}$	1158 $\frac{1}{4}$	959	888 $\frac{1}{2}$
Total hay.....	855 $\frac{1}{2}$	881 $\frac{3}{4}$	710	480
Silage.....	2036	2040	1596	1886
Roots.....		100		
Oil meal.....	9 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$	9 $\frac{1}{2}$
Average daily gain.....	2.11	1.88	2.22	2.40
Grain per pound of gain	5.00	5.64	5.33	4.56

Oregon Agricultural
EXPERIMENT STATION.

Bulletin No. 38. - September, 1895.

DEPARTMENT OF ENTOMOLOGY.

FRUIT PESTS.

1. *Report on Fungicides and Insecticides.*
 2. *Fruit Pests and Remedies.*
 3. *Entomological Calendar..*
 4. *Beneficial Insects.*
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F. L. WASHBURN.

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of Oregon who request them.

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<i>G. W. SHAW, M. A.</i>	<i>Chemist.</i>

WORK WITH A COMBINED FUNGICIDE AND INSECTICIDE IN 1894-'95.

F. L. WASHBURN.

It has come to be regarded as a fact among station workers throughout a part of the United States that Bordeaux Mixture is the best remedy for the fungus known as "Apple Scab" (*Fusicladium dendriticum*) occurring on apple and pear, and that, when properly combined with paris green, it, at the same time checks the ravages of the Codling Moth and of all mandibulate insects attacking trees upon which it is used. It has not been known in Oregon, however, just how many sprayings were necessary, and how early and late they should be applied. It was for the purpose of determining these points that, in 1894 the Botanist, Prof. Craig, and the Entomologist, began a series of experiments which have been continued in 1895, and at date of writing, Aug. 15, 1895, are far enough along to warrant a partial report at least which will be appreciated by fruit-growers. Inasmuch as the principal part of this work belongs to the Botanist an apology is due the reader for the presentation of the results by the Entomologist. A report of the work is called for, however, and the Botanist having resigned, the task devolves upon the Entomologist. Were Prof. Craig reporting, his remarks would probably be much more full and explicit than my own, and he might differ with me on various points.

To go into details regarding the work is not advisable; the results attained can be given in a brief and serviceable form, without entering into particulars.

It should be borne in mind that *where only a few trees in an orchard are sprayed and others left as checks, an experiment cannot be as conclusive as if the entire orchard were sprayed.* In the experiment under discussion sufficient money was not allowed to spray the entire orchard of about one hundred and twenty trees, and from fifteen to twenty only, were used, the others serving as checks. Both the Botanist and Entomologist felt that no decisive report on last year's work could be given, yet certain points were brought out which are worth commenting on, viz:

One pound of IXL in five gallons of water will kill all oyster shell scale or apple bark louse (*Mytilaspis pomorum*) with which it comes in contact.

Bordeaux Mixture (6 lbs. of Blue Vitrol, 6 lbs. of Lime, 22 gals. of water) will do the same, as will also American concentrated lye, one lb. to

five gallons of water. This strength of lye was used in March with very good effect.

Old trees should have scaly bark on trunk and branches scraped off, otherwise scale which might be killed by the above washes, and insect eggs which should be destroyed, are not reached. This was very clearly demonstrated.

Results in 1895.

Trees sprayed with Bordeaux for the first time Mar. 29, and again May 18, make a far better showing than those left until later and sprayed for the first time May 18, and again June 6. This was noticed in every case and offers proof of the value of early spraying and the inefficiency of late spraying. Later spraying may, to a greater or less extent check the growth and spread of the fungus, but the effect is not very marked and some observers affirm that late sprayings have no effect whatever. It should be borne in mind that this parasitic growth sends little projections into the apple or pear under the skin and when this has taken place no wash on the surface of the fruit can reach it.

In a general survey of the orchard one finds some unsprayed trees, left as checks, quite free from scab. This is true from the fact that some varieties of apples are more resistant than others. The same is true of many pears. Bartletts for instance, are, as a rule, less liable to suffer, other things being equal than some other kinds. Careful examination of the orchard, however, Aug. 10, shows that trees which were sprayed for the first time Mar. 28, and again May 18, are yielding large quantities of sound handsome fruit, while the check trees, with the few exceptions noted, are universally scabby. It is further to be noted that the age and thriftiness of a tree has much to do with its condition as regards scab. For instance, a young vigorous Bartlett made a much better showing, though unsprayed, than a sprayed tree of the same variety which was much older, and which, for a Bartlett, was very scabby.

Sprayed trees show less mildew than unsprayed trees.

One tree, badly infested with branch forming Woolly Aphis, was treated, July 3, with special reference to this pest, the colonies being sprayed thoroughly with Bordeaux. On Aug. 10, there was no woolly aphis on the tree.

A third spraying, June 6, with Paris Green added, did not show any better results than when only two sprayings were applied (March 29, and May 18).

Since, therefore, the last spraying would occur before the time for using preventatives against the Codling Moth, it would seem that it is of no especial advantage to combine paris green with the Bordeaux Mixture, but that the Codling Moth must be attacked later, by itself. The presence of the paris green, however, in the Bordeaux early in the season, in no way detracts from the effectiveness of the latter, nor does the Bordeaux interfere with the working of the poison. Furthermore, Tent Caterpillars begin their work quite early, in May, and call for application of some kind of poison.

RECOMMENDATIONS.—Scrape old trees in winter. Use 1 lb. of Amer-

ican Concentrated Lye in 5 gals. of water twice during the winter season, once in January and again in February. This kills moss, green and woolly aphids, scale insects, all fungous growths etc. Lye is a disagreeable spray to handle, and one should avoid getting it on hands or face or in one's eyes. All traces of it should be removed from pump and hose after use. The lime, sulphur, and salt wash, which has recommended itself among all orchardists, is, on many accounts, preferable and is a most excellent wash.

RECIPE FOR LIME, SULPHUR, AND SALT WASH.—(a) Boil 10 lbs. of lime and 20 lbs. of sulphur in 20 gals. of water until all the sulphur is dissolved. (b) Mix 15 lbs. of salt and 15 lbs. of lime and add enough water to make 60 gallons. Unite the two mixtures. Mix well and strain through burlap. Spray affected trees with the solution, warming to about blood heat. A nozzle with a large orifice should be used, otherwise it will clog the aperture. This wash is to be used only before the buds have begun to swell.

Both of these washes are for winter use when the buds are dormant. In March, or as soon as the buds begin to swell use the Bordeaux Mixture (6 lbs. of Blue Vitrol, 6 lbs. of lime and 30 gals. of water).

RECIPE FOR BORDEAUX MIXTURE.—Made and used at different degrees of strength at different seasons and under different circumstances. The following is a very good general recipe: Sulphate of Copper (blue vitrol) 6 lbs., quick lime, 6 lbs., water, 30 gallons. Dissolve the vitrol in a wooden or earthen vessel; slack the lime and add it to the blue vitrol, straining through burlap. Add enough water to make 30 gals. of the mixture. Repeat this three or four weeks later when the leaves are "the size of a mouse's ear" using 45 gals. of water to the same proportion of copper sulphate and lime. A third spraying might be given later, using the same proportions, but from this year's results the third spraying would seem unnecessary.

Should a third spraying with Bordeaux be given in June add Paris Green in the proportions of 1 lb. to 160 gals. of the mixture, the lime allowing of more paris green in a given quantity of water.

Codling Moth does not call for treatment until June 6, to June 12, in ordinary seasons at which time the following spray should be applied: 1 lb. of Paris Green in 300 gals. of water in which water has been dissolved about 20 lbs. of soap. Repeat about the first of July and on late apples. Baldwins, for instance, make two more applications, one late in July and one about the middle of August.

The Horticultural Department of this Station is now spraying for the Codling Moth using lime in the solution, 6 lbs. to every 45 gallons.

The entire orchard should be sprayed, always.

Rain occurring some days after application of Bordeaux does not seem to affect results.

I do not wish to be misunderstood regarding the use of Bordeaux in midsummer. From this season's work I do not advocate it, *yet it does no harm certainly, and may reinforce the earlier treatments.*

The Pests of our principal Fruits, and Remedies therefor.

F. L. WASHBURN.

PESTS OF THE APPLE.—CODLING MOTH.—A small grayish moth one-half of an inch long with a bronze spot on the posterior part of fore wing. It is three brooded in Oregon, the first brood laying eggs on upper part of apple early in June.

Codling Moth, pupa, cocoon, head of larva enlarged, and larva on apple.

Several natural enemies attack this pest, notably, larvae of *Raphidia* and various parasitic flies.

ARTIFICIAL REMEDIES.—See article on combined fungicide and insecticide in this issue. Banding is a good adjunct to spraying. It consists in placing about the trunk of the tree a band of burlap, or 2 bands epuidistant from each other. These bands should be on trees from July 1, to Sept. 1, and should be examined every six days, the larvæ found concealed therein should be killed and the bands replaced. The larvæ or worms will be found to have made small oval white nests or cocoons. Windfalls

should be destroyed.

KILLING IN STOREHOUSES.—Orchardists who have storehouses for their fruit, if they screen the windows and make the building otherwise moth proof, will find in the spring hundreds of codling moths escaping from their cocoons under barrel-hoops in cracks of fruit boxes, etc., and flying about the store room. These can then be easily killed.

Buildings of this sort, more especially if they are not closed up as above suggested, should be carefully cleaned in March of each year, and all the cracks and crevices should be thoroughly wet with a solution made by saturating chloride of lime with all the coal oil it will take up and thinning with water until it can be applied with a brush. This will penetrate the white cocoons or nests and effectually destroy the larvæ or pupæ within.

DISINFECTING FRUIT BOXES.—Boxes in which fruit has been stored through the late fall or winter, should, when emptied, be freed from any trace of cocoons by dipping for two minutes in a *boiling* solution of 3 or 4 lb. of concentrated lye in 20 gals. of water.

(Egg of Codling Moth, (much enlarged).)

San Jose Scale.

Female scale round, flattened, gray, with centre yellowish, about one-tenth in. in diameter. Scale of male smaller, darker, and slightly elongated. The eggs hatch about the time cherries are turning red and the young insects migrate over the tree, soon becoming fixed and secreting a scale. This scale is becoming alarmingly abundant in Oregon. It has been found on other than fruit trees, and is undoubtedly carried, in larval stage, from orchard to orchard and tree to tree by winds, by birds, by bees and other insects.

Branches badly affected with this scale look reddish, and leaf and fruit, if scale is found thereon, show small red rings on their surface about the insects. This is a peculiarity characteristic of this scale. The sapwood of badly infested trees is found to share this red color.

This scale attacks pear, peach, prune and plum as well as apple. It is preyed upon by the "Twice-stabbed lady Bird.

ARTIFICIAL REMEDIES.—The lime sulphur and salt treatment in the winter season is the only practical remedy.

RECIPE FOR LIME SULPHUR AND SALT.—(a) Boil 10 lbs. of lime and 20 lbs. of sulphur in 20 gals. of water until all the sulphur is dissolved. (b) Mix 15 lbs. of lime and 15 lbs. of salt and add enough water to make 60 galls. Unite the two mixtures. Mix well and strain through burlap. Spray affected trees with the solution, warming to about blood heat. A nozzle with a broad orifice should be used, otherwise it will clog the aperture. This wash is to be used only before the buds have begun to swell.

Should young trees be received affected by this or any other scale they

should be disinfected before planting. Dipping them for a few seconds in a solution of 1 lb. am. concentrated lye to every 2½ gallons of water is recommended. The sale of such trees is against the law and is punishable with a heavy fine.

Woolly Aphis.

Branch form: Recognized by the woolly like growth concealing the insect. Found in bluish white clusters on our apple trees and occasionally on pear. Everywhere too common.

Root form, Same as above, but with less woolly growth. Found in clusters on the root, causing a gnarled condition. This pest saps the vitality of the tree, and is a serious enemy to the fruit grower. When present in large numbers it may cause the death of a tree. An alarming feature in connection with this insect enemy is the marvelous rapidity with which it produces its young, the colonies spreading quickly from old neglected trees to some of the choicest in the orchard.

Woolly Aphis: a. galls on root. b. larva. c. winged female. d. leg. e. beak. f. antennæ of female. g. antennæ of larva.

A beetle with black body and red head and thorax (*Podabrus comes*) preys upon this Aphis, as does also the common lady beetle known as *Hippodamia convergens*. Various Syrphus Flies and parasites also wage war against it.

ARTIFICIAL REMEDIES. BRANCH FORM.—Spray with resin wash (see recipe) 1 part wash to six parts of water, spraying colonies forcibly; or kerosene emulsion (see recipe) one part wash to 12 parts water.

ROOT FORM: Remove much of the soil from above the roots and pour over them the wash at the above strength. Cover roots with soil other than was taken out. It is quite possible that treatment with Bisulphide of Carbon would be efficacious against the root form; we are only awaiting an opportunity to test it. When the colonies are on branches of young trees, and still small and few in number, a feather dipped in coal oil and applied to the colony will be efficacious. Do not put the coal oil on leaf or bark. Or they can be crushed with the hand. Old and valueless trees which are

badly infested should be destroyed by burning, root and branch. In Oregon this insect works to some extent in winter. Eggs are also found in winter. For means of destroying these eggs see under Green Aphis.

RECIPE FOR KEROSENE EMULSION.—(*Riley-Hubbard formula.*)—One half pound of hard soap or one pound of soft soap dissolved in one gallon of water. When boiling hot, take from fire and add two gallons of kerosene. Churn with a force pump for five or six minutes until a thick creamy mass is formed. When wanted for use dilute as directed above under the heads of the various insects for which it is used. If free oil should gather on the surface when it is being used it should be skimmed off. It should further be borne in mind that kerosene itself is fatal to vegetation, and while kerosene emulsion properly prepared and properly used is a very valuable insecticide, in the hands of a careless person it might cause very much damage. A more safe wash, in the hands of the inexperienced, is, doubtless, the Resin wash.

RECIPE.—To three pounds of carbonate of soda—common washing sode in other words, (this has proved better than lye which has formerly been recommended,)—add 4 lbs. of rosin and 1 gallon of water. Heat until dissolved and while boiling gradually add four gallons of hot or warm water, stirring all the time, and continue the boiling until the mixture is the color of molasses. When wanted for use, warm and dilute as follows with cold water:

For woolly aphis—1 part, to 6 parts of water.

For any other aphis—1 part to 10 or 12 parts of water.

For mealy bug—1 part wash to 10 parts water.

Mr. Albert Koebele,, who has done much work with this wash is high in its praises.

Oyster Shell Scale.

Frequently called "Apple Bark Louse." The female scale is brown, about $\frac{1}{8}$ inch long and resembles somewhat an elongated oyster shell. The scale of the male is straight and much smaller than that of the female. The eggs hatch into tender yellow lice about the time the trees are blooming and before.

ARTIFICIAL REMEDIES.—Scrape mature trees well in winter to get rid of old, scaly bark. Examine young trees before planting and clean if infested. After scraping the trees use the wash recommended below for apple tree borers or use ordinary whitewash. This scale is by no means as injurious as the San Jose, but when very numerous is destructive.

We have found that I X L. 1 lb. to 5 gals. of water will kill these where it comes in contact with them, as will concentrated lye, 1 lb. to every 5 gallons. This latter wash should be used only in winter.

This scale is sometimes densely crowded on trunk and large branches, and while it is not nearly as bad a pest as the San Jose Scale, nevertheless, it, like all similar insects saps the vitality of the tree.

Flat-headed Apple-tree Borer.

A beetle about $\frac{1}{2}$ in. long somewhat flattened, dark above, with under parts coppery. The larva when full grown is $\frac{3}{4}$ in. long yellowish and footless, with a large, flattened head. It bores into solid and sap wood.

Flat-headed Apple-tree borer. a larva, b pupa, c head of borer, d Beetle.

REMEDIES.—Examine collar and trunk and even the larger branches twice a year, as for peach tree borers and remove the "worm." A discoloration and softening of the bark, or a drop of sap, or a few sawdust-like castings will indicate the presence of the pest. Apply the following wash (as a preventive) in the same way and at the same time as for peach borer. One gallon of common soft soap or whale oil soap dissolved in one gallon of hot water. Stir in one pint of crude carbolic acid. When thoroughly mixed by heat add 10 gallons of warm water and enough lime (quick lime is the best, though slaked lime can be used) to make a whitewash of about the consistency of paint. We find that adding glue to this mixture makes it more durable—1 lb. of glue dissolved in two quarts of water.

We would also recommend adding Paris green to the wash, at the rate of one heaping tablespoonful to every 5 gallons of the mixture, in order to poison any young borer hatching from an egg laid on the bark previous to application of wash. The first bite of the larva as he attempts to gnaw into the bark would, in this case, probably prove fatal. Observe directions for this wash carefully. Do not use more carbolic acid than actually given. Rather than do that leave out the acid altogether.

Protect newly planted trees from sun-scald for it is at such places that the borer is likely to work.

Green Aphis. (*Aphis mali*.)

A green plant larva found on the apple. Not to be confused with other aphids found on hops, willow, alder, etc., etc. When the terminal leaves of fruit trees curl and look sickly examination of the leaves will generally disclose colonies of green aphis, winged and wingless forms on the under side of the leaves, with beaks deeply buried in the plant tissue. The presence of the pest in large numbers causes the twigs in their vicinity to look dark, and generally quantities of ants can be seen crawling up and down the tree. These ants are not attacking the aphids, far from it, they are after the sweet "honey dew" which the lice emit from their bodies.

Green Aphis. Winged and wingless forms. Inset in the size on right.

REMEDIES.—Kerosene emulsion, (see recipe) 1 part, water 12 parts; or resin wash, 1 part, water 10 parts; or the following: 1 quart of soft soap (or $\frac{1}{2}$ lb. of hard soap) in 5 gallons of water to which two quarts of a strong tobacco decoction is added. This decoction is made by steeping waste stems obtained at a cigar factory. The last two remedies are safer than the first, though kerosene emulsion is

excellent when properly made and properly used. Whatever wash is used it is an absolute necessity to spray forcibly the under side of the leaves where the lice are concealed.

In the winter season the shiny black eggs can be destroyed by a wash of concentrated lye, one pound of Am. concentrated lye in 2½ gallons of water. This must only be used when the tree is dormant.

Tent Caterpillars.

In Oregon two kinds of Tent Caterpillar (*Clisiocampa*) prey upon apple, cherry, prune, plum, and peach. They also attack rose, privet, elm, willow, and other trees. A third kind *C. constricta*, feeds upon oak, and does not touch fruit trees. The moths of the first two species look much like this illustration.

Moth of Tent Caterpillar, female, which lay eggs for another brood. These eggs do not hatch until the following spring; in other words there is only one brood in Oregon.

These moths lay eggs in bands around the twig, and these eggs hatch in May and June into caterpillars. When these caterpillars are full grown they spin white cocoons on sides of fences, houses, in the trees where they were feeding, and elsewhere, and shortly turn into moths

These caterpillars are subject to attack from a Tachina fly which lays its white eggs upon or near the head. Some birds tear open the cocoon and feed upon the soft pupa within. Wet weather in June has destroyed many by encouraging fungous growths fatal to the insect.

ARTIFICIAL REMEDIES.—Destroy egg bands found on twigs during autumn and winter by burning. These bands can be broken and slipped off the tree if one does not care to prune. When found massed on side of limb or trunk, a large number of the caterpillars can be killed by the use of a flat stick, piece of shingle or the like. Sometimes a young colony will be seen on a single leaf; pick it off carefully and crush under foot. The nests high up in a tree can

Two Tent Caterpillars, a b with web, d be reached with a torch cocoons, c egg with cement covering removed. Spraying with the arsenites

poisons the leaves and thus kills the leaf-eating caterpillars. (See under "C. Illin Moth.")

Corythuca.

Leaves on apple trees sometimes look wilted, and the under surface appears brown. Careful examination of this under surface shows the presence of a small flat scale like insect, about $\frac{1}{8}$ in. long brownish and more or less transparent. This is *Corythuca*, many specimens of which have been sent to the Station from apple trees. They are closely allied to plant lice and if a remedy were necessary they should be treated in the way suggested for the Green Aphids.

Climbing Cut Worms.

The various colored larvæ of several night-flying moths, unfavorably

Cut worm and Moth.

known as "cut worms" on account of their habit of cutting through the roots of many garden vegetables just below the ground, or through the stalk just above the ground. Some species also injure young fruit trees by climbing up the trunks and feeding on the tender buds and leaves.

REMEDIES.—Inasmuch as they lie concealed during the day in the immediate neighborhood of the plant attacked the previous night, when a young tree is observed to be newly injured, the orchardist should look for the depredator in the earth a few inches from the tree and one or two inches below the surface. Pieces of tin or zinc fastened round the tree in the form of an inverted funnel keeps them from ascending. Shaking the trees late at night and so jarring them onto a sheet below is one good means of collecting them. Numerous holes, about one inch in diameter and a few inches deep, punched in ground about trees will serve as traps into which some will fall and be unable to extricate themselves. Sprinkling the leaves and buds with Paris Green solution (1 lb. to 300 gals. of water) will kill them. Poison baits, made by dipping freshly cut bundles of clover into a strong paris green solution, and scattered among the trees will kill many. Cabbage leaves, it is claimed, laid on the ground form attractive baits under which they conceal themselves and can be killed in the morning.

Red Spider.—(*Tetranychus telarius*.—Linn.)

Not a true spider, but a minute mite which sometimes swarms on branches of fruit trees. Their small eggs, colorless when laid soon turn reddish, making affected spots on branches, look as though covered with iron rust.

These little fellows spin delicate webs on the under side of a leaf and there feed on the leaf's juices. The leaves thus affected turn yellow.

REMEDIES.—Spray with strong soap suds the under sides of the leaves.

Kerosene emulsion is disastrous to these animals, as is any wash containing sulphur. In winter the small, round, red or colorless eggs may be destroyed by a wash 1 lb. American lye in $2\frac{1}{2}$ gals. of water. Lye must not be used in summer.

Scolytid Borers.

The larvæ of very small snout beetles which not only destroy vast areas of forest but frequently attack fruit trees. A number of reports have reached the Station, accompanied by specimens, which bear evidence to this later habit. Their presence in a tree in large numbers foretells its death. They work on trunk and branch and their mines are just underneath the bark. Frequently the course of the burrow is plainly indicated on the outside of the bark by a narrow, tortuous blister, as it were.

The whitewash recommended for the apple tree borer would act as a preventive in this case. We have before us now (Feb. 23) some of these larvæ transforming into beetles, indicating the necessity for early spring treatment.

Once in the tree the surest way to combat them is to cut off the branch, or trunk, below the affected region and burn it. It is fair to conclude that where young fruit trees are planted amongst timber, they may invite attack. We would suggest to those planting fruit trees in the midst of extensive tracts of timber, as on claims, that if the forest in the vicinity is affected the best way to prevent the spread of the pest is, as far as practicable, to cut down all the dead and dying trees in the neighborhood, strip off the bark, and use it (the bark) for fuel. The loosened bark on foreign trees newly affected should, if deemed practicable, be stripped off and burnt. Thousands of these minute larvæ can be found in one stump in felled regions. If the bark from such stumps be burned, the naked stumps do not offer so great inducements. Such radical measures as above outlined would hardly be called for unless the pest became much more destructive than at present.

Cicada or "Locust."

See under Prune.

Red-humped Apple-tree Caterpillar.

A leaf eating caterpillar a little over an inch long emitting a strong disagreeable odor when handled. Head red and a red hump on fourth segment. Not numerous; hand picking and jarring trees could be resorted to if necessary.

Pocket Gopher & "Digger Squirrel."

The first named of these pests frequently gnaws the roots of young fruit trees.

It is a common thing to see gopher mounds arranged in a straight line from the side of a field or garden to some fruit tree or potato, parsnip, or carrot patch, indicating that his main burrow beneath the surface has been pushed directly to these sources of food supply.

REMEDIES FOR THE POCKET GOPHER.—*Poisoning.*—We have introduced powdered strychnine into pieces of potato an inch square and placed this bait down the branch burrow, or even as far as the main burrow, with fair success. We have never had conclusive evidence that the animals

were poisoned, except that digging ceased in that neighborhood which was pretty convincing proof that the strychnine had done its work.

This has proved most effective in the absence of other succulent root crops which may be more tempting to the gopher. And inasmuch as he may push out the bait with a lot of earth, before he fairly reaches it, it has been found best to put into the burrow more than one piece.

It goes without saying that *strychnine, being a deadly poison, should be kept under lock and key*, out of the way of children and others ignorant of its use.

Wakelee's Poisoned Wheat is claimed by some to be not only efficacious against the so-called "Digger Squirrel" but to be also a good remedy for the pocket gopher. If this is so, it must be at times when other more juicy food is scarce.

Shooting.—A handy shotgun is very effective. The pocket gopher works during the night, and is quite likely to be found digging *early in the morning, again about noon and again late in the afternoon*. At these times he frequently thrusts his head out of his hole and a few pellets of shot will kill him.

But the farmer or the orchardist can not afford to spend time in watching gopher holes, and their best resources are poisons and

Traps.—There are many so-called gopher and mole traps on the market but apparently very few which can be profitably purchased.

The accompanying figure illustrates the Picard Gopher and Mole Trap, manufactured by John Picard, St. Paul, Marion Co., Oregon. It is a good trap when properly set.

By far the most efficacious contrivance is a breech-loading gun called a "gopher gun," 16 bore, which, with a small load of powder and shot, is very satisfactory, both against gophers and moles. It is sold by Emma Riggs, Crowley, Ore.

The "Digger Squirrel" so-called, or "Ground Squirrel" is really a gopher and no squirrel at all. My attention has been repeatedly called this season to injury by this pest and he is no mean foe to the fruit grower. I have seen, on yearling apple trees growing near timber, the tender leaves

eaten off completely, tell-tale mud on the trunk affording evidence of the culprit. Again in older trees, with branches several inches long, too slender to bear his weight, he has shown intelligence to a marked degree by

gnawing said branches at the base until they hung down close to the trunk whence the leaves could be reached.

REMEDIES FOR THE "DIGGER SQUIRREL."—Poisoned wheat introduced into the burrow, out of the way of birds, is a common method of destruction. A California orchardist suggests tying newspapers round the tree trunk in such a way that four inches of the paper at the upper edge extends out. The rattling of the paper, as the squirrels attempt to cross it, will frighten them. Mr. J. H. Stewart, of Medford, Oregon, uses successfully in his orchard a home-made "trap." In the fence corners he places boxes about one and one-half feet square at the ends and about four feet long. The top and two ends are united and can be lifted off the box. The ends do not reach quite to the bottom board, an open space of about three or four inches intervening and enabling the animal to run through the box. On the bottom, midway between the two ends, pieces of pork rind are se-

End view of Mr. Stewart's trap.

curely nailed. The pieces have been first soaked in a solution made by boiling strychnine in water. The top is fastened on to the box by means of a couple of nails which can be easily pulled out when putting in new bait. Mr. Stewart asserts that his trees are free from attack. Strychnine is not very soluble in water, but, if thoroughly boiled, enough will dissolve to make a poison. We would suggest sweetening the solution.

Bisulphide of carbon poured upon a wad of cotton the size of one's fist and thrust down the hole which is immediately closed with earth is quite effective, it is claimed, both with this pest and with the pocket gopher. We have tried it on the latter and believe it to be good, though conclusive evidence was not given.

A light of any kind must never be brought near this liquid as it is highly inflammable.

CICADA, see under Prune. RED SPIDER, see under Plum. CLOVER MITE, see under Plum.

Pests of the Pear.

THE PEAR AND CHERRY TREE SLUG.

Sawfly producing Pear and Cherry Tree Slug.

Cherry leaf showing Slug at work. a. Larva, natural size.

A dark green, olive, or yellowish slimy worm about $\frac{2}{3}$ of an inch long when full grown, feeding on the leaves of pear, cherry, and other trees. It eats the upper side of the leaf causing the leaf to wither and fall to the ground. This larva undergoes its transformations in the ground, changing to a four winged fly which lays its eggs on the leaves.

REMEDY.—A weak Paris Green spray (1 lb. to 300 gals. of water) will kill them, hence any trees which are being treated with the arsenites for

codling moth or tent caterpillar should be exempt to a greater or less degree from this pest.

Air slaked lime dusted on the foliage has been found to be excellent. Hellibore, one ounce to two gallons of water is claimed to be an effective remedy, applied the same way. Lime is much to be preferred to the paris green remedy on cherries, and on any fruit till in bloom. Road dust thrown on the foliage is fairly effective, but lime is the best.

Branch and Twig Borer.

Branch and Twig Burrower.

A brownish beetle, half an inch long or over, burrowing into the twigs and small branches of many of our fruit trees. It is reported to infest apple, peach, apricot, grape, etc., but it has been reported to this department as especially affecting pear trees. The axil of a bud or of a small branch is the place chosen for the operations, and the beetle eats into the pith. The opening of the burrow always points upward and rainwater, lodging in the same, causes decay, or the branches break off when thus weakened.

REMEDIES.—It is quite probable that the eggs of this species are laid before the mature beetle is seen at work on the twig, hence collecting and burning the infested twigs with the beetles would be like locking the door after the horse was stolen, yet it would do no harm to take this latter precaution.

As a preventive spray the twigs, about the time the beetles appear, with paris green and water that the insect may be poisoned when attempting to eat into the twig. If whale-oil soap is added to the paris green solution it would be beneficial in that it is obnoxious to the beetle, and would probably keep many away.

The Pear Leaf Blister Mite.

This affection of the pear leaf is caused by a minute mite *Phytoptus pyri*, and is probably more common and has been here longer, than most orchardists realize; in fact, it is very likely that much of that which has been called "blight" on the pear, is really the work of this pest. The mite is very small, hardly visible to the naked eye and is well represented in the accompanying photo-micrograph furnished by Mr. Pernot.

Pear Leaf Blister mite, enlarged about 300 times.

It attacks both sides of the leaf, but individuals are more numerous on the under side where the small "blisters" can be seen with the naked eye. A lense, however, is required to show the opening in the center of the blister which serves as a doorway for the mite. The location of the injury below is made apparent on the upper surface of the leaf, by an irregular reddish spot, (in the early stages) which changes later to brown and black, while the tissue of the leaf between these two points, in which tissue eggs and young mites are found, becomes corky and dies.

The injury to the tree is more readily seen in the middle and late summer, when, in bad cases, almost its entire foliage looks blighted.

The young mites when hatched spread from leaf to leaf, creating new blisters and thus bringing about the condition referred to above. In the autumn when leaves begin to wither and fall, the mites migrate to the twigs and hibernate beneath scales of bark or bud in the minute crevices on twigs, and in the spring they are fully open. It is hardly necessary to say that this mite saps the vitality of the tree, and interferes with the natural functions of the leaves. The work of this pest is illustrated by the accompanying page plate, showing views of upper and lower surfaces of leaves affected with pear leaf blister.

REMEDIES.—When a tree is observed to be first attacked, pick off and burn the infected leaves. Heavy pruning and burning the cuttings of such trees as are badly affected, during the winter will probably be more efficacious than anything else. One or two sprayings of kerosene emulsion in the autumn when mites are migrating would destroy many. The same spray, used several times, has been recommended for winter use. It is highly spoken of in a Cornell University bulletin, and is to be used in this proportion,—one part emulsion to seven or eight parts of water.

CODLING MOTH.—See under Apple. The first brood does not attack the pear, hence, on pear the first spraying need not take place until two weeks or more after the first spraying of apples.

SAN JOSE SCALE.—See under Apple.

WOOLLY APHIS.—See under Apple.

GOPHERS AND SQUIRRELS.—See under Apple.

CICADA, "LOCUST."—See under Prune.

RED SPIDER.—See under Apple.

CLOVER MITE.—See under Plum.

Pests of the Prune.

PEACH TREE BORER.—A troublesome pest wherever any tree is grafted on Peach or Plum stock.

A steel-blue, wasp-like looking, clear-winged moth which flies in the day time. It lays its eggs on the plum, cherry and peach tree (or peach stock whatever the tree may be) at or near the collar and the larva hatching, bores downward in the sapwood and bark.

The full grown worm is about 1 inch long, yellowish white with a red-

Leaves affected with Pear Leaf Blister

dish, brown head and strong brown jaws. The presence of the pest is indicated by exuding gum often mixed with sawdust-like castings.

It behooves all owners of peach or prune trees to be alive to the destruction which this pest can cause.

REMEDIES AND MEANS OF PREVENTION.—Examine trees twice a year, once in October, and again in February or March, removing earth from about collar and upper roots, taking out borers with a knife, and making as small a wound in doing so as possible. Apply wash recommended for apple tree borer in April. A second application in August is desirable. Heaping earth or leached ashes around the base of the tree is also recommended, as is the tying of newspaper (several thicknesses) or of stout paper of any kind, (tarred paper is good) around the trunk, allowing it to extend from 15 inches above the ground to three inches below the surface. This latter prevention meets with much success, but is only of use after all borers have been removed from tree.

Some object to cutting out the borer, claiming it injures the tree. To overcome this they take hot water, almost at the boiling point, and removing a little earth from about the collar of the tree, in order to expose the opening of the burrow, they pour hot water into the depression, which is said to penetrate the burrow, reach the borer and kill it. We have never tested this.

Cicada or "Locust."

This is the insect which we hear "singing" in tree tops during summer. It is allied to the "Seventeen-year-Locust", though the latter species does not occur here. Two or three other species are found here, and these sometimes lay eggs in gashes which they make in twigs of fruit trees. This weakens the twig and it is easily broken.

REMEDIES.—When such gashes are seen cut off twig and burn, thus preventing the hatching of the eggs.

SAN JOSE SCALE.—See under Apple.

PEACH TWIG MOTH.—See under Peach.

DIVARICATED BUPRESTIS.—See under Peach.

CODLING MOTH.—The Entomologist has found a few codling moths in Prunes.

Insects Infesting the Plum.

RED SPIDER.—See under Apple.

PEACH MOTH.—See under Peach.

PEACH TREE BORER.—See under Prune.

SAN JOSE SCALE.—See under Apple.

The Clover Mite.

Bryobia pratensis.—Garman.

It is now evident that this pest is more prevalent in Oregon than is generally supposed. No complaints having been received from growers of clover, the Entomologist has referred specimens of eggs and young mites sent him to the species known as the Red Spider with which this mite is almost identical. But suspecting from its abundance, that it might be *Bryobia*, specimens have been recently sent to specialists at Washington D. C.,

and our suspicions confirmed. The young Clover Mite resembles so closely the young of the so called Red Spider that only specialists in this branch of entomology can satisfactorily determine the difference.

The two belong to the same family, *Tetranychidae*, and have been for a long time confused. Like the Red Spider, the Clover Mite feeds on plant tissues, infesting almost all kinds of fruit trees, though red clover is said to be its principal food plant. When attacked the leaves of clover look sickly as if suffering from some fungus. It is also found on some grasses and has been known to occur in houses. It was first reported from this coast (California) as early as 1879. May 28, 1889, Mr. E. Shipley, of James Valley P. O., Oregon sent specimens of this mite to Washington, D. C., with the statement that it was abundant on boards, stones, fences and fruit trees. It has been found on Apple, Pear, Plum, Prune, Poplar, Elm, Peach, and Almond.

In some localities young mites are found with the eggs during the entire winter season. These eggs are red or reddish, easily seen with the naked eye, and are laid in masses on the bark or beneath the scaly bark of old trees. In the winter they are found by the hundred in protected situations.

When attacking forage crops, it cannot, with our present knowledge, be combatted. When on fruit trees, the Department recommends spraying with kerosene emulsion to which a little sulphur has been added, and when infesting houses the same solution should be used on the lawn and outside walls of the house.

As stated before, no complaint of this pest with regard to clover has been received at our Station. If, at any time, the clover crop should appear to be suffering from the attacks of this mite, the Entomologist would like to be advised of the fact, and to receive specimens of the mite and its work.

Enemies of the Peach.

PEACH MOTH OR PEACH TWIG BORER.—Not to be confounded with the Peach Borer. The moth is grayish, about $\frac{3}{4}$ in. long. The larva or borer is pink about $\frac{2}{3}$ in. long when full grown. It effects the fruit of the peach and plum as well as the twigs.

REMEDIES.—Not likely to become a serious pest. The only sure remedy is to remove infested twigs and burn them. Some repellant agent sprayed (any safe wash containing sulphur) or dusted (flowers of sulphur or air slaked lime) on the twigs early in the spring would doubtless serve to keep many moths from laying their eggs on tree.

This pest in larval form bores in the terminal twigs of the peach and must not be confounded with the Peach Tree Borer.

Peach Aphis.

A louse somewhat resembling the green aphid except in color. They are black, brownish or yellowish. A root form is said to occur on the roots.

REMEDIES.—When found on branches, the tobacco and soft soap solution mentioned under "Green Aphid" is the best remedy.

Divaricated Buprestes.

A rough bronze-colored beetle nearly 1 in. long. The wing covers at posterior end are slightly spread apart. Frequently found sunning itself on limbs of cherry and peach. The larva or grub which feeds on the sap-wood closely resembles the flat-headed borer. Though not reported as troublesome I have taken from the collar of a peach tree a larva of this species over $1\frac{1}{4}$ inches long and in the same tree found two or three specimens considerably smaller.

REMEDY.—The treatment recommended for the peach tree borer would be efficacious here.

PEACH BORER, see under Prune. CICADA, see under Prune. SAN JOSE SCALE, see under Apple.

Pests of the Cherry.

CHERRY APHIS, see under Peach. CHERRY SLUG, see under Pear. DIVARICATED BUPRESTIS, see under Peach.

Enemies of the Grape.

But few or no enemies of the Grape in Oregon are known to the Entomologist. The Phylloxera as far as is known does not occur here, and this fruit seems to be remarkably exempt from attack. A species of *Alyppia* has been sent to me in one instance reported as "flying about and lighting upon grape vines," but no further report of damage by larva has been sent in.

An Entomological Calendar.

F. L. WASHBURN.

The following brief calendar is inserted with the thought that it might serve as a memorandum to orchardists and is intended to be used in connection with the preceeding article in Fruit Pests. It refers to insects injuring the orchard, and the reader is to refer to the article above mentioned for particulars regarding remedies and means of prevention, when these are not given in the calendar. For example,—under June this paragraph occurs: "If any of the pear leaves show the reddish blisters with minute openings on under surface in this month or in July, it indicates the presence of the Pear Leaf Blister Mite." (See page 17.

The reference in parenthesis refers, of course, to the paragraph on the Pear Leaf Blister Mite which occurs in the article on Fruit Pests.

This calendar might be criticised on the ground that it is somewhat of a repetition of suggestions made in the article on fruit pests. This is in a measure true. It is intended to serve as a monthly reminder to the orchardist and has been made as brief as possible consistent with its object. It is hoped that this object will be attained.

JANUARY.

A good time for winter treatment with lye, or lime sulphur and salt, for scale, eggs of plant lice and Woolly Aphis, moss, and dormant spores of fungi. Before spraying see that old scaly bark is scraped off. All trees not worth attention which are not reserved for grafting purposes, and which were not destroyed the preceeding summer should be grubbed up.

FEBRUARY.

Same treatment, either for the first time, or a repetition of January's work.

MARCH.

This month is not too late for winter treatment with caustic washes, as above outlined if it has not been done before. Or, it is a good time for a second application of winter washes. Two applications are desirable. Spray for scab on apple and pear sometime from the middle to the last of the month, using Bordeaux Mixture (See page 5.) This treatment will also kill oyster shell scale. Should you have used lime, sulphur, and salt this month, it would not be necessary to use Bordeaux now. If any trees were infested with Pear Leaf Blister Mite the preceding summer, heavy prunings of affected trees, and burning of cuttings could well be done now.

Look through the orchard carefully for eggs of Tent Caterpillars, and when egg bands about twigs are found, crack them, break them off and burn them; or prune and burn cuttings. These bands can be cracked and slipped off with the fingers without injury to the twig.

Sometime this month a careful examination should be made of collar and upper roots of peach, prune, plum and cherry trees, for peach tree borers (See page 17.)

It is also a good time to poison gophers when no root crops are in the ground and before this pest has brought forth and weaned its young. (See page 13.

APRIL.

Apply wash (see recipe page 19) for Peach Tree Borer on peaches, plums, prunes, and cherries, and on apples for Flat-headed apple tree borer.

Go through the orchard carefully a second time for eggs of tent caterpillar. Do this early in the month.

MAY.

Look sharply for colonies of green aphid starting on apple trees, and kill them by spraying, or by picking off affected leaves and crushing if but few leaves are affected.

Spray a second time for scab a little while before blossoms open. It would do no harm to add paris green to the solution, 1 lb. to every 160 gallons. The presence of the arsenite would not interfere with action of fungicide and the poison would kill tent caterpillars if they were present and all other mandibulate insects. (See article on "work with a combined Fungicide and Insecticide," for strength of Bordeaux etc.) Do not spray trees when blossoms are open.

The latter part of this month, and early in June careful observations in the orchard from time to time will disclose young colonies of Tent Cater-

pillars, just hatched, on the leaves. By picking off the leaves so affected which can be reached and crushing under foot, a large number may be killed before they have done any harm. Spraying the leaves with paris green (1 lb. and water 300 gals.) will kill them,

JUNE.

Look out for Woolly Aphis on apple tree and where tree is not too large, or colonies too numerous keep them in check by touching with a feather dipped in kerosene.

Keep Green Aphis in check on your apple trees. Spray for Codling Moth (see under codling moth) for the first time about the 10th or 12th or rather, as seasons vary, let us say when apples are about the size of marbles. The same spray will kill tent caterpillars which may be feeding on the leaves.

The Branch and Twig Borer is working on the twigs during this month.

If any of the pear leaves show the reddish blisters on under surface with minute openings, in this month or in July it indicates the presence of the Pear leaf Blister Mite. (See page 17.)

JULY.

As an adjunct to spraying place burlap bands about apple trees, a foot from the ground and examine every week for six weeks, killing the larvæ found beneath. A second band, one foot above the lower band is better than one alone.

A second spraying for codling moth and all mandibulate insects on the fruit trees, three weeks or less after first spraying, should occur in this month. At the same date, and for the first time spray pear trees for the Codling Moth. The pears do not call for the early spraying given to apples.

Examining leaves of Cherry and Pear for Pear and Cherry-tree slug, and if present, throw air-slaked lime over the leaves.

Look to your young fruit trees during this month and the following; if the leaves are being bitten off close to the stem the "digger squirrel" is probably the cause. Look for other indications of his presence, and if you are fairly certain that he is the depredator use the remedies given under "Gophers and Squirrels."

AUGUST.

A third spraying for Codling Moth three weeks after last application. This should be the last except on late varieties which call for another treatment. Do not be unnecessarily alarmed if a delicate flat scale-like insect is observed on under side of apple leaf, causing a browning of the under surface and a withering of the leaves. It is *Corythuca*, and has not been abundant enough to be especially injurious. Should it prove so use the remedies for the Green Aphis.

The Cicada is working on twigs of fruit trees. (See page 19.)

If Pear and Cherry Tree slug is still affecting your trees, use lime as before. It would do no harm and is generally recommended, to apply, during this month a second coat of whitewash to peach, prune, plum and cherry trees, depending of course, on the extent to which rain may have washed off the previous application made in April. (See page 15.)

SEPTEMBER.

Give last spraying for Codling Moth to Baldwins and other late varieties during this month. To insure good results every spraying must be thorough, and an even distribution of the poison over the fruit must be received. Some orchardists go so far as to spray every ten or twelve days during the summer for the codling moth. Such energy is very commendable, and probably brings better returns than fewer sprayings, albeit the labor and expense is much greater.

Before rains begin, burn all rubbish about orchards and about the farm generally, in corners, along fence rows, that no good place be left for insects to hibernate in.

Do not pile green cord wood along side of orchard; you are likely to thereby bring into the vicinity of your fruit trees pests which, if left in the forest, would not injure you.

OCTOBER.

Put away spray pump after last spraying and all spraying machinery, tanks etc., in good order, thoroughly clean and free from any corroding substance.

NOVEMBER.

Buy some good books on fruit pests and diseases of fruit trees and lay out a course of reading which will help you the coming season. You will want to look over your file of Experiment Station Bulletins. You have no doubt carefully put them away, as they have been received from time to time.

If any member of your family; or if you, have taken the time to collect specimens of pests and insects generally it is a good time, with the literature you have to become familiar with their appearance and habits.

DECEMBER.

Before the last of December you have probably, having first received price lists from reliable firms, made arrangements for purchasing a spray pump if you need one, and have obtained lye, sulphur, quick lime, salt, blue vitriol, paris green, or london purple, and any and all insecticides which you will need for winter and spring use. Be careful to get *good* Paris Green. A good quality of this poison should mix readily with water and form a mass of the consistency of cream. In fact this is the way we have always mixed it in spraying. First mix it with a small quantity of water, and then pour it into the larger quantity of liquid.

Beneficial Insects.

It is well that the farmer should know that among the class of insects which we are wont to look upon as foes we find those which are benefiting us.

These may benefit us *directly*, as for example the honey bee, or silk worm; the cochineal insect or the lac insect, or they may aid us *indirectly*, that is in following out their natural instincts they may be of great help to the orchardist and farmer.

Many of these have been referred to in the body of this bulletin, but a

short description of the leading forms will not be out of place. These insects may be *predatory*, that is, they may attack and eat injurious forms, or they may lay their eggs in or on the pest or its larva and the death of the latter be brought about by the larva which hatches from the egg feeding upon the tissues of its host or injurious insect. This second class is called *parasitic*. It is to the first sub-division of indirectly beneficial insects that we now call the reader's attention. The most common of the predatory forms are as follows:

1. GROUND BEETLES.—Blackish or brownish beetles from $\frac{3}{8}$ of an inch to 1 inch long, rapid runners, found everywhere, under boards, logs, etc. *Omus Californicus* is an abundant species, as is different species of *Harpalus* and *Pterosticus*. All have strong jaws especially adapted to their predatory habits. Many a cut worm and codling moth larva falls a victim to these friends of the farmer.

2. TIGER BEETLES.—Beetles generally marked with white on the back, formidable jaws, slender legs; many forms are greenish or purplish green with white markings. They are about $\frac{3}{4}$ of an inch long. They are by no means as common as the preceding, and occurring on sandy shores, and in places away from the orchard are not so likely to be so well known as other forms. They are fond of the hot sunshine and quickly take flight at the approach of the net to alight a few feet farther on.

3. PODABRUS COMES.—A beetle with a black body and red head and thorax. It has no common name. It feeds upon Woolly Aphs.

4. LADY BEETLES: Sometimes erroneously called "lady bugs" or "lady birds." It is a family containing many species. Every one is familiar with the old rhyme "Lady Bird, Lady Bird, fly away home, Your house is on fire and your children will burn", which is applied to members of this family. As a rule they are small, about $\frac{1}{4}$ of an inch long, though a few forms are over $\frac{1}{3}$ of an inch long, hemispherical. Some are black with two red spots on their backs. A very common kind in Oregon is *Hippodamia convergens*, reddish or brownish, $\frac{1}{4}$ in. long with black head and thorax. The back may or may not have spots.

Its larva is a "worm" blackish, rough and bristly, $\frac{3}{8}$ in. long. The adult beetle lays its eggs among plant lice, and both adult and larva consume large numbers of these pests,

5. SYRPHUS FLIES.—One frequently sees these flies poised over plants infested with plant lice, darting here and there, having much the motion of bees; some forms mimicking bees or wasps very well in coloration, having yellow bands across the back. Others are of darker color. The eggs, laid among plant lice, quickly hatch into "worms" greenish or brownish, about $\frac{3}{8}$ in. long when full grown. These consume hundreds of lice.

6. LACE WING FLY.—Green with delicate gauzy wings. The insect is $\frac{1}{2}$ in. or over and is very common in orchards. Its eggs are laid on fruit or leaf, and are *placed on thread like stalks*. The stalk and eggs are white. When an egg is on the point of hatching, the stalk bends, allowing the occupant of the egg to crawl out on the surface of the leaf or fruit, while the

other eggs are out of the way of the jaws of this voracious little larva, which at once begins to look about for woolly aphids or green aphids.

7. ANT LION.—A beneficial predacious insect but not so helpful to the agriculturist as some of the previous forms because it is found away from the farm in sandy places in the woods. Here its small pits, an inch or less in diameter are frequently seen, at the bottom of which is snugly ensconced the strong jawed larva about $\frac{1}{4}$ of an inch long, waiting for any luckless insect which may fall into his trap. The imago or perfect insect is about $\frac{3}{4}$ of an inch long and its four wings expand about one inch.

Parasitical Insects.

As mentioned above there are insects whose young are *larvæ* feed on the tissues of injurious (and in some cases it must be said, beneficial) forms. Chief among them are:

8. ICHNEUMON FLIES: These have heads broad transversely, with very long antennæ; generally a prominent ovipositor projecting from the posterior end of the body. They vary in size from a very small species, almost microscopical to the large *Thalessa* nearly an inch and a quarter long, with a long slender ovipositor which is thrust into the burrow of some borers in wood.

9. TACHINA FLIES: One frequently sees caterpillars with one or more white eggs on or near the head. These eggs are deposited by Tachina flies. These are short flies with stout body more or less covered with bristles, and are frequently found about flowers. The host, or injurious insect they infest, does not die at once, but it never transforms to an imago, its death taking place after the parasite or parasites have issued from its body.

There are several other families of parasites, many of them so small as to be hardly visible to the naked eye; and the most of them, while doing an almost incalculable amount of good, do not attract attention.

Prof. J. H. Comstock writes of parasitic insects so entertainingly and so instructively withall that we quote him in full here:

"When the discouraged farmer sees his crops harvested before due time by hordes of hungry insects, he is apt to long for a miracle to remove the plague from his fields. Oftener than he dreams the miracle takes place and millions of insect pests never live to lay their eggs for another brood. Such miracles are most frequently wrought by numbers of this (referring to Ichneumon Flies) and allied families.

Very many other insects play an important part in the destruction of insect pests; but in most cases these other insects are simply predaceous, pouncing upon and destroying such insects as they can overcome. But the true parasites act in a very different way. Although some species are external parasites, most of them live in the bodies of their victims, within which they have their entire larval existence. Their presence in this strange situation is due to the fact that the parent lays her eggs within or upon the body of the insect to be destroyed. When the egg is laid upon the body of the victim, the larva as soon as it hatches bores its way into the

body. So, in either case the young parasite is in the midst of suitable food. It is probable that the young parasite feeds only on the blood of its host; hence the parasitized insect is not destroyed at once, but lives on with the parasite within it, which gradually attains its growth. Finally, the parasitized insect perishes; and from the larva that has been nourished in its body there is developed a winged creature, which in turn lays its eggs in other victims."

Beneficial Birds?

While there may be and undoubtedly are some injurious birds, there is no doubt but that the majority of our commoner small birds, are in the long run decidedly beneficial, the injurious insects they destroy more than paying for the fruit and cereals they consume.

Excluding the English Sparrow, a foreigner for whom we have little or no sympathy there is perhaps only one bird which really stands on dangerous ground and I refer to the so-called "sap-sucker" or "sap-sucking woodpecker." This title is only deserved, it must be noted, by *one* bird, not by the entire group of woodpeckers.

And yet, a recent bulletin from the Department of Agriculture at Washington D. C., claims that the trees are punctured, and the sap induced to flow by this bird, in order that the sweet juice may attract insects upon which the bird has been seen to feed. During certain seasons of the year the "sap sucker" subsists very largely upon insects.

Most fruit growers, however, no matter how humane they are theoretically, are not going to look quietly on, while Robins and other birds in hordes are eating up their berries, and they have resource to their shotgun. This is a matter which the entomologist will have to leave to their own consciences.

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DEPARTMENT OF CHEMISTRY.

G. W. SHAW.

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A STUDY IN THE ECONOMY OF CATTLE FOODS.

BY G. W. SHAW.

The subject of stock feeding is an important one to this State, and is destined to be more so in the near future. It is important not only to the producer of cattle for the butcher's block, but also to every farmer who has to do with stock of any kind, for it improves the chance of supplementing the articles at hand in an economical manner and to suit the varied conditions and desires. This is the more so in these times of close margins, when every business has to be reduced to the strictest economy. It is "penny wise and pound foolish" for us to pursue in these days the methods of twenty-five years ago, when there was scarcely anything known either of the composition or digestibility of cattle foods. If we would succeed in any business it behooves us to spend a portion of our time in reading the experience of others, and of the investigations that are being conducted along the lines in which our business interests lie. It is no more essential that the manufacturer should be abreast of the times in order to succeed, than that the farmer should be acquainted with the latest discoveries in his business.

There is today a veritable struggle for existence, and this becomes more intense year by year in all pursuits. Farming, once regarded as the simplest of all occupations, has become one of the most complex. The farmer who follows practices of years ago, when he had but to sow the seed and harvest the crop, to pitch out the hay to his cattle, letting them eat as much as they would and trample under foot any that remained, has little remuneration to-day for his toil. The new methods that have taken the place of the old hap-hazard ways always require considerable thought, and often very close study. As the result of this, the farmer must become a student as well as a thorough business man. As time advances it becomes more and more evident that "No department of natural science is incapable of yielding instruction to the tiller of the soil." We can no longer look with

suspicion upon anything that smacks of science, for knowledge which comes to us through its channels has been obtained by the most careful observations and experiment.

The ultimate purpose of all agricultural investigation is how to produce more plants and animals upon the same area at a less expense. With reference to this question during the last ten years a great many important problems have been solved, and none has a more important bearing upon farm economy than that of rational stock feeding. We must admit that much still remains to be done in this field, yet the results so far obtained have put an entirely different aspect upon this branch of farm operations. The field is a vast one, and we might almost say that it is boundless; and the varied local conditions so modify the circumstances that there is need of special investigation in each locality. The solution of these problems demands long and carefully conducted experiments, for the questions that have to be met are not only the composition of the fodder articles, but also their relative digestibility under the existing circumstances and with the particular kind of animal in hand, and how much of the various nutrients each kind of animal needs to support life, and to do the desired work.

In the state of Oregon on January 1, 1893 there were the following animals.

Horses.....	294,509.	Valued at \$13,479,667
Mules.....	4,755.	" " 249,503
Milch Cows.....	107,183.	" " 2,572,392
Oxen and other Cattle.....	781,114.	" " 12,238,890
Sheep	2,456,077.	" " 5,903,182
Hogs.....	204,609.	" " 912,760

A saving of but ten cents per month would aggregate over four and one-half million dollars to the state per year, and such a saving by rational feeding alone would be a very conservative estimate. Then there are the wasteful methods of handling manure, which will demand attention at another time.

A writer has tersely put the question of farm management as requiring a knowledge of "1. What fodder crops to grow; 2. which will produce the most nutritive matter per acre at the lowest cost; 3. how to feed these in such a way as to get the benefit of all they contain; and 4. how to return to the soil as

much as possible of the manurial matter removed with the crop.”

It is the province of this bulletin to set forth the results of the analyses of some of the grasses commonly grown in this state, as well as some explanation of the methods used in calculating rations. It is the legitimate office of any bulletin to disseminate among the farmers of the state in which it is published, results that will be useful to them, wherever those results may have been obtained, of course giving proper credit for the source. Hence in this publication is given a table showing the average composition of many common feeding stuffs. It is deemed best to give this at this time since of late there has been considerable inquiry for such information. The results given in Table III. represent averages of a large number of analyses made in many places in this country.

As this is essentially the first bulletin issued from this Station bearing directly on this important question, it will not be out of place to explain some of the terms which are used in all discussions of a like nature. These it will be necessary to understand in order to intelligently comprehend not only this bulletin, but also the farm literature as it appears in the best agricultural papers.

COMPOSITION OF CATTLE-FOODS.

The following description is put in as simple terms as possible without sacrificing accuracy of statement, and in no sense pretends to be new matter. The composition of food-stuffs, whether plant or animal, may be graphically represented as follows:

It will be noticed that in all cases water is present. In

many instances this is very evident, as in grass, beets, turnips, etc.; while in other material it is not so evident, yet when they seem perfectly dry under ordinary conditions, there is from 5 to 10 per cent moisture present. This water has no more food value than that taken from wells or streams. It is, however, a necessary constituent of the animal body, of which it composes from 40 to 50 per cent. Moisture is determined in the laboratory by heating the material for a long time at the temperature of boiling water, and in feeding stuffs, for technical reasons, this is conducted in a current of dry hydrogen. After the moisture has been driven off there is left the *dry matter*, which is partly organic and partly mineral in its composition. The mineral matter of plants has already been discussed in a previous bulletin, No. 36. In fodder analyses this mineral part of the plant is expressed by the term *ash*. It is the residue left after burning to perfect whiteness.

The organic matter embraces two well marked classes, viz., those containing the element nitrogen, *nitrogenous*; and those which lack nitrogen, *non-nitrogenous*. Of all the material composing a food-stuff, the nitrogenous matter is the most important. It embraces both albuminoids and amides, which, however, are not usually separated, but classed together as *Crude Protein*. The albuminoids compose much the larger part, and are the more important. They contain about 16 per cent of nitrogen, and are determined by an estimation of this element in the food-stuff. The part which these bodies play in the animal economy is the very important one of producing or renewing flesh (muscle or lean meat.) Their office is two-fold for they also furnish material from which the animal is able to elaborate a certain amount of fat. Yet by feeding the animal protein alone he cannot be kept alive for any length of time. Experiment has conclusively demonstrated that only by feeding all three ingredients can this be done without sacrificing health or flesh. The relative amount of protein, and its digestibility, determines in a large measure the commercial value of a food-stuff.

Nearly all food-stuffs contain more or less fat. This term is not used here in as definite a sense as in ordinary language, but rather refers to a class of bodies which have a similar com-

position, and since they are determined by extraction with ether, many chemists prefer to use the name *Ether Extract*. It really denotes more than fat, including in the case of grasses, clovers and other green food-stuffs, the coloring matter and certain gums. But in grain the extract is nearly all fats and oils. These do not differ in any essential particular from the animal fats and oils, which all belong to a class of bodies known as glycerides. As intimated above an animal has power to form fats in its own body, hence does not rely solely on the supply from the food-stuff. The function of this class of bodies is to keep up the animal heat. It seems to make no difference as to the source of the fat, for even in the butter from milch cows that had been fed on cotton-seed meal, thereby affecting the milk, Babcock failed to find any trace of the foreign fat, and pronounced it all butter fat.* As a heat producer the value of the fat of a food-stuff is $2\frac{1}{2}$ times that of the other carbohydrates.

The CARBOHYDRATES are usually separated into *Crude Fibre*, and another class called *Nitrogen-free Extract*. The former is the woody tissue of the plant, which remains after successive boilings with a weak acid and a weak alkali. Carefully conducted experiments show that even this woody fibre has a nutritive value, a small quantity usually being digested. Still the value of food-stuffs usually varies inversely as the amount of crude fibre present. The *Nitrogen-free Extract* is composed of a number of substances, as starch, sugar, dextrin, and gums, grouped together because similar in composition. The entire group of carbohydrates is used to keep up the vital heat of the body, and produce fat to be stored up in the animal tissues for reserve fuel.

So far as known all changes of whatever kind occur in nature in accordance with fixed methods. "Like causes produce like results." This is as true in the process of animal digestion as elsewhere. The processes of nutrition are carried on according to well fixed laws, and it has been one of the objects of scientific research to arrive at a better understanding of these laws in order that they may be applied in feeding animals. The history of investigations to ascertain just what is the correct

*6th Annual Report of N. Y. Exp. Station.

proportions of nutrients to feed animals to produce different results, and that the most economically, covers a period of about thirty years, the earliest experiments being made by Bischoff and Voit, in Munich, Slohmann and Hennebey, in Weende, and Wolff, in Hohenheim. The results of these investigations, and later ones in America, have resulted in such intelligent tabulations as to enable us to get better results and more profit than with the old hap-hazard, guess-work method.

That a food-stuff may be of the greatest value, it must have a certain proportion existing between the nutrients, and these must be accompanied by a certain amount of non-nutritive matter. All the material of a food-stuff is not digestible. The per cent of digestible matter, then, is not the actual amount of nutritive matter present as shown in the analysis of the fodder. But a chemical analysis is the first step to render the results of feeding experiments intelligible, and is absolutely essential to an understanding of the material we are using in rations. *It is the foundation upon which the whole question of rational system of feeding rests. By chemical analysis it has been possible to determine not only the amount of nutritive matter in a great many fodders but also what percent of each class of nutrients is digestible.* So it is possible to measure the nutritive value of most of the common food-stuffs.

Before animals could be fed intelligently it was necessary to know their demands for the production of certain results. For instance, what was the proportion of nutrients demanded by an ox to simply maintain life and health, and what did he demand when at hard labor, and what should be the proportion to produce the quickest returns when he was intended for the block? This was a difficult question to solve, but the Germans, with their accustomed persistency, went at the problem, and as a result have been able to formulate a table of feeding standards, which gives the needs of various animals under different conditions. The ones obtained by Prof. Emil Wolff are the ones which are almost universally adopted by both German and American feeders. These results represent the average of a large number of experiments, as do the other tables here given.

TABLE I. FEEDING STANDARDS.

Pounds per Day per 1,000 Pounds Live Weight.

	Total Organic Matter.	Fat.	Protein.	Nitrogen-Free Extract.	Total Nutritive Substance.	Nutritive Ratio.
Horse at light work.....	21.0	0.40	1.5	9.5	11.40	1:7.0
Horse at average work.....	22.5	0.60	1.8	11.2	13.60	1:7.0
Horse at hard work.....	25.5	0.80	2.8	13.4	17.0	1:5.5
Oxen at rest in stall.....	17.5	0.15	0.7	8.0	8.85	1:12.
Oxen at ordinary work.....	24.0	0.30	1.6	11.3	13.2	1:7.5
Oxen at hard work.....	26.0	0.50	2.4	13.2	16.10	1:6.0
Oxen fattening—first period.....	27.0	0.50	2.5	15.0	18.0	1:6.5
Oxen fattening—second period.....	26.0	0.70	3.0	14.8	18.5	1:5.5
Oxen fattening—third period.....	25.0	0.60	2.7	14.8	18.1	1:6.0
Milch Cows.....	24.0	0.40	2.5	12.5	15.4	1:5.4
Sheep—wool producing (coarse breed).....	20.0	0.20	1.2	10.3	11.7	1:9.0
Sheep—wool producing (fine breed)....	22.5	0.25	1.5	11.4	13.15	1:8.0
Sheep—fattening, first period.....	26.0	0.50	3.0	15.2	18.7	1:5.5
Sheep—fattening, second period.....	25.0	0.60	3.5	14.4	18.5	1:4.5
Swine—fattening, first period.....	36.0	.....	5.9	27.5	32.5	1:5.5
Swine—fattening, second period.....	31.0	.....	4.9	24.0	28.9	1:6.0
Swine—fattening, third period.....	23.5	.....	2.7	17.5	20.2	1:6.5

In place of the standard as above given for milch cows, Dr. Babcock* suggests the one given below as better adapted to this country:

Total organic matter.....	25.0 lbs.
Digestible protein.....	2.2 "
Digestible carbohydrates.....	13.1 "
Digestible fat.....	.7 "
Total digestible matter.....	16.0 "
Nutritive Ratio	1:6.8

NUTRITIVE RATIO AND FUEL VALUE.

It is found that under different conditions animals demand different ratios of the flesh-forming nutrients (protein) to the heat-producing nutrients (carbohydrates.) For instance, if the carbohydrates are disproportionately increased and the proteins correspondingly decreased the result will be a loss of flesh and strength. Since this is true it can readily be seen that it is a matter of importance for any feeder to understand thoroughly the feeding material with which he has to deal. He should understand not only its composition, but also its digestibility.

The ratio existing between the protein and the carbohydrates is known as the "*Nutritive Ratio*", and is an extremely important index to the quality of the food, as found by actual di-

*9th Annual Report of Wisconsin Exp. Station.

gestion experiments. The term shows not only the relative amount of food constituents in the material, but also indicates on what side the food should be supplemented to produce the desired results at the least cost. To illustrate how the nutritive value, or nutritive ratio, is determined, let us take a chance illustration.

There is in Red Top hay

Digestible Protein.....	4.13 per cent.
Digestible Nitrogen-free Extract.....	30.35 "
Digestible Fibre.....	17.28 "
Digestible Fat.....	$72 \times 2\frac{1}{2} = 180$ "

4.13) 49.43

11.9 or 1:11.9

which expresses the nutritive ratio. The fat is multiplied by $2\frac{1}{2}$ since experiments shows that pound for pound it supplies $2\frac{1}{2}$ times as much heat as the carbohydrates. Provided there is much protein matter the ratio is said to be close; and wide when there is a small amount of protein as compared with the carbohydrates. If we examine the table of feeding standards on page 37 we shall see that in the case of fattening cattle, we have a much closer ration in the second period than in either the first or third periods.

The heat producing power of foods is also an important element. This is expressed in terms of "Potential Energy," the unit of which is the *calorie of heat*, or the amount of heat required to raise one pound of water 4 degrees Fahrenheit. The heat giving power is best expressed in *calories per pound of food consumed*. Calculated in this manner the following general estimate may be made of the average potential energy in one pound of food nutrients.

Calories per pound.

Protein.....	1860
Fat, or Ether Extract.....	4220
Carbo hydrates.....	1860

It is doubtless true that these figures are not absolutely correct, but they represent the best of modern research, and are certainly within a very small limit of error.

DIGESTIBILITY OF FOOD-STUFFS.

The chemical analysis of a fodder does not represent its food value. A part of the food eaten by an animal is indigestible. The relative amount of digestible and indigestible matter varies with different food-stuffs and the higher or lower degree of digestibility very materially affects its nutritive value. Different stages of growth also influence the digestibility of the food-stuff, and therefore its food value. The amount of digestible matter for most of the common cattle-foods has been determined by feeding animals for a stated period upon food whose composition has been previously determined by analysis. The material so used is weighed, and the excreta of the animal very carefully collected, weighed and analyzed. The excreta is supposed to closely represent the indigestible matter, and from its analysis and that of the food eaten can be calculated the amount digested. The per cents of the various nutrients that can be digested by an animal are called the *Digestion Co-efficients*.

The amount of digestible matter, then, can be computed, when we know the digestion co-efficients, as follows: Suppose we know the composition of alfalfa to be as follows:

Protein.....	5.91	×	78	=	4.61	Digestible
Fat	1.15	×	42	=	0.48	"
Nitrogen-free Extract.....	12.02	×	70	=	8.41	"
Crude Fibre	10.57	×	42	=	4.44	"

The digestion co-efficients of a number of the common food-stuffs, as determined by various experimenters, is given in table II below, that the figures may be accessible to the farmers of this state. The figures will be subject to change as more extended experiments are conducted in this country. Such figures, on account of the time required for digestion experiments are not subject to rapid change, and they will serve as a fair index of the digestibility for some time.

The chemical department of the Station is now at work determining the composition of Oregon grasses, forage plants, grains and mill products and will issue bulletins relative to each as often as it seems best to do so. These analyses will be followed as far as possible, by digestion experiments with animals in order to further demonstrate the value of the various foods. In the present bulletin we wish to set forth the composition of a few Oregon grasses as determined in the laboratory of the Station. The writer is well aware that the results show a condition of things contrary to the popular idea in some portions

of the state. Yet this is just the reasons for publishing the results. The results are in harmony, however, with the recognized facts as found in other states.

TABLE II.

*Showing the Digestion Co-efficients as determined by
American Experimenters.*

FEEDING STUFFS.	Trials.	Organic Mat- ter.	Protein.	Fat.	Nitrogen-free Extract.	Fibre.
Grass, Rye, etc., green.....	6	.....	74	67	73	83
Corn Fodder, green.....	3	.....	74	69	73	74
Clover, Alfalfa, etc., green.....	2	.....	67	64	78	53
Corn Silage.....	18	.....	46	80	67	67
Sorghum.....	.....	62	62	85	78	60
Hay of Grasses.....	47	.....	54	54	63	55
Corn Fodder, dry.....	37	.....	58	71	69	70
Corn Stalks.....	4	.....	52	52	64	66
Mixed Hay, clover and timothy.....	3	.....	42	54	57	49
Clover, Alfalfa, etc., hay.....	14	51	61	49	65	46
Oat Straw.....	2	.....	40	37	52	57
Cow-pea hay.....	2	.....	65	50	71	43
Vetch hay.....	.....	.....	76	60	66	54
Wheat Straw.....	.....	.....	17	36	39	56
Rye Straw.....	.....	.....	23	32	37	58
Potatoes.....	.....	.....	69	...	96	55
Roots.....	8	.....	84	...	95	80
<i>Milling and other material.</i>						
Wheat Shorts.....	.....	.....	78	68	68†	...
Corn Meal.....	2	.....	76*	82	92	87
Pea Meal.....	2	.....	83	54	94	26
Wheat Bran and Middlings.....	6	68	78	76	72	33*
Linseed Meal.....	.....	.....	86	90	80	35
Cotton Seed Meal.....	2	.....	89	100	68	33*
Oats.....	.....	.....	82	80	75	23
Gluten Meal.....	1	89	87	88	91	...

*European Experiment.

†Includes fibre.

The materials which we propose to discuss are red clover, timothy, orchard grass, tall oat grass, cheat, and oat straw. The value of the articles given below is not intended to express more than the *relative* value. The actual value is governed by too varying circumstances to be expressed in any definite figures. The figures do tell us this, that if we pay \$12.87 per ton for clover hay, we should be able to secure timothy at \$11.73. If we pay less than the amount named above for the clover the proportion existing between the prices should be as 12.87 is to 11.73. In reckoning these values we have counted the digestible fat and protein as worth 4 1-3 cents per pound, and the digestible carbohydrates at 9-10 of a cent per pound.

A FEW OREGON FODDER PLANTS.

RED CLOVER. *Trifolium pratense*, L.

The sample was cut when in full bloom in the summer of 1894, and hung in the laboratory till the spring of 1895, when it was analyzed. The composition was as follows:

	Percentage Composition	Calculated to Dry Substance.	Digestible Matter in 100 lbs.
Water.....	9.39	- -	- -
Dry Matter.....	90.61	- -	- -
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Ash.....	7.71	8.58	- -
Protein.....	8.26	9.11	5.04
Crude Fibre.....	28.45	31.40	13.09
Nitrogen-free Extract...	43.76	48.29	28.44
Ether Extract.....	2.43	2.69	1.19
Nutritive ratio 1:8. 8. Heat units in 1 pound 916.42. Relative value \$12.87 per ton.			

This excellent forage plant is so well known that a description here would be superfluous, however, a few words as to its production may not be out of place. There is no doubt but that the farmers of the Willamette valley could profitably pay more attention to the production of clover. There are three reasons for this statement, first, that clover is king of all forage plants; second, owing to its power to gather nitrogen from the air, it is a great enricher of the soil, and therefore would tend to preserve the soil fertility; third, the conditions, as shown by careful trials, are in many cases favorable to its production. As the question of soil fertility is forced upon the attention of the farmers, as it is bound to in the not far distant future, the merits of clover will become better known, and we shall see it taking a regular place in farm crops. As to its adaptability to the Willamette valley, and the method of seeding to secure a good stand, we refer the reader to Bulletin No. 35, by Prof. H. T. French, of this Station. There are many soils in this valley adapted to its production, and at the Station success has attended its seeding even on the "white lands." There is a popular belief that the soils of the Willamette valley are deficient in lime and therefore unsuited to the growing of clover. But analysis does not show this to be the case, in fact the soils in nearly all cases carry a fair amount of lime—on an average about 0.4 per cent—while

east of the mountains this amount is nearly doubled. There is certainly a sufficient supply of lime to meet the demands of clover, which, while it is said to do the best on a calcareous soil, will do well even if the lime content is comparatively small.

TIMOTHY. *Phleum pratense*, L.

This is an average sample, and was gathered when in early bloom.

	Percentage Composition	Calculated to Dry Matter	Digestible Matter in 100 lbs.
Water.....	11.19	- -	- -
Dry Matter.....	88.81	- -	- -
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Ash.....	3.98	4.48	- -
Protein.....	6.02	6.77	3.25
Crude Fibre.....	30.35	34.15	16.69
Nitrogen-free Extract...	46.25	52.13	29.14
Ether Extract.....	2.20	2.47	1.19
Nutritive Ratio 1:14.8. Heat units in 1 pound 963.11. Relative value \$11.42 per ton.			

The grass is a perennial, and adapted to moist heavy soils, but since it roots shallowly it is quite easily affected by drouth. While popular judgement places this grass at the head of the list, yet a large number of chemical analyses and digestion experiments fail to support this idea. Timothy is successfully grown throughout the valleys of the state, and in some localities grows as high as 7 to 8 feet. While this grass sells better than most other grasses, yet for feeding purposes it is not equal to some others, as will be seen by comparing the figures above given with the following.

ORCHARD GRASS *Dactylis glomerata*, L.

The sample was cut while in bloom. Its composition was as follows:

	Percentage Composition	Calculated to Dry Matter	Digestible Matter in 100 lbs.
Water.....	11.80	- -	- -
Dry Matter.....	88.20	- -	- -
<hr/>			
Ash.....	5.90	6.60	- -
Protein.....	8.17	9.26	4.41
Crude Fibre.....	38.33	43.46	21.08
Nitrogen-free Extract...	33.54	38.12	21.13
Ether Extract.....	2.26	2.56	1.22

Nutritive Ratio 1:7.2. Heat units in 1 pound 918.81. Relative value \$11.73 per ton.

This grass has been tried on the Station farm and of it Prof. French says:

"There is no state in the Union where orchard grass does better than in Oregon. It makes good pasturage, and when cut early it can not be easily excelled for hay. It does well on the level lands of the Willamette valley, and on the red hill land it grows with great vigor. In most parts of Oregon it is desirable to get a grass which will mature early so that it can make its growth before the dry season begins. This grass meets these requirements completely. It begins to head in April, and is often ready to cut in May. It continues its growth through the winter, furnishing a good growth for pasturage. If sown alone it should be sown thick; but the best results are obtained when sown with clover or some other grass. In spring this grass will furnish a bite two weeks earlier than most other grasses. When grazed down it soon recovers its vigor of growth."

In England the grass is considered better than timothy, and many feeders in this country who have tried it side by side with other grasses give it the preference. Of it Mr. I. A. Cole says: "After twenty years experience I have settled down on orchard grass as possessing greater merits than any other for both the pasture and meadow for fattening animals or for the dairy stock. When cut for hay just before its bloom, and cured with as little sun as possible, it will make more milk than any other variety known to me."

Its superiority is also borne out by chemical analyses. To obtain the greatest food value the grass should be cut while in early bloom.

TALL OAT GRASS *Arrhenatherum avenaceum*, Beauv.

	Composition of Air Dry Substance	Calculated to Dry Matter	Digestible Matter in 100 lbs.
Water.....	14.30	- -	- -
Dry Matter.....	85.70	- -	- -
Ash.....	7.23	8.43	- -
Protein	10.88	12.69	13.14
Crude Fibre.....	24.36	28.42	26.97
Nitrogen-free Extract....	42.82	52.34	26.97
Ether Extract.....	2.41	2.80	1.20

Nutritive ratio 1:7.2. Heat units in 1 pound 912.56. Relative value \$12.39 per ton.

The trials made with this grass in Oregon have met with marked success. It is a deep feeder, and consequently will withstand very dry weather and produce an excellent crop. An examination of its analysis as stated above will show it to have a high feeding value, indeed to have the highest of any of the grasses here treated. It is best used together with some clover as the cattle eat it more readily when thus mixed.

CHEAT, OR CHESS. *Bromus secalinus*, L.

	Composition Air Dry Substance	Calculated to Dry Matter	Digestible Matter in 100 lbs
Water.....	8.56	- -	- -
Dry Matter.....	91.44	- -	- -
<hr/>			
Ash.....	9.19	10.05	- -
Protein.....	3.61	3.94	1.95
Crude Fibre.....	31.90	33.79	17.55
Nitrogen-free Extract...	44.99	50.30	28.44
Ether Extract.....	1.75	1.92	.95

Nutritive ratio 1:24.5. Heat units in 1 pounds 941.77. Relative value \$10.79 per ton.

In some portions of the state this grass is grown considerably. For hay it does not compare with any of the grasses named above. The samples used for analysis were of average quality, and while if cut a little earlier they would have made a little better showing, yet experience elsewhere conclusively has shown that this is a poor grass so far as food value is concerned. Our farmers would do better to use either tall oat grass or orchard grass. Foods are pretty fairly measured by the amount of protein they contain. In cheat we find this constituent low. The fact of its low feeding value is so well established that it is rarely used elsewhere as an agricultural grass. Our analysis simply adds strength to other analyses, and the sooner the farmers of certain portions of the state recognize the limited value of the grass the better. To more fully test the grass in this state the writer, in connection with the agriculturist of the Station, will shortly enter upon a feeding experiment with the hay of

cheat. But the results given in the above table may be taken as fairly representing its relative value.

The reasons for it being a poor grass may be set forth as follows. As stated above, experiments show that animals require a certain amount of each nutrient for the maintainance of life, health and strength. Of these ingredients protein is the most important, and of this cheat contains a relatively small amount. Hence in order to obtain the requisite amount of flesh-forming matter (protein,) the animal has to eat an excessive amount of other ingredients, which is a waste, and tends to injure the digestive system of the animal. To use cheat alone would be much the same as to attempt to feed a person altogether on potatoes. A correct ratio with this hay should contain a more liberal supply of nitrogenous grains than most other hays. It will be noted that cheat contains but little more protein, or flesh-forming material, than the sample of oat straw analyzed, which was an excellent sample. Less cheat and more clover would, indeed, be a boon to the state.

There is also another reason why cheat is considered inferior. It is an annual, necessitating the preparation of ground and seeding each year which is no small expense. This of course increases very materially the cost of the crop over that of either oat or orchard grass which are perennials. In calculating the feeding value of course this has not been taken into account, but in counting the actual agricultural value of the grass this would form a very important item, and make this grass still less valuable. In fact cheat comes much nearer to oat straw in value than it does to either of the other grasses mentioned.

OAT STRAW.

The sample of oat straw may be considered a good one, as the grain was not over-ripe when cut, and therefore shows a little closer nutritive ratio than is usual.

	Composition Air Dry Substance	Calculated to Dry Matter	Digestible Matter in 100 lbs
Water.....	9.62	- -	- -
Dry Matter.....	90.38	- -	- -
<hr/>			
Ash.....	5.20	5.62	- -
Protein.....	3.51	3.78	1.40
Crude Fibre.....	43.37	46.94	24.82
Nitrogen-free Extract...	36.02	41.63	18.73
Ether Extract.....	2.21	2.39	.44

Nutritive ratio 1:27.8. Heat units in 1 pound 853.62. Relative value \$9.43 per ton.

By comparing the analysis of straw with the other as here given it will be seen that it is deficient in feeding qualities, particularly in albuminoids and fats, yet by a proper balancing by means of succulent foods, as roots or silage, and materials rich in albuminoids and fats, as oil meal, a considerable amount of straw can be fed to animals at a profit, especially if the animals are properly housed. Oil meal can now be had as cheaply on this coast as it can in the east, and indeed it is even cheaper than quoted in Chicago. It is an extremely valuable food to be fed in connection with the coarser foods, and it is safe to say that if it does not cost more than \$25 per ton it can in most cases be used with profit. At present it is quoted at a much lower figure than this. A too large proportion of straw should not be used as it will tend to constipate the animal, but with a proper balancing the succulent food and roots will furnish the necessary laxative matter to counterbalance the above tendency, and the straw will serve as an excellent source of income on the farm.* The ill repute which it has obtained comes largely from trying to economize by feeding it without combining the proper amount of protein and fats.

We have not spoken of the manurial value of any of these substances, which of itself is an important item. While it is not our intention to speak at length of this side of the matter at this time, it may be said that an animal averages to take out of a fodder about 20 per cent of its value, the balance being contained in the excreta which in all instances should be saved and returned to the land. There is not as much attention paid to this saving as there ought to be, but in the not far distant future its necessity will be forced upon us. In the calculation of the quality of any food-stuff for farm use, the manurial value should also receive attention and be added to the food value, thus giving the total value of the fodder to the farm.

CALCULATING RATIONS FROM THE TABLES.

While it is not our purpose to dwell at length on the question of cattle rations, yet it is desirable to introduce the subject in this bulletin in order to explain the use of the tables, and to pave the way for future publications treating of feeding experiments.

Having discussed the various terms applied to fodder analysis, we can come directly to the use of the tables. In the computation of rations it is evident that only the digestible part of a food need be considered. An examination of Table II, page-39, will show that some fodders may be considered as *concentrated*, while others are *coarse*. Among the concentrated foods we would place such substances as wheat, oats, oil meal, pea meal, etc.; while the latter class would include the hays, grasses, and many waste products. In the compounding of rations we attempt to make such a combination of the two classes as will give the best results. Let us illustrate, suppose we have on hand red clover hay, oat hay, cut in the milk stage, wheat bran, and coarsely ground wheat, and that we are desirous of compounding a suitable ration for milch cows, the average weight of which is 1000 pounds. Find in Table I, or rather the American standard below the table, the *nutritive ratio* required under the circumstances, and also the amount of the various nutrients. There we find that the nutritive ratio should be about 1: 6. 8, that the animal should have about 25 pounds of dry matter composed as follows:

Protein.....	2.20
Carbohydrates	13.10
Fat.....	.70
Total Nutritive Matter.....	16.00

In making up the ration the tables should not be followed too rigidly for no two lots of food material will have exactly the same composition. They do, however, represent a very close approximation to the true composition of the substances given. After a careful examination of the table, suppose we decide to form a *trial ration* of 10 pounds clover hay, 15 pounds oat hay, and 5 pounds wheat bran. In Table II, page 39, we find that in 100 pounds clover hay there are 6.74 pounds digestible matter, or .0674 in one pound. In 10 pounds then, there

would be $.0674 \times 10$, or $.674$ as in the table below. In like manner the other nutrients are calculated.

	Protein.	Carbohydrates.	Fat.
10 lbs. Clover hay.....	0.67.....	3.76.....	0.16
15 lbs. Oat hay.....	0.75.....	6.61.....	0.20
5 lbs. Wheat bran.....	0.57.....	2.19.....	0.12
<hr/>			
Total Digestible Nutrients..	1.99.....	12.56.....	0.48

Comparing these nutrients with the standard they will all be found too low. To remedy this let us use 15 pounds clover and 10 pounds oat hay. Calculating in the same manner as above, the ration will stand as follows:

15 lbs. Clover hay.....	1.01.....	5.64.....	0.24
10 lbs. Oat hay.....	.50.....	4.45.....	0.13
5 lbs. Wheat bran.....	.57.....	2.19.....	0.12
<hr/>			
Total Digestible Nutrients...	2.08.....	12.28.....	0.49

Still the nutrients are too low. For a third trial let us use 11 pounds of Oat hay, and add 1 pound of the ground wheat, which will give the following ration:

15 lbs. Clover hay	1.01.....	5.64.....	0.24
11 lbs. Oat hay	.55.....	4.89.....	0.14
5 lbs. Wheat bran.....	.57.....	2.19.....	0.12
1 lb. Wheat.....	.10.....	.71	0.02
<hr/>			
Total Digestive Nutrients...	2.23.....	13.43.....	0.52.

Calculating the nutritive ratio as before explained we shall find it to be 1: 6. 6 which is close to our standard. The fat is lower than the standard, but the carbohydrates are higher, and will to some extent compensate for the lack of fat since the two classes have the same office in animal economy. While a small departure from the standard is allowable, a broad one should always be avoided. If these tables are even approximately followed there will be a decided saving in the feeding of animals. The tables are in no wise speculative, but are the result of laborious and painstaking experiment conducted by many trained specialists, and so far as experience has gone there is no reason to doubt their accuracy. They are not, however, inflexible rules, but rather guides, to be followed as good sense and judgment may direct, bearing in mind that a wide deviation will always be at the expense of the desired results.

TABLE III.—Average Composition of American Feeding Stuffs.

FEEDING STUFFS.	No. of analyses.	PERCENTAGE COMPOSITION.							PER CENT DIGESTIBLE MATTER.			Nutritive Ratio.
		Water.	Ash.	Crude protein.	Crude fibre.	Nitrogen-free Extract.	Ether extract.	Organic matter.	Crude protein.	Carbo hydrates	Ether extract.	
<i>Green fodders and silage.</i>												
Pasture grass.....	80.0	2.0	3.8	4.0	9.7	.8	18.0	2.6	10.6	.5	4.5	
Green fodder corn (maize).....	126 79.3	1.2	1.8	5.0	12.2	.5	19.5	1.3	11.8	.4	9.8	
Alfalfa (lucerne).....	23 71.8	2.7	4.8	7.4	12.3	1.0	25.5	3.6	11.4	.4	3.4	
Green clover.....	43 70.8	2.1	4.4	8.1	13.5	1.1	27.1	2.9	14.1	.7	5.4	
Alsike clover, in bloom.....	4 74.8	2.0	3.9	7.4	11.0	.9	23.2	2.7	13.1	.6	5.4	
Rye fodder.....	7 76.6	1.8	.6	11.6	6.8	.6	21.6	2.1	14.1	.4	7.2	
Oat fodder.....	5 65.2	2.5	3.4	11.2	19.3	1.4	35.3	2.7	22.7	1.0	9.3	
Red top, in bloom.....	5 64.8	2.3	3.3	9.4	19.1	1.2	32.9	2.3	20.5	.7	9.6	
Meadow fescue, in bloom.....	4 69.9	1.8	2.4	10.8	14.3	.8	28.3	1.7	17.8	.5	11.2	
Timothy.....	56 61.6	2.1	3.1	11.8	20.2	1.2	36.3	2.2	23.0	.7	11.1	
Blue grass.....	18 65.1	2.8	4.1	9.1	17.6	1.3	32.1	2.9	19.2	.8	7.3	
Corn silage.....	99 79.1	1.4	1.7	6.0	11.1	.8	19.5	.8	11.6	.7	16.6	
Clover silage.....	5 72.0	2.6	4.2	8.4	11.6	1.2	25.4	2.0	13.2	1.0	8.0	
<i>Hay and dry coarse fodders.</i>												
Fodder corn (maize), field cured.....	35 42.2	2.7	4.5	4.3	34.7	1.6	55.1	2.6	33.3	1.1	13.8	
Hay from red clover.....	38 15.3	6.2	12.3	24.8	38.1	3.3	78.5	6.5	34.6	1.6	5.9	
Hay from mammoth clover.....	10 21.2	6.1	10.7	24.5	33.6	3.9	72.7	5.7	32.6	1.9	6.4	
Hay from alfalfa (lucerne).....	21 8.4	7.4	14.3	25.0	42.7	2.2	84.2	7.6	37.8	1.3	5.4	
Hay from alsike clover.....	9 9.7	8.3	12.8	25.6	40.7	2.9	82.0	6.8	36.8	1.4	5.8	
Oat hay, sowed in milk.....	9 9.2	6.5	8.9	28.1	44.7	2.7	84.3	5.0	44.0	1.3	9.4	
Timothy hay.....	68 13.3	4.4	5.9	29.0	45.0	2.5	82.4	3.0	43.9	1.2	15.6	
Hay from mixed meadow grasses.....	11 16.0	4.6	6.4	29.9	41.0	2.1	79.4	3.6	42.7	1.0	12.5	
Marsh hay.....	2 7.9	5.2	7.8	30.1	46.3	2.7	86.9	3.5	44.7	1.7	13.9	
Oat straw.....	12 9.2	5.1	4.0	37.0	42.4	2.3	85.7	1.9	41.4	.7	27.1	
Barley straw.....	97 14.2	5.7	3.5	36.0	36.0	1.5	80.1	.9	41.3	.6	47.5	
Wheat straw.....	7 9.6	4.2	3.4	38.1	43.4	1.3	86.2	.8	37.9	.5	48.9	
Rye straw.....	7 7.1	3.2	3.0	38.9	46.6	1.2	89.7	.8	42.7	.4	54.1	
Buckwheat straw.....	3 9.9	5.5	5.2	43.0	35.1	1.3	84.6	2.3	37.7	.6	17.0	
Pea vine.....	14 13.6	6.6	9.0	35.5	33.7	1.6	79.8	4.3	32.3	.8	7.9	
<i>Roots and Tubers.</i>												
Potatoes.....	12 78.9	1.0	2.1	.6	17.3	.1	20.1	1.4	16.1	.1	11.6	
Red beets.....	9 88.5	1.0	1.5	.9	8.0	.1	10.5	.9	7.6	.1	8.7	
Sugar beets.....	19 86.5	.9	1.8	.9	9.8	.1	12.6	1.1	9.3	.1	8.6	
Mangel-wurzel.....	9 90.9	1.1	1.4	.9	5.8	.2	8.0	1.1	4.8	.2	4.8	
Rutabagas.....	4 88.6	1.2	1.2	1.3	7.5	.2	10.2	.9	7.1	.2	8.4	
Turnips.....	3 90.5	.8	1.1	1.2	6.2	.2	8.7	.6	5.5	.2	10.0	
Carrots.....	8 88.6	1.0	1.1	1.3	7.6	.4	10.4	1.0	7.1	.3	7.8	
<i>Grains and Mill Products.</i>												
Corn (maize).....	208 10.9	1.5	10.5	2.1	69.6	5.4	87.6	7.1	62.7	4.2	10.3	
Corn and cob meal.....	7 15.1	1.5	8.5	6.6	64.8	3.5	83.4	6.5	56.3	2.9	9.7	
Oats.....	30 11.0	3.0	11.8	9.5	59.7	5.0	86.0	9.1	44.7	4.1	6.0	
Oat shorts.....	6 10.0	5.2	16.2	7.5	54.5	6.6	84.8	12.6	45.7	5.4	4.6	
Barley.....	10 10.9	2.4	12.4	2.7	69.8	1.8	86.7	9.5	66.1	1.2	7.2	
Wheat.....	310 10.5	1.8	11.9	1.8	71.9	2.1	87.7	9.2	64.9	1.4	7.4	
Wheat bran—roller process.....	7 12.0	5.6	16.1	8.4	53.7	4.2	82.4	12.6	44.1	2.9	4.0	
Wheat bran—old process.....	9 12.0	4.9	13.0	8.1	53.2	3.8	83.1	10.1	47.5	2.6	5.3	
Wheat shorts.....	12 11.8	4.6	14.9	7.4	56.8	4.5	83.6	11.6	45.4	3.2	4.6	
Wheat middlings.....	33 12.1	3.4	15.7	4.7	60.2	4.0	84.5	12.2	47.2	2.9	4.4	
Rye.....	9 11.6	1.9	10.6	1.7	72.5	1.7	86.5	8.3	65.5	1.2	8.2	
Rye bran.....	7 11.6	3.6	14.7	3.5	63.8	2.8	84.8	9.7	48.0	1.6	5.4	
Rye shorts.....	1 9.3	4.9	18.0	5.1	59.9	2.8	85.8	11.9	45.1	1.6	4.1	
Buckwheat.....	8 12.6	2.0	10.0	7.0	45.2	2.2	85.4	7.7	49.2	1.8	6.9	
Buckwheat bran.....	2 10.5	3.0	12.4	31.9	38.8	3.3	86.5	7.4	30.4	1.0	4.7	
Buckwheat shorts.....	2 11.1	5.1	27.1	8.3	40.8	7.6	83.2	21.1	33.5	5.5	2.2	
Buckwheat middlings.....	6 12.7	5.1	28.2	4.2	42.3	7.5	82.2	22.0	33.4	5.4	2.0	
Pea meal.....	2 10.5	2.6	20.2	14.4	51.1	1.2	86.0	18.0	56.0	.0	3.1	
Cow pea.....	5 14.8	3.2	20.8	4.1	55.7	1.4	82.0	18.3	54.2	1.1	3.1	
<i>Miscellaneous Feeds.</i>												
Linseed meal, old process.....	2 9.2	5.7	32.9	.9	35.4	7.9	85.1	28.3	32.8	7.1	1.1	
Linseed meal, new process.....	14 10.1	5.8	32.2	9.5	38.5	3.0	84.1	27.2	32.9	2.7	1.0	
Apples.....	36 84.8	.5	.4	1.5	12.5	.3	14.7	.3	12.8	.2	44.3	
Apple pomace.....	7 76.7	.5	1.4	3.9	16.2	1.3	22.8	1.0	11.0	1.1	14.6	
Skimmed milk.....	96 90.4	.7	3.3	.....	4.7	.8	8.9	9.3	4.7	.8	2.1	
Butter milk.....	85 90.1	.7	4.0	.....	4.0	1.1	9.2	3.1	4.0	1.1	1.7	
Whey.....	46 93.4	.7	.9	.....	4.8	.3	5.9	.8	4.7	.3	6.9	

RESUME.

In the State of Oregon on January 1, 1893, there were the following animals: horses, 204,509; mules, 4,755; milch cows, 107,183; oxen and other cattle, 781,114; sheep, 2,456,077; hogs, 504,609. A saving of but ten cents per month per head in the method of feeding would amount to over four and one-half million dollars annually. The question of rational feeding, then, is an important one, and demands the attention of every farmer.

It is the province of this bulletin to discuss this subject from the chemical standpoint, as well as to present analyses of some Oregon fodder plants.

The analysis of a food-stuff is expressed in the following terms: water, dry matter, ash, protein, ether extract, crude fibre, and nitrogen-free extract. The water has no more food value than that obtained from streams. The dry matter is what remains after all the water has been driven off. The ash is the mineral matter which remains after the organic matter has been burned away. The term protein is applied to the class of bodies containing nitrogen, which element composes about 16 per cent of the protein. The office of these nitrogenous bodies is that of flesh forming. The ether extract includes fats, oils, certain gums, and coloring matters. Crude fibre is the woody tissue of the plant or grain. The nitrogen free-extract embraces all other bodies than those named, among which are sugar, starch, dextrin and certain gums. The ether extract, crude fibre, and nitrogen-free extract together are called carbohydrates, the office of which is to furnish vital heat and produce fat, for which pur-

pose the ether extract has $2\frac{1}{2}$ times the value of the other carbohydrates.

All the material of a food-stuff is not digestible. To be of the greatest value there must be a certain ratio existing between the nutrients, and there must be a certain amount of non-nutritive matter. These conditions vary according to what is desired from the animal.

By chemical analysis, which is the foundation of rational feeding, it has been possible to determine not only the composition of the various food-stuffs, but also the digestibility of each nutrient, and what proportions of nutrients are needed by various classes of animals to produce desired results. (See Tables I, II, and III.)

The index to the quality of food is its "nutritive ratio," or the ratio existing between the digestible protein and the digestible carbohydrates.

The percents of the nutrients that can be digested are known as digestion co-efficients. Knowing these and the analysis of any fodder, it is possible to ascertain approximately the amount digestible. The digestion co-efficients for many materials have been determined, (See Table II) and also the composition of many food-stuffs. (Table III.)

Analysis and computation of the relative digestible matter in red clover, tall oat grass, orchard grass, timothy, cheat, and oat straw, show their relative value to be in the above order.

Clover can be successfully and profitably produced on soils of the Willamette Valley and in most parts of the State. Farmers should give more attention to this most excellent forage plant. Timothy is not so valuable a fodder plant as is popularly supposed. It is inferior to either orchard grass or tall oat

grass. Cheat, or chess, is relatively a poor fodder plant, and should give way to either orchard grass, tall oat grass, or these mixed with clover. Oat straw may be made a greater source of revenue to the farmer by feeding it more than is now done, and using a greater quantity as litter, thereby securing a greater manurial value than by burning. It can well be fed when compounded with more concentrated foods.

In compounding rations it should be remembered that the standards here given are not inflexible rules, but rather guides from which there should not be a wide deviation.

April 20, 1896.

Oregon Agricultural
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Prunes, Apples, and Pears,
in Oregon.

By U. P. HEDRICK.

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The Bulletins of this Station are sent free to all residents of Oregon who request them.

Oregon Agricultural College.

Corvallis Or., Jan. 1, 1896.

The following bulletin on prune, apple, and pear growing, is respectfully submitted to the fruit growers of Oregon. The teachings and conclusions set forth in this bulletin are largely derived from data collected in making a Survey of the fruit interests of Oregon, an undertaking which was begun by the Horticultural Department of the State Experiment Station, September 1st, 1895, and which will be continued during the summer of 1896. In making this Survey, several weeks were spent by the writer, by Mr. A. H. Carson of Grant's Pass, and by Mr. E. L. Smith, of Hood River, in a careful examination of the orchards of Western Oregon. A large mass of data and observations has been acquired and it is hoped at the conclusion of the work that this may be published in such form that it will be of value to the fruit grower. Meanwhile, the information collected will be the basis of all bulletins upon practical horticulture issued by the Horticultural Department of the Station.

U. P. HEDRICK.

PRUNE GROWING IN OREGON.

THE prune industry has grown to be one of the most important interests in the state. Already it has assumed greater proportions than all other orchard industries.

As the favorite fruit crop of Oregon it has much in its favor; the trees are sure to bear, there are no climatic conditions to overcome, the finished product is not perishable, and its insect pests and fungous diseases are less numerous than other fruits. The trees suffer, it is true, from several pests but they are slight afflictions in comparison to the codlin moth and apple scab of the apple and pear, and, until we have curculio and black knot which render plum growing in the East almost impossible, we can say that prunes are free from diseases. Moreover, there is a growing demand for the product, dried and green, which promises well for the industry.

There are about 26,000 acres devoted to prune growing in Oregon. Prunes are grown throughout the western part of the state and along the Columbia and its tributaries in northern and eastern Oregon, but the major part of the industry is comprised in the Willamette and Umpqua River valleys. In the Willamette Valley, there are about 15,000 acres of prune orchards. As yet most of these orchards are on the black alluvial soil near the river and have not to any appreciable extent encroached upon the red hill soil farther away, though that this soil will produce prunes is certain. The second largest prune district is the Umpqua River Valley. Here there are about 6,500 acres of prune orchards. The valley of the Umpqua seems to be the most favored region for prunes, trees and fruit reaching their highest perfection there. The Petite or French prune especially seems to thrive; the Italian can be as well, and perhaps better, grown in the Willamette Valley. The Petite prune, and the Italian

more or less, are grown very successfully in the Rogue River Valley also, where there are approximately 1,500 acres. Attempts are being made to grow prunes in Hood River Valley and along the Columbia in eastern Oregon, but experienced orchardists say that these sections cannot well compete with the more favored prune localities, and that their splendid fruit resources can be used to better advantage in growing other fruits. In these districts there are about 2,500 acres.

Climate.—One of the resources of Oregon is its climate. An adequate estimate of its functions and value as a factor in producing prunes, and its influence upon prune growing, would lead us far beyond the limits of a brief bulletin. But some of the practical information gathered from the recent Survey will be in place.

The horticultural effects of the Willamette Valley climate are as follows. All fungous diseases are more prevalent than in higher and drier valleys. The great prune pest of the state, shot hole fungus, finds a more congenial home and is far more rampant in the Willamette Valley than elsewhere. Brown rot, newly introduced into the state, is as yet found only here and will soon be a most greivous pest. In the humid atmosphere, moss and lichens quickly cover the trees. Strong winds, a feature of Willamette Valley climate, make it necessary to head low and prune so as to secure strong, stocky trees. Sunburn is not so common as in the warmer and drier valleys. Fruit ripens from one to three weeks later than in the other valleys. Deficiency in sunlight and summer heat makes the growth of some varieties of prunes unsatisfactory.

The chief horticultural effects of the Umpqua, Rogue, and Hood River Valley climates, are, in comparison with the Willamette; fewer fungous, but more insect pests; woolly aphis, green aphis, San Jose scale, red and yellow spider, are more plentiful, except perhaps in Hood River. There is an earlier and more perfect ripening of fruits, especially those of summer and autumn, because of the continual sunshine and dry air. On the other hand, Italian prunes do not attain their full size and best characteristics because of being forced into early maturity. Injuries from hot winds and sun-scald are more frequent. Local influences governed by topography are much more marked in these valleys, making it important that fruit locations be select-

ed with great care. More attention must be given to the special conditions and natural agencies which contribute to the development of fruit in any location. The rainfall is much less and the atmosphere not nearly so humid so that in some places prune growers may have, sometime, to resort to irrigation.

The same causes that make the differences in the various valleys, make local variations also, and these need always to be taken into consideration by the fruit grower. There are, for example, all through the state, small valleys, protected from cold winds, and heavy fogs, and open to sunshine, which produce fruits earlier in the season, and of better quality, than locations not so favored. Elevation ministers to the same effect. Rivers moderate climatic influences somewhat. In general, then, the metes and bounds of latitude are set aside somewhat by local modifications, and the intelligent fruit grower who chooses his location in accordance with climatic condition, will find in the climate a valuable ally.

Soils.—Soils and stocks are intimately related, but of the latter we shall speak hereafter. Prunes thrive best in a rich sandy soil, as is well demonstrated by the splendid orchards grown on that soil in Douglas county. The second best soil is the black loam of the valleys, always provided that it is well drained. At present, most of the Willamette orchards are in this soil, and better ones can hardly be produced, when other conditions are proper. The red lands are third in the list of desirable soils, but great care in selecting locations on red lands must be taken in regard to depth of soil. One of the greivous mistakes made by planters all through Western Oregon is that of locating their orchards on shallow soils. This is especially true on the red lands. The minimum depth of soils for prunes is four feet, and as much deeper than that as possible is desirable. Fine prunes are grown on granite soils, but these soils are not lasting and must be irrigated if best results are to be had. The above claims for the various soils are not arbitrary. In fact, location, drainage, and depth of soil have almost as much to do with success in prune growing as does the kind of soil. It must be remembered that there are infinite gradations between the various soils.

The prune tree is a gross feeder, its limbs growing oftentimes several feet in one season, so whatever the soil, it must be rich. On the other hand, a soil may be too rich, producing a

weak, watery growth not at all desirable. Prunes contain a large amount of water so that it is necessary to have a soil somewhat retentive of moisture, and also one that can be thoroughly tilled, that being essential to proper conservation of moisture. But, as before stated, the land for prunes must be thoroughly drained. This is to be emphasized at all times since one of the great faults of the prune orchards of Oregon is that they are not on properly drained land. Briefly, the ideal soil for a prune orchard is: A rich, sandy loam, warm, mellow and deep, containing sufficient vegetable humus to give lightness and retain moisture without being damp and heavy, and having good natural or artificial drainage. The character of the soil is not to be determined by surface appearance but by thorough examination.

Procuring trees.—Oregon is well supplied with good nurseries and a grower can get first class trees, but many hardly know what they want. One of the chief complaints among the prune growers we visited this fall, was in regard to their young trees. Procuring trees is so largely a matter of business and good judgment, that anything which any one aside from the buyer could say would be of little value, but a word or two in a general way will be proper here. Patronize the nearest reputable nurserymen, endeavoring to get stock at a low price, but not purchasing simply because of cheapness. Buy only first class trees, two years from the bud, having as an ideal, trees of medium size, with straight, stocky, hard growth, clean trunks, free from borers, insects and injuries, and a perfect union of stock and cion. Have your trees shipped as soon as they can be well dug, and set them as soon as possible, having the ground in the best condition. Buy only varieties which show the greatest adaptability to your particular location, a point which seems trite, but which nevertheless is not always observed. Varieties in unsuitable locations and mixed orchards are such common faults that particular attention is called to the fact, that only those which you know will do well should be planted.

Stocks.—Throughout the prune regions visited, perhaps no question awakened as much interest or received as much attention as that of stocks for prunes. The statistics collected by Mr. Carson show that in a little more than nine-tenths of the or-

chards visited prunes are on peach stocks. Mr. Carson believes, with the prune growers, that the peach *is* the proper stock. But after examining carefully, in this particular, all orchards coming under my observation, and taking the testimony of Prof. Coote, who as horticulturist at the Station, gave the matter attention for several years, the writer is satisfied that peach stocks are used too commonly in Oregon, and that the poor orchards on the heavy, black, damp, or cold soils are largely attributable to the fact that peach stocks *were* used.

Prunes can be and at one time were grown on their own roots, but their habit of sending up suckers condemned this practice. Peach roots were next adopted as a stock upon which to grow them, but in nearly all prune and plum growing regions, excepting the Pacific Northwest, the peach has been discarded for the myrobolan plum chiefly, and the marianna and St. Julien stock somewhat. We know of no experiments in growing prunes upon the latter two stocks in Oregon though extensive trials of prunes on these stocks might lead to valuable results. Any information concerning such trials will be gladly received at the Station.

The writer has but few followers in his belief that the peach is not the *best* stock for prunes in Oregon and so will give his reasons for thinking so pretty fully.

First. The range of soil on which peaches will thrive is very small. There are but few localities where prunes are grown in Oregon in which peaches would thrive at all even if climatic conditions were right. On the other hand the myrobolan plum is a thrifty tree in almost any soil.

Second. Peach roots require better drainage than plum roots. Good plum trees will grow on myrobolan roots, where it would be waste to plant them on peach roots. The importance of this is obvious to those planting on low lands.

Each peach seed produces a tree different from every other one in habit of growth and vigor. Does it not follow that the stocks must vary in their capacity to develop trees? Moreover, the pits in most cases have been obtained from a cannery from immature and poor fruits and there is a constant tendency in trees from such seed to *degenerate*. Stocks from myrobolan and marianna plums are obtained from cuttings, or ought to be, of

strong, vigorous trees and will therefore produce trees of a more uniform character.

Third. Prunes do not "take" as well on peach roots as on the plums. To do well some varieties, yellow egg for example, ought to be double "worked."

Fourth. Some growers claim the myrobolan to be a dwarfing stock. Wickson says "it is sufficiently free growing in California to suit all purposes, and to form a good foundation for full standard trees." I know this to be true in other states and from reason and observation believe it to be true in Oregon.

Fifth. While plum stocks are susceptible to peach borers they are not nearly so much so as the peach stocks. Diseases affect peach roots oftener than the plum, and their life in general is more precarious than that of the plum so that a prune tree on a peach root is shorter lived than when on plum roots.

Sixth. We have the word of authorities in most other fruit regions that in general the plum roots are better. Wickson, in California says: "Choice of stock should be made according to soil, but unless it is known that there is some local advantages in the use of other stocks, the myrobolan should be used." Taft, in Michigan says: "Plum trees do best on myrobolan stocks though the peach is sometimes recommended for light soils." In the two greatest peach growing states in the Union, myrobolan stocks are recommended for plums.

We cannot help but think that many prune growers in Oregon have made a grievous mistake in selecting trees with peach roots and we advise any one contemplating planting prunes to look into the matter of stocks thoroughly. Only use peach roots when you have a peach soil is the advice we would give.

Preparation of Land.—One of the striking features of Oregon horticulture, as brought out by the recent Survey, is the great need and the great lack of drainage. In all of the orchards visited between Ashland and Portland and Portland and The Dalles, there were only eighteen that had been artificially drained, and not half that many that had been subsoiled. This fact is all the more significant because nearly one hundred of the fruit growers visited gave it as their opinion that their land would be benefitted by drainage, and Mr Carson takes a still more radical view of the situation, and says that nearly half of the prune

orchards will be practically profitless because of the lack of proper drainage. The whole trend of the information obtained in this Survey points to drainage as one of the great fundamentals of a rational system of horticulture in the valleys of Western Oregon. The need of it can hardly be over estimated and fruit growers must come to look upon the lack of it as the direct and indirect cause of a multitude of the ills of their orchards.

The essential mechanical features of good fruit land demand drainage. There must be an ability to get rid of surplus water if any orchard tree is to grow and thrive, even if the water is only over abundant when the tree is dormant. Proper drainage helps to retain moisture in the dry season, since, if a soil have too much water it becomes puddled, then bakes, and sun and wind quickly evaporate all moisture from it. Well drained land is warmer in spring and fall because of not having the cooler water in it; it is cooler in the heat of the summer, when proper root growth demands an amount of moisture, coolness, and circulation of air, that can not be had in a baked, parched soil. A boggy, miry condition of the soil prohibits cultivation often times when it should be given, and so hinders good tillage. Good drainage makes available plant food that is otherwise lost. By allowing a free passage of currents of air, carrying with them rich substances in the atmosphere, it helps to fertilize a soil.

Subsoiling.—Intimately connected with drainage is subsoiling. What has been said about the necessity of drainage largely applies to subsoiling. It is a peculiarity of Oregon soils that you can not judge the subsoil, with any certainty whatever, from the surface, nor can you infer that the same subsoil extends for any great distance under the same surface soil. Conditions vary so that every fruit grower should examine his soil in several places and judge for himself if any part of his orchard needs subsoiling.

Any soil having an open porous subsoil cannot be benefitted by having the soil made more open. But any soil upon which water stands, or runs off, having a subsoil that is at all compact, and to any great degree impervious to water, ought to be subsoiled. Often times deep plowing will help to accomplish this object. But generally an implement which can be pulled through this compact soil, breaking, and loosening it up, must

be used. The nature of the soil determines the depth of subsoiling.

Like drainage, subsoiling tends to dispose of surplus water, allowing it to filter through the hard-pan, and also helps to retain it in a dry season, since the water sinks lower in the ground and is not so easily evaporated, but rises gradually by capillary attraction. The act of subsoiling tends at first to dry a soil out, and unless a rain follows before crops are put in may in this way be for a time somewhat injurious. Therefore, subsoiling ought to be done sometime before a crop is planted that the soil may contain the proper amount of moisture. The after cultivation of land that has been subsoiled should be as shallow as possible, thus by mulching, the evaporation is checked and moisture is retained. Such cultivation should be frequent and long continued.

Setting Trees.—There are a few points about setting trees which need emphasizing. It is obvious, first of all, that the rows must be straight. Any man with ingenuity and a "good eye" can secure this result. So far as trimming trees before planting is concerned, it is advisable to cut away all roots which are broken and injured, since a smooth wound will heal more more quickly than a ragged one. Roots of inordinate length may of course be cut back to make a symmetrical root system. When a tree is dug, half of the fibrous roots are left in the ground. The top, therefore, ought to be cut back a corresponding amount, or more so, since it will require some time to resume vital activities. Trees not so trimmed often fail to grow at all, or if they start, are, in their weak condition, destroyed by drouths or pests.

The following rules for tree planting are always in order: The soil should be well firmed about the roots of trees; the roots straightened out in approximately their natural position; the hole should be large and roomy; the earth fine and dry enough to crumble; the tree to be set a little deeper in the soil than it stood in the nursery row; the roots of the tree must not be long uncovered; and every care must be taken to get the tree in the natural environment as quickly as possible. If the operation of tree planting is to be perfect these details must be observed.

Distance Apart.—It is an almost universal fault throughout

the state for prune growers to plant their trees too close together. The shrewd growers are convinced of this and will tell you not to plant less than twenty-two feet apart. The Petite prune, perhaps, may be well grown at twenty feet. Trees are gross feeders and need plenty of room. Additional reasons for a greater distance apart are, that it allows of better cultivation, enables you to spray more easily, and it will give you a well formed, strong tree with an individuality of its own.

Cultivation.—The most widespread, and the most serious fault of Oregon prune orchards, as I conceive it, after having spent some time among them, is, *neglect*. Commonest among the many things neglected, is neglect in tillage. It must be said that prune orchards in general yield so abundantly without tillage that it is not to be much wondered at that the prune growers think they do not need tillage. Every orchard is so greatly influenced by special soils and conditions in which it grows that it is hard to attribute the behavior of an individual orchard to either tillage or the lack of tillage. But if a man thinks for a moment of the obvious effects of tillage upon any crop in the soil he will see at once that cultivation is essential to any rational system of horticulture. Corn, potatoes, vegetables, all annual crops demand cultivation. Berries and fruits do not differ from vegetables in any of their activities of life, and that which benefits them must be as useful to these. Cultivation must be judicious or greivous damage to an orchard may result. There are underlying principles of the operation which must be interpreted with considerable skill if cultivation is successfully done. Just what proper cultivation is, must be determined by every man, for every farm, and for every season. Only general principles can be given and a few of these are as follows: All young orchards should be given perfectly clean cultivation. All through the state we saw young orchards smothered in weeds the owner thinking it not necessary to cultivate until the trees began to bear. *It is necessary to cultivate the first year* so that the trees may be rightly started and the roots sent deep enough into the ground to escape the plow and cultivator in future years. As the orchard comes into bearing, the cultivation, perhaps, need not be so thorough, the orchard itself, in its wood and fruit, being the indicator of the treatment needed.

Usually, sowed crops should be avoided in an or-

chard, since they forbid all chance of cultivation and use up plant food and moisture that should go to the trees. Occasionally, on an extremely rich soil, an orchard may be brought into bearing by sowing a crop of grain in it. There is no objection to growing hoed crops or small fruits in a young orchard but the land must be well tilled and well fed, and it must be stopped when the trees come into bearing as there is but little land that can be worked on the share system—a good yield of fruit and of another crop at the same time.

Cultivation should begin as early in the season as possible and should be given *frequently* thereafter until the time to cease comes, which, in this climate, is the middle of July or the first of August, this always to be governed by the growth the tree is making. Early cultivation is important since it warms up the soil, gets it in good mechanical condition, kills the sprouting herbage, and gets the trees quickly to work. It should stop as soon as the tree has completed the desired growth so that it can ripen and harden its wood for the winter.

We are not sure but at this time a *catch crop* of rye, crimson clover, or some other quick growing plant might not be grown to advantage, to be plowed under in the spring. The merit of such a course would be that the unsightly crop of weeds which springs up after the summer's cultivation is finished, scattering its seeds to the four winds, certainly poor husbandry, would be destroyed; more important than this the mechanical condition of the soil would be greatly improved since it would keep it from running into a molten mass in the winter, would dry it out more quickly in the spring, and add very greatly to the vegetable matter of the soil. It would also aid in ripening the wood of the trees. This matter is only a suggestion however to be thought over by the grower. The practice is becoming a favorite one with Eastern orchardists and is recommended by Eastern writers.

In a young orchard it is advisable to plow the land each year for several years. The after cultivation should be with an implement which with the minimum expenditure of time and labor, will destroy weeds and keep the surface soil loose and friable. There are such a host of good implements that there need be no trouble in finding one suitable for any purpose. Disk harrows,

spring tooth-harrows, clod-crushers, smoothing-harrows, weeders, and cultivators all have their places. The reversible disk-harrow, we find, is a favorite implement with many Oregon fruit growers. The frequency with which we should cultivate, depends upon the soil, season, and purpose. Cultivating once a week some seasons is not too often especially if its object be to conserve the moisture. A crust should never be allowed to form or weeds to become established. The soil should always be left soft and fine if the fresh and grateful effects of a mulch are to be obtained; when left in this condition the roots are enabled to reach every portion of the soil, thus utilizing a maximum amount of plant food much of which otherwise might remain unavailable. An implement should be used which will allow of working close to trees so that high pruning need not be encouraged on account of close working.

Pruning.—Prune trees, generally, have been fairly well pruned in Western Oregon. It is an operation not at all difficult to learn since the advice given in horticultural books is plain and generally good. Opinions differ as to what the ideal tree, after pruning, should be. The concensus of opinion of the best growers, as we conceive it, after talking with them, would favor a tree about as follows: A medium, low, roundish, symmetrical top, upon which the fruit can be readily thinned and picked, the tree easily sprayed, and upon which there are strong branches, that will not break with a load of fruit, and that will shelter the stem from the sun. Such a tree will be vigorous, and long lived. Considerable data regarding pruning was obtained in the Survey, but is of a nature hardly suitable for a short and popular bulletin, however, one can conclude from it that while failures are not often caused by neglect in pruning yet they are aggravated by it, and the experience given in the various reports presses home in the most convincing way the fact that careful and thorough pruning has much to do with the success of a prune orchard. A man of good judgment will not adopt arbitrary rules for pruning, but the following hints, as a guide, may be of value to him.

In forming the head the branches should be distributed upon the different sides of the stock as much as possible. It should be formed by selecting several branches well distributed along the

stem for a distance of one foot down from the top and pointing in such a way that the head becomes well balanced and symmetrical. The strongest upright branch should be left as the leading shoot and be so trained that other branches can be given off from it. Side branches should be well cut back.

After the head is formed an annual pruning should be given though branches or shoots out of place ought to be removed as soon as discovered. In Oregon, prune growers consider late winter the best time to prune but the work can be done any time after the wood has thoroughly ripened and before the buds start in the spring. It is almost a universal fault in a prune orchard to find too much wood. There ought to be just so much wood and so much fruit, to secure which, you may either head back or thin out branches. If headed back, the cut should be made above a bud growing on the upper side of a limb so that the new branch will take a natural upward and oblique position, making a broad, strong branch with great weight bearing power. Be prudent in thinning out the branches of a prune tree as a tree will support many branches, having a tendency to "open up" as the branches become loaded with fruit. Crotches should be avoided, as when two branches of equal size form a crotch it is almost certain that one of them will break.

A pair of pruning shears or a sharp pruning knife is sufficient to do all the pruning needed if the work is undertaken in time. The use of a saw is to be discouraged though it is frequently a necessary evil. In making a cut no projecting spur should be left and the wound should be as small as possible, care being taken not to tear or injure the bark. The cut should always have a good slant. Whenever a wound is made with so great a diameter that it will not grow over in one season, it should be painted with something to keep the wood from checking and rotting. Shellac dissolved in alcohol is good, or ordinary paint may be used. To prune intelligently the habit of growth of the tree, whether upright, spreading, or close growing, should be studied. In fact, in practice, it will be found necessary to give every variety of fruit a little different treatment.

Thinning Fruit.—One of the striking facts brought out by the Survey, in regard to profit in growing prunes, was, the much greater net profit in growing prunes of a large size. Net

profits were almost double in some cases by an increase in size. The question as to why prune growers did not *thin* their fruit and get large prunes was constantly suggesting itself. In looking over the records of the Survey I do not find a dozen men who practice thinning their prunes other than by reducing the wood of the tree by pruning. The best prunes can not be grown, nor really good prunes can not be grown on overloaded trees. The quantity of fruit in bushels will be the same on a tree whether the fruit is thinned or not, and you have for the trouble of thinning a handsomer and much more valuable product. Thinning requires considerable work but if systematically done it resolves itself in a simple job, and, at any rate, the fruit must be picked sooner or later and the work done in June and July saves just so much work when the crop ripens. From this stand point then, it is an extremely short sighted policy not to thin fruit, but there is another factor which makes the operation still more important:

On trees that have had their fruit thinned there are, of course, many less pits, the large fruits being mostly watery flesh. For the formation of the excessive number of pits in the fruits on unthinned trees it requires a much greater quantity of the mineral elements of the soil and since these are the elements most apt to be wanting and most difficult to obtain it is obvious that the growth of a tree, over loaded with fruit, is checked, its vitality weakened, and in the end productiveness lessened.

During most seasons, on trees overloaded, much of the fruit drops. Had this fruit been taken off at the proper time there would have been a much less strain upon the tree. If properly thinned, the danger from "brown rot" or "plum rot," which has shown itself in the State and which threatens to do considerable damage, will not be so great, since the disease is communicated from fruit to fruit, hence will be worst where the fruit is the thickest.

The thinning can be best done when the prunes are about the size of the end of one's thumb, though no set rule can be given for the operation. The quantity of the fruit removed must vary with the size, and vigor of the tree, the variety, and the way in which the tree has been pruned. When the work is done the fruit should be evenly distributed over the tree, making due

allowance for the size and strength of the various branches. With a little experience a tree can be very easily thinned, the prunes being pulled off in hand fulls. The work is much facilitated if the tree has been well pruned, since pruning in itself reduces the number of fruits to be removed, and makes it easier to get at the fruit on the tree.

Fertilization of prune blossoms.—Important discoveries have been made by workers in the Agricultural Department at Washington in regard to varieties of fruit that are infertile, or somewhat infertile, with themselves,—that is the pollen of a variety does not fertilize the flowers of the same variety but is perfectly potent upon the flowers of another variety. The Clapp and Bartlett pear and Spy and Spitzenburgh apple are notable examples of varieties which are somewhat self-sterile and require trees of other varieties to be mixed with them to secure free fertilization of flowers. The subject is, as yet, but little understood, no experiments of value having been tried with prunes, so we dare not say much that can be construed as at all authoritative. We diligently sought for information upon the subject while making the Survey but could get but little. What we could learn, and observation, lends color to the view that some varieties of prunes, like apples and pears, are inclined to be somewhat self-sterile and that better fertilization is secured in a mixed orchard. The matter is one of great interest and some importance, especially to large prune growers, and the writer will be pleased with any data or information bearing upon the subject.

Insects and diseases.—The following is a brief summary of the number of orchards attacked by the various pestiferous enemies of the prune, as summarized from data obtained on the Survey: All of the prune orchards visited were affected with shot-hole fungus; all had been or were affected by borers; the green aphid had been in forty-one of them during the season. San Jose scale and woolly aphid were found in a few orchards, but orchards were generally, even in infested regions, pretty free from both these pests neither of them being particularly fond of the prune, the bark being so compact that they can hardly pierce it with their beaks. "Canker" was found in fifty-one orchards the disease being the most grievous in the Willamette Valley. A

small yellow mite, the "yellow spider" was found doing considerable damage in Rogue River, and Umpqua River valleys. "Brown rot" one of the worst fungous diseases Eastern plum and peach growers have to contend with was found in several orchards in the Willamette. Gophers were everywhere abundant and the amount of damage this pestiferous animal does is almost equal to that of all other pests combined, this of course will be lessened as the orchards grow older.

In general, prune orchards were in a very fair condition, in regard to pests, though it was everywhere obvious that all pests were becoming more numerous, and that the necessity for spraying had not existed in the past as it does at present. Prune growers should congratulate themselves that they have not as yet the curculio and black knot, the great enemies of prune culture in the East. Shot hole fungus seems to be firmly established in all orchards; some were but slightly diseased, the foliage of others was completely riddled. Prune growers must take means to keep this disease in check, or, through the defoliation and consequent weakening of the tree the prune crop will be greatly lessened. Only 30 prune orchards had been sprayed and the work in half of them had not been done thoroughly.

A spraying bulletin has just been issued from the Station which gives direction for spraying prune orchards, so that the matter only needs to be briefly touched here. For shot hole fungus and all other fungi, spray two weeks after blossoms have fallen with Bordeaux mixture. 10-12 days later repeat. Repeat when fruit is about half grown. After the crop has been gathered, it is well to spray again. For fungi we do not think a winter spraying needful. If a necessity arises for spraying when the crop is nearly ripe, for "brown rot" for instance, use the copper sulphate mixture, 1 pound to 300 gallons of water.

Varieties.—Though other sorts are locally popular, the French, or as it is known in Oregon, the Petite prune, is the universal favorite in the commercial world, and where it thrives among fruit growers. Unfortunately it does not do well in the Northwest except in certain favored spots and so growers must be content to grow a prune not quite so popular in the market at the present time, but one which bids fair to create a special market for itself, and when its good qualities becomes known

by a more general introduction it may be confidently expected that it will command a price equal to the French prune; and, since it can be only grown to perfection in the Pacific Northwest it is not beyond the range of possibilities that it may become a special product. We speak of course of the Italian prune.

THE ITALIAN PRUNE.—*Fellenburg, German Prune, Swiss Prune.*—Medium size or large roundish but tapering at both ends; suture small but distinct; color dark purple with a heavy bluish bloom; stalk 1 inch long cavity shallow; flesh yellowish green, juicy, parting easily from the stone; flavor sweetish with sub-acid, delicious; tree hardy, vigorous and very productive. It is not known where the Italian prune originated but it has been grown in Italy for a long time, where it finds great favor in its fresh state.

At present the Italian is the recognized prune of the Pacific Northwest. As grown in this section it is superior in quality, size and productiveness to any other prune grown. When dried it is much larger than the French Prune, and its acid flavor makes it more agreeable to the taste for most people. In color the dried product is black or bluish black, in quality it is quite distinct from other prunes, having a most agreeable sub-acid flavor.

PRUNE D'AGEN:—*Petite Prune, French Prune, Prune D'Ente, and Robe de Sergeant.*—The fruit as grown in Oregon may be described as follows. Medium-sized or small, oval or egg-shaped; suture small, distinct; color, violet purple with bright colored bloom; stem short, slender; cavity small, and shallow; flesh greenish yellow, sweet, full of sugar, rich and delicious, clinging slightly to the stone.

This is the prune which is grown in the leading prune districts of the world. It is known under so many names, there are so many sub-varieties, and the nomenclature in general is so confused that the real Prune D'Agen is hard to identify.

The Prune D' Agen is smaller than most other varieties. It has a larger proportion of solids and sugars and so shrinks less in drying. The lack of acid, however, gives it an insipid flavor and this is the chief defect of the prune when dried, and renders it almost worthless in the fresh state. The qualities that make it so popular are, the wonderful productiveness of the tree, small shrinkage in drying, and its sweetness recommends it to many. The tree is very healthy and vigorous, bearing large crops and rarely failing to yield a crop. It is very particular in regard to soil and climate, doing well only on a rather light, dry soil, and in a warm, dry climate. In Oregon

these conditions are to be found best in the Umpqua and Rogue River valleys.

SILVER PRUNE.—*Coe's Golden Drop.*—Size large, oval or roundish; suture distinct, one side. abnormally large oftentimes, necked; color light yellow, in the sun small red dots; stalk stout, nearly one inch long; flesh yellow, juicy, firm, adhering slightly to the stone; flavor rich, sugary, good quality; tree a vigorous grower and very productive.

It was originally thought to be a seedling from Coe's Golden Drop, but authorities have decided beyond all question of doubt that the two plums are one and the same, local modifications and conditions changing the fruit so that one might think the one a sub-variety of the other.

The trees are hard to grow and for this reason, as a general thing, the variety has not proved profitable.

The dried product of this variety, if properly prepared, is as fine as any put upon the market, both in size, and flavor for many. Unfortunately, public taste demands that a white prune be sulphured, a process which injures the quality of the product as a food, and which in some markets creates a prejudice against it. The dried prune contains much sugar but has enough acid to give it an agreeable flavor.

REINE CLAUDE.—As yet we are not quite sure about this variety. The Reine Claudes that the writer has seen in Oregon were the old Green Gages grown so extensively in the East. The fact that the Reine Claude of France, the favorite plum of that country, is our Green Gage lends color to the view that the Reine Claude grown in Oregon is the Green Gage, though prune growers deny it. Another year we shall be sure of the matter.

The fruit of the Reine Claude is small; suture faintly marked; color yellowish green sometimes marbled with red; stalk slender, three-fourths of an inch long; flesh greenish yellow, not clinging to the stone, juicy, melting; flavor excellent, very mildly acid, sweetish, unsurpassed. As a dried product, when bleached, it is a bright golden yellow in color and has a delicious flavor.

The Reine Claude will never be one of the great commercial prunes but as a fancy product it is surpassed by none, being almost equal to the best raisins or figs.

WHITE EGG.—*Yellow Egg, Magnum Bonum.*—A very large, oval plum with a neck at the base and a distinct suture; stalk an inch long, not sunk but surrounded by a fleshy ring; color light yellow with a thin white bloom; flesh firm and juicy and clinging to the stone; flavor acid. Not to be recommended for the dried product though it finds some favor in the fresh state.

A few varieties of prunes, several of considerable promise, have originated in the Northwest, among them are the following.

The descriptions, in the main, are condensed from this year's "Prune Number" of the Rural Northwest, a paper to which we are also indebted for some facts concerning the preceding varieties.

GOLDEN PRUNE.—A prune clearly resembling Coe's Golden Drop or the Silver Prune, being however, a little more rounded, slightly different color, and flavor a little different. The dried product is of excellent quality. The tree, like that of the Silver Prune is not hardy or vigorous. This is its great defect. The prune originated with Mr. Seth Lewelling of Milwaukee, the originator of the Black Republican and Bing cherries.

WILLAMETTE PRUNE.—A dark ruddy brown prune of the Italian type. Said to be some larger than the Italian, a little sweeter, a little earlier, and to dry heavier. The dried prune is dark much like the Italian. It requires considerable skill in curing. In the fresh state it is hardly surpassed in quality. Originated with Mr. Jessie Bullock of Oswego, Oregon.

TENNANT PRUNE —Another prune of the Italian type, which originated with Rev. John Tennant of Ferndale, Washington. Said to be much earlier in ripening than any of the prunes now generally used. It has been largely planted in the northwest, but enough trees have not come in bearing so that its qualities can be well known.

THE PACIFIC.—A variety having the general characteristics of the Willamette prune. The Pacific is said to be larger and more juicy than the Willamette. Especially recommended for good quality in the fresh state.

THE DOSCH.—A seedling plum coming from Mr. H. E. Dosch of Hillsdale, Oregon. An early and unusually large prune, making a cured prune larger than that of the Italian, though too juicy to dry well. It is sweet and of first class flavor in the fresh state.

CHAMPION PRUNE.—Also an Italian seedling originated by Mr. Bullock of Oswego, Oregon. Earlier than the Italian. Large, round, reddish bloom; flesh firm, good quality, sweet, and parting from the stone easily. Tree productive and a good grower.

Evaporators.—Getting the fruit evaporated is the greatest bugbear the prune grower has to deal with. The evaporators now in use turn out all grades of prunes, and while a poor product may be largely attributed to the care and attention which has been given the operation, yet it is more largely the fault of the evaporators. Herein lies a great chance for improvement and prune growers should begin to give the question considerable thought. The Station has given the matter all the attention possible and hopes before the next crop is evaporated to issue a bulletin upon the subject. Not much can be said in this bulletin, but I can say, after having examined a great number of driers, that I am convinced that steam in steam pipes furnishes the most efficient and economical heat for drying prunes, especially for a large establishment and advise those who contemplate building evaporators to look towards steam as one of

the means of making better evaporators than we now have. The greatest objection to steam is its cost, but once in use there is such a saving in running the plant that the excess in first cost is soon made up. Steam driers may be built in many localities through some co-öperative plan. It is certain that when a few have been built that competition will force all growers, both because of economy and because of the much better product put out, to take their fruit to evaporators using steam.

Steam may be used in an almost endless number of ways to suit circumstances and may be adapted to many styles of evaporators now in use. A great point of merit in a steam evaporator is that the operation of drying the fruit is completely under the control of the operator; chance and "luck" are largely eliminated and a standard product is assured. Another feature not to be lost sight of, is that the steam may be utilized in running graders, parers, dipping apparatus, hoisting fruit, pressing machines, heating water etc, making altogether a thoroughly practical and buisness like establishment. As a model evaporator of this kind the reader is referred to that of Mr. C. H. Richer of Vancouver, Washington. We are well aware of the fact that there are two or three steam evaporators in the state that are not doing good work, but this does not alter our view of the matter as we consider their lack of success due to poor arrangement for carrying off the moisture laden air, rather than the means of furnishing heat.

Shipping fresh prunes.—In the shipping of fresh prunes East one may reasonably believe that a new era has opened for the prune industry. The opening of the era however is too recent to warrant much discussion. The out look is promising indeed for this branch of the industry and has already stimulated into renewed activity growers who were inclined to take pessimistic views of the future of the dried product. The popularization and distribution of good fresh prunes in the East must cause the demands for them to grow until the past few years achivements will appear but little more than a suggestion when the real development has taken place. Because of their tough skins the Italians have, so far, proved the best shippers.

Cost of a Prune Orchard.—At the Experiment Station we are often asked what it costs to produce a bearing orchard. The following, taken from data given by 132 prune growers, is the

average cost of planting and caring for a four year old prune orchard.

FIRST YEAR.

	Per acre.
Cost of trees, 20 feet apart, at 10 cents each.....	\$10 80
Preparing ground.....	3 10
Planting trees.....	3 15
Cultivating.....	3 20
Total.....	\$20 25

SECOND YEAR.

Cultivating.....	4 95
Pruning.....	80
Replanting.....	40
Total.....	\$ 6 15

THIRD YEAR,

Cultivating.....	5 05
Pruning.....	1 45
Spraying.....	45
Replanting.....	30
Total.....	\$ 7 25

FOURTH YEAR'

Cultivating.....	5 15
Pruning.....	2 05
Spraying.....	65
Replanting.....	30
Total.....	\$ 8 15
Total for four years.....	\$41 80

While the data given above was taken from those engaged in growing prunes, it must not be thought that the figures represent more than the *approximate* cost of an Oregon prune orchard. The writer believes that the cost is somewhat lower in the average given than the real cost of a *good* prune orchard because, in the statistics given us by the growers many of the needful operations had been omitted, especially true of spraying, thus reducing the average. There were many orchards, too, that were entire failures from which no data was taken.

Profits.—One hundred four and a half dollars, is the average net profit per acre of the 1894 crop, as summarized from the reports of the Survey. The extremes in the figures given us were so great, and the growers seemed to know so little about the cost of the various operations connected with getting the fruit on the market that we hardly know whether we dare recom-

mend the average given, as even approximately correct. However, it is of interest and will serve as a guide to any one who cares to make estimates on the profits of a prune orchard.

The figures refer to sales in the open market of all grades of fruit. We believe the estimate to be a very conservative one from the orchards from which the data was taken. But the reader need not order trees to plant his farm. Data could not be obtained from the scores of profitless orchards. Moreover, prices are not apt to be so good in the future, as no product of the soil will bring a fancy price through a long series of years. This is not to discourage the real fruit grower, as we believe there is no branch of horticulture that promises greater rewards than prune growing does to the careful and energetic horticulturist. But the lawyer, doctor, preacher, merchant, or the man who fails in the trades and professions, need hardly hope to gain a fortune in growing prunes.

APPLES IN OREGON.

APPLES are not as plentiful in Oregon as they were a few years ago. The situation seems to be this. The old orchards were largely planted as minor appendages to a general farm. Fruit was grown for home use, and not with the idea of selling it. Years ago these old orchards began to die. On this decreasing orchard area a whole host of pests concentrated their energies; they came unnoticed and without hindrance; moss was allowed to cover the trees and cultivation was neglected. All this was allowed because the incentive for an orchard was in no sense a monetary one. But this is changed, there is now a monetary incentive for an orchard, and thousands of acres of new orchards are being planted and attempts are being made to rejuvenate many of the old ones. We have fewer apples in Oregon to day, then, because this is a transitory period, in the production of apples, between the old orchards, now nearly annihilated, and the new ones not yet in bearing.

The cause of the failures of the old orchards can be remedied.—There are no insurmountable obstacles in the way of growing as good apples, in the land once famous for its "big red apples," as ever have been grown. No great climatic changes have occurred since the fine fruit was grown; the soil is the same, with the exception that it has been robbed somewhat of its fertility; and these, climate and soil, are the factors that make a fruit region. To again grow Oregon apples in their pristine beauty and quality, the orchardist has but to renovate or rejuvenate his orchard, by tillage, enrichment of the soil, pruning, and by making warfare upon all pestiferous enemies by spraying. But to do this, apple growing needs and must be made a special industry, to be handled by keen and energetic men.

Favored apple regions.—There are still localities in Oregon, where the apple grower can rely upon the fertility of the soil, the congeniality of the climate, and the immunity from pests and diseases, to produce good apples without much care on his part. The apples that are grown in Hood and Rogue River valleys and Eastern Oregon, fruit unsurpassed in beauty and qual-

ity, are grown under much the same condition that they grew in Willamette Valley years ago. The lesson to be learned by the horticulturist in these favored spots, from their neighbors in the Willamette Valley, is easy. The splendid young orchards growing in these valleys, should not be neglected,—allowed to go unpruned, the land untilled, and the trees yearly taking the fertility of the soil and nothing returned. Because of present immunity from pests, security from them should not be overestimated. Fungi and insects, numerous and voracious, are already swooping down upon the orchards in these valleys and it behooves individuals and communities to wage war upon them. The future profitableness of apple growing in all virgin apple localities in Oregon, depends upon their now being rightly pruned, sprayed, fertilized, and cultivated.

HINTS ON PLANTING AND CARING FOR AN ORCHARD.

Lack of space prevents going into details in this bulletin with apples, as with prunes. It is hoped that a more comprehensive treatise on the subject may be issued within a few years. However, general principles laid down in the prune part of the bulletin, regarding soils, climate, drainage preparation of land, and cultivation, will be found as applicable to apples as to prunes.

Before planting.—"Well begun is half done." In an orchard, on a badly selected site, or composed of poor varieties, or in which the soil has been imperfectly prepared, all subsequent treatment will give correspondingly poor results. First of all, then, a fruit grower must be sure that his location and soil are well adapted to apples, and to the particular variety he wishes to grow.

Secondly, a careful study of varieties should be made before trees are purchased, as an error in this direction is a costly one. In general, the behavior of a variety in the planter's own neighborhood is a good indication of its value to him, provided of course that it is marketable. A mistake in selecting varieties once discovered, should speedily be remedied by top grafting. Thirdly, the soil should be in the best possible tilth,—in an all around good condition, before a tree is set.

Locations and soils.—The apple tree is a comprehensive feeder and will thrive on almost any type of good soil. A more

primal requisite in Oregon is, that the location be a good one. In this state only perfect familiarity with most land will qualify a man to judge of its fitness for an orchard. Bed rock and impervious subsoils approaching the surface make much land unfit for an orchard. Flat wet land and land with "bad spots" which remain cold and sour, and in which trees die out after a year or two, is poor land for an apple orchard even if tile drained, as the soil is apt to be hard and full of clods. Some rolling lands will require drainage because of having stiff, tenacious subsoils near the surface. Familiarity with the "lay of the land," and with its possibilities is necessary to enable a man to judge of its adaptability for an orchard.

Lack of drainage the commonest fault of Oregon orchards.—Too many young orchards are set in undrained land. Undrained land does not admit of proper tillage; plant food is not available; the soil is too cold in the spring and bakes and is too warm in the summer; it does not allow of proper air circulation. Naturally wet, boggy, land, or land with a hard impervious subsoil is unfit for an apple orchard unless it is *thoroughly and systematically drained*.

Preparation of land.—The best way to get a soil in good mechanical condition for an orchard, is to grow some cultivated crop the season before the orchard is to be set. In this way the soil will be made mellow, pernicious weeds will be destroyed, and any "sour places" may be discovered and possibly done away with. It is very essential that the soil be fine and mellow so that the young tree can establish itself well, and send its tender roots deep in the earth, out of the way of the plow and cultivator in the future. Loose, fine earth also acts as a mulch, by destroying capillary attraction, and thus prevents the moisture of the soil from being evaporated.

Planting the trees.—Whether spring or fall planting is best in this climate is hard to say. To plant in the fall and have the trees stand in the water-soaked soil during the rainy season, does not seem right. But when conditions are proper there are many advantages in fall planting. If the ground is well drained, and in good condition, and the trees well matured, apples can be set with best results in the fall. For these reasons; the trees will become established during the winter and will start to growing in the spring before spring planting can be

gin; the early growth thus made will enable the tree to better withstand the dry summer which is sure to follow; fall planting saves heeling in; and better trees may generally be had by ordering in the fall. The operation of setting the trees needs to be done with every care, taking all precautions to quickly get the plant in its natural surroundings without injury to it.

I advise not less than 35 feet apart each way for apples. A good safe distance apart allows of many conveniences in working in an orchard and by the added productiveness, arising from better tillage, more plant food, more sun, and more water, will well pay.

Cultivation.—What has been said concerning cultivation of prunes is quite as applicable to apples. It is a safe generalization, to say that an orchard should never be seeded down. Even in growing crops in an orchard that may be cultivated, the temptation to continue doing so is so strong that the orchard sometimes become a minor crop. If necessary to sow grain in an orchard, sow it in strips, running one way between the trees, allowing room to cultivate between the grain and trees. As a temporary expedient an apple orchard may sometimes be thrown in bearing by planting it to grain, but this done, it should be brought under cultivation the following summer.

As stated in the prune part of this bulletin, cultivation should begin the first year; it should begin each spring as soon as the ground is dry enough to allow it; and should be stopped in time for the wood to ripen for the winter.

Since writing the paragraph concerning *catch crops* for prunes, (to which the reader is referred,) my view of the matter has been considerably strengthened, and I wish to urge its practice more strongly than I did in that paragraph. In a paper written by Prof. E. R. Lake for the State Horticultural Society, the value of a catch crop was strikingly shown.

A 25 acre strip in a large prune orchard worked by Prof. Lake, was allowed to become covered with a rank growth of wild mustard. The crop was turned over, and the following season, Prof. Lake says:—"The soil of this mustard strip remained moist and friable all summer through, and with one-third the tillage it presented a more favorable condition for tree growth, as shown by the vigor of the trees, than any other part of the or-

chard under similar circumstances. The saving in expense of tillage can fairly be estimated at \$75.00 as we tilled the rest of the orchard the past year."

We have quoted this passage simply to show the value of such a crop in saving tillage, but there are other effects well worthy of consideration, chief of which is, its office in catching and holding plant food—both nitrogen and the mineral elements; its office in destroying weeds, and its rendering early tillage possible.

The nature of the catch crop must be determined by practice in the different localities. Prof. Lake has been growing vetches and crimson clover as well as the mustard, but at present, prefers the wild mustard which he allows to seed itself. Other possible crops are, oats, rye, buckwheat, peas or rape.

Pruning.—In this short bulletin, it is not intended to enter into a general discussion of pruning. The reader is referred to the horticultural literature upon the subject, much of which, judiciously interpreted, is good, remembering always to prune for advantages peculiar to our climate and your particular location. Pruning to produce fruitfulness in Oregon need never be given consideration, but, on the other hand pruning to reduce the crop by cutting out bearing wood, is sometimes a necessity.

The height to head is greatly influenced by location. The warmer and drier a climate the lower trees should be headed. Low heading has many practical advantages, such as ease of picking fruit, of pruning, of spraying, and less damage from strong winds. But the good health of the tree resulting from shading the trunk is the chief merit of the system. In heading low the limbs must be trained obliquely otherwise there will be difficulty in getting close to the trees with the cultivator. We are not advocating for this climate the California method of pruning, but recommend a mean between their low heading and our high heading, not dispensing, as the Californians do, with a central trunk and strong side leaders.

Self sterile varieties of apples.—The studies of Waite and Fairchild in the Agricultural Department at Washington, have quite clearly demonstrated that some varieties of apples are more or less self-sterile, and that to insure free bearing these varieties ought to be planted in a mixed orchard. The following

varieties are supposed to be somewhat self-sterile: Gravenstein, Bellflower, Chenango, King, Spy, Melon, Rambo, Red Astrachan, Roxbury Russet, Spitzenburg, Talman Sweet. The only varieties much grown in Oregon that are credited with being self-fertile, are Baldwin, and Greening. Remarks made by extensive growers of Newtown Pippin lend color to the view that this variety is somewhat self-sterile. The matter is one of great importance to those planting large orchards, and it is deplorable that the knowledge upon the subject is so scant and fragmentary. We shall be pleased, indeed, at the Station, to have the results of any experiments, or any experience that the fruit growers may be able to furnish us. The matter we know is receiving some consideration in the state, one large grower has top-grafted alternate rows in a number of acres in his orchard in order to be sure of free fertilization.

Insects and diseases.—Of all fruits, the apple suffers most from pests in Oregon. Out of the 128 apple orchards visited by the Survey workers this fall, all were affected with apple scab and codling moth. A few in Hood and Rogue River valleys were but slightly affected, yet the pests were there. Nearly all were, or had been affected with green aphid. Woolly aphid was found in 86 orchards; San Jose scale in 74 orchards; and "canker" in 83 orchards. Various other insects and fungi were found to a minor extent.

Codling moth and apple scab were to be found everywhere in the Willamette Valley, and but few orchardists had done anything to check either. Exact data concerning the matter was not taken, but it is believed, at a conservative estimate, that nine-tenths of the apples in Willamette Valley were this year made unsalable by these two pests. The outlook for the apple grower would be bad, indeed, were it not for the fact that those who have tried have succeeded in effectually checking both pests by means of fungicides and insecticides. The testimony of several growers to the fact that they had saved 95 per cent of a crop of sound apples should be reassuring to those who doubt the efficacy of spraying. There are many fruit growers who still lack information concerning remedies and their application. This is not a proper place for a detailed consideration of the subject, but briefly, scab and codling moth may be con-

trolled by the following treatment: A spraying with Bordeaux mixture should be given for apple scab just before the buds swell in the spring. A second one as soon as possible after the blossoms drop and a third 12 to 16 days later; a fourth, if desired, 12 to 16 days after the third. The first spraying for codling moth in Western Oregon should be made between June 6th and June 12th; the application to be repeated about the first of July and on late apples again in the latter part of July and about the middle of August. Paris green,—1 pound to 200 gallons of water to be used for codling moth.

San Jose scale and woolly aphid occasion more loss to the apple orchards in the Umpqua and Rogue River valleys than all other pests combined. Both do considerable damage in the Willamette Valley, the latter especially. The woolly aphid can hardly be annihilated since it lives upon both root and top, but by constant warfare its numbers may be so reduced that the fruitfulness and vigor of the tree, need not be seriously impaired. We have much faith that there will yet be found a root, Northern Spy perhaps, that will resist the woolly aphid, and that the pest can then be controlled on the branches by the caustic washes.

About half of the fruit growers visited this fall, in whose orchards San Jose scale was found, did not know there was any scale there. Yet it may be very readily known. A roughish appearance of the bark of a tree, or a dark spot with edges discolored with red on the fruit; in both cases of which upon examination a small scale is found, and as a distinction from other species of scale, red blotches wherever branch, leaf, or fruit has been stung, are the distinguishing marks. For San Jose scale the lime, sulphur, and salt mixture has given the best satisfaction in this state.

I believe almost every orchard I have visited in Oregon, is affected with green aphid. The pest is a most greivous one, and like the woolly aphid there seems to be no way of annihilating it. Constant spraying with kerosene emulsion, or strong tobacco decoction, are the remedies to keep its numbers reduced.

At present we cannot say much about the "canker" that is causing so much trouble in the young apple orchards. Knowledge concerning it is scant and fragmentary,—to be much added to, we hope, before another season. "Canker" is a fungus

which spreads from a small infected spot in the bark of a tree to large areas, finally killing the tree. The only known remedy is to cut it out,—the sooner the better of course, and wash the wound with Bordeaux or a solution of copper sulphate. A spraying in the fall after the leaves have fallen will kill many of the spores of the fungus.

There are numerous rusts, mildews, and rots that affect orchards to a minor extent, but all these, at present, we think, will be kept in check by the fungicides that should be used for the more prevalent diseases.

Varieties.—There are practically, for commercial purposes, but seven varieties of apples grown in Oregon: These are, in order of choice as given by the fruit growers interviewed, and I believe in order of acreage of orchards visited: Spitzenburg, Ben Davis, Yellow Newtown Pippin, Baldwin, Red-cheeked Pippin, and Northern Spy. Only a few varieties of apples should be grown in a commercial orchard and these should be selected with special reference to their growth and productiveness in a particular location and to the market for which they are destined. Yet it seems to me that Oregon apple growers could well enlarge upon the number of varieties grown, not as individual growers, but as a whole. All ought not to grow so nearly the same varieties. Fameuse, Canada Red, Greening, Swaar, Roxbury Russet, Wagener, and Wealthy, are all good apples and offer a greater choice of varieties.

I think growers are making a mistake in planting so many Ben Davis apples. While the Ben Davis bears at an early age, is very productive, and is handsome in appearance, yet the quality is wretchedly poor, and in many markets where this has been found out they will not now sell well, and this dislike will of course grow. Moreover, the apple growers in Missouri, Arkansas, and Nebraska, are growing Ben Davis more than any other variety, thus preventing Oregon growers from finding any market at all in the East for the Ben Davis.

In Rogue River and Hood River valleys where the fruit matures earlier than in other sections of the state, a few apple growers will find it profitable to make settings of summer and fall apples. These apples are in demand in northern markets and facilities are good in both the valleys named for reaching

the selling places. Of course such apples come in direct competition with other autumn fruits, peaches and grapes, so that the demand for them is in this way limited, and commercial orchardists will not find them worth their attention unless they are sure of a special market. Good apples for such a trade are: Red Astracan, Gravenstein, Yellow transparent, Early Harvest, Chenango Strawberry, King, and Duchess of Oldenburg.

Some New Northwest apples.—The Report of the U. S. Pomologist for 1894, describes several promising new apples from the Pacific Northwest. Among these are:

ALMOTA.—A large pale yellowish green apple, stripped and splashed with crimson; conical in shape, somewhat ribbed; flavor mildly sub-acid; quality good; season autumn. Originated with C. R. Mays, of Pullman, Washington.

BLACKWOOD.—Size medium; shape roundish conical. Color light green with brownish blush in the sun; dots conspicuous, russet, raised; flesh yellow with a dark core line, tender, juicy; flavor, mildly sub-acid; quality very good; season winter. Originated with M. L. Smith of Farmington, Wash.

COLFAX.—Very large; shape roundish oblong; stem an inch long, slender; color bright yellow, stripped and splashed with crimson; dots numerous, minute; flesh yellowish, firm, crisp, juicy; flavor sub-acid; quality good; better for cooking than desert; season winter. Originated with Nelson Davis of Colfax, Wash., in 1886. A seedling of Rhode Island Greening.

KLICKITAT.—Size large; shape round, ribbed; stem stout and fleshy; surface smooth and glassy; color yellow marked with carmine and striped with crimson; dots minute to medium, yellow and russet, indented, flesh yellow, coarse grained, tender, moderately juicy; flavor mildly sub-acid; quality good; season winter. Originated with H. C. Cook, White Salmon, Wash., about 1876.

STEPTOE.—Size large; shape roundish, slightly ribbed; stem long slender, fleshy at the connection with the fruit; surface smooth, oily; color pale yellow; dots variable, grayish to brown; flesh yellow, fine grained, crisp, juicy; flavor sub-acid; quality very good; season early winter; tree a strong grower and good bearer. Originated with John R. Reavis, Spokane, Wash., about 1882.

YAKIMA.—A Baldwin seedling now quite well known in Oregon. A winter apple, in appearance much like the King, in flavor like the Baldwin. The Yakima is finding considerable favor.

While visiting orchards with Mr. A. H. Carson in Southern Oregon last fall, Mr. Carson called my attention to some remarkably fine Spitzenburgs in a certain orchard. Across the road, at a little distance, we visited another orchard growing in a different soil and under different conditions. At the first glance we

hardly knew the fruit. Close examination showed them to be Spitzenburgs but greatly inferior to the first; possibly from the same nursery row as the others, however. What was here so strikingly shown we found true throughout the whole state. The character of the fruit changes, in Oregon with soil, topography and all conditions affecting the growth of fruit, to an extent not dreamed of by one accustomed to Eastern fruit growing. The thought to be derived from this is, that the variety of apples to plant is a local question. Every fruit grower must settle it for himself. When an error is made, top-grafting is the only remedy.

Profit and loss sometimes a matter of using the whole product of an orchard.—Some years even the best orchards will contain such an ill assorted lot of fruit that the profits are small or none at all. There are also many orchards from which the product is never taken. Last fall the writer saw tons and tons of fruit rotting on the ground that might well have been utilized as evaporated fruit or in making cider, jelly, apple butter, or vinegar. These products are all salable at prices that will very materially help in making an orchard profitable. A fruit grower who does not make use of every possible means of profit is neglecting his opportunities and has no right to say that "fruit growing does not pay." Every fruit-growing community should have an establishment, either private or coöperative, to work up the fruit that heretofore has been waste product.

Strains of Varieties.—Part of the variance in apples in Oregon may be explained from the fact that there are so many strains of different varieties. This has been brought about no doubt, largely, from their being introduced from so many different sources. The practical point here is that all trees should be propagated from the best strains. This brings us to another matter which can be best brought out by quoting from L. H. Bailey of Cornell University:

*"*It is probable that many trees fail to bear because propagated from unproductive trees.*—We know that no two trees in any orchard are alike, either in the amount of fruit which they bear or in their vigor and habit of growth. Some are uniformly productive, and some are uniformly unproductive. We know, too, that cions or buds tend to reproduce the characters of the tree from which they are taken. A gardener would never think of

taking cuttings from a rose bush or chrysanthemum or a carnation which does not bear flowers. Why should a fruit-grower take cions from a tree which he knows to be unprofitable?

The indiscriminate cutting of cions is too clumsy and inexact a practice for these days, when we are trying to introduce scientific methods into our farming. I am convinced that some trees cannot be made to bear by any amount of treatment. They are not the bearing kind. It is not every mare which will breed or every hen which will lay a hatfull of eggs."

A FEW NOTES ON PEARS IN OREGON.

THE following notes on pear growing are written with particular regard to conditions in Western Oregon. All the information possible concerning pears was gleaned in the Survey last fall, but such information was scant and fragmentary because of there being but few commercial pear orchards, as yet, in the state. The old pear plantations are seldom more than scattered plantings about the farm yard and along the road-side. Most of these trees were of poor varieties and have outlived their usefulness. In the last few years, however, a new interest in pear growing has been awakened by a demand from the East, for our quite superior pears; this interest has been stimulated no doubt by the somewhat phenomenal profits made in a few of the existing commercial orchards.

As yet it can scarcely be said that pear growing can be termed an industry, there being only a few thousand acres of pears in the state. There is every reason to believe that there is profit in the fruit if growers are careful to inform themselves concerning all phases of growing and handling it. The acreage is sure to increase. Rogue River pears ship better, because of firmer texture, than pears grown elsewhere in the state, and in Rogue River pear growing might well be made a special industry. It is well that there be centers for growing fruits, since

*Bulletin 107, Cornell Experiment Station.

scattered plantations make uncertain amounts of fruit, and buyers will not buy so confidently as they would were the plantations grouped.

It will not be necessary to enter into many details of the cultivation of the pear, because the remarks respecting the apple will apply almost equally for the pear.

Land.—The best land for pears is a deep, mellow, clay loam; or at least the body of the soil should be clay—not hard clay which bakes in the furrows, but that which contains vegetable matter and crumbles under cultivation. Sandy gravelly lands are too deficient in water for the pear. In preparing the land it is important to plow it deep and fit it with great care so that the roots may go deep where they may obtain a liberal supply of water, for pears must not feel the effects of drouths. Flat lands with the subsoil close to the surface should be well tile drained before pears are set upon them, otherwise a weak, unhealthy growth, much subject to disease, and a poorer quality of fruit will be the result.

Distance.—Pears live to a good old age and attain a large size, and while their limbs do not spread comparatively far, yet their roots reach a long distance, so the trees must be given plenty of room. I should say pears ought not to be planted less than 22 feet apart. Even at this distance in old orchards I have seen trees with their branches interlacing, the trees in a pyramidal form at that. All orchard operations,—cultivation, spraying, and harvesting, are made so much easier and the quality of the fruit is so improved by roominess that the loss in number of trees is well made up.

Caring for the trees.—Pears should be given the same tillage recommended for apples. It is generally thought that pears, more than all other fruits may be neglected in the matter of tillage, or that they will do well in sod, but no fruit responds more quickly to tillage than the pear. This is largely because the fruit, to reach its full capabilities, require a great deal of water. The moisture of the soil is well conserved only when good tillage is given. It is therefore especially important that cultivation be begun early in the spring, and that it always be given as soon after a rain as possible. In the Willamette Valley climate, trees are quite apt to make a weak willowy growth that is much subject to blight and other diseases; so it is quite important that

cultivation be stopped when the tree has completed the required growth. As with apples and prunes I shall recommend that a cover crop of some rank growing grain be sown at this time to force the trees to ripen their wood. The crop plowed under in the spring, will more than repay for itself in fertility added to the soil and expense saved in tillage during the season.

Pruning.—A pear orchard will require but little pruning after the trees have been made to assume the desired shape, which ought to be accomplished in the first four or five years of the tree's life. My ideal pear tree is one with a low, spreading head, with a trunk about three feet high, and with a top consisting of from three to five main branches rising obliquely from the trunk thus assuming the shape of a somewhat pyramidal apple tree rather than the usual spire shaped pear tree.

There are several important advantages gained from this form of tree. First the low spreading head shades the stem and main branches from the hot sun and winds which causes their bark to crack and split, thus admitting germs of blight, and "canker." To obviate this difficulty is a great point in favor of this style of a head. Second, if allowed to grow upright without any checking, the limbs reach the height, in old age, of 40 or 50 feet, and since the fruit is mostly borne near the extremities of the limbs, it can be gathered only by the use of long ladders, thus making harvesting a difficult matter. A third advantage is, the trees can be better sprayed. A fourth is the ground is better shaded and more moisture is retained.

Diseases and insects.—Pear diseases and insects are so many of them common to the apple, that it only needs an enumeration of them here, to serve to call attention of pear growers to them. There are a few pests of the pear not found on the apple and of these a short description will be given.

The apple scab is unquestionably the worst pear pest in this state. It is particularly abundant in Willamette Valley. The only treatment is to spray with the Bordeaux mixture as for scab on apples. The apple moth is not quite so bad on pears as on apples but is nearly so. It is readily checked by the treatment for the apple,—spraying with Paris green. Woolly aphid is as bad on pears as apples and San Jose scale worse perhaps. The caustic sprays are the remedies. "Canker" should be cut out as soon

as discovered and the trunk of the tree washed with a solution of copper sulphate.

Pear blight scarcely needs description. It is well known by all pear growers, and yet the records of the Horticultural Survey show that it was present in nearly every pear plantation visited. It is presumed that the reader knows that the disease is caused by a bacillus and is as contagious in an orchard as diphtheria is in the human family. Only the most drastic measures will keep this disease in check. Safety lies in cutting it out as soon as discovered. When the disease has made some headway this seems harsh and entails some labor, but cutting it out is the only way to save the orchard.

The pear mite, *Phytoptus pyri*, is a most pestiferous insect in this state. Last season it was abundant everywhere. Prof. Washburn has described it in a previous bulletin from this Station so it needs no detailed description. It is an insect so minute that it can be seen only by the aid of a lens. It works in the leaves on which it raises a great number of minute, black blisters. There is no specific remedy for the pest. All badly diseased leaves and branches should be removed and burned. In the fall when the insects are migrating, a caustic wash would probably kill great numbers of them.

Pollination.—It is now an established fact that many pears to bear well must receive pollen from another variety blooming at the same time. The following varieties are said, by Waite, of Washington, to bear freely standing alone: Bosc, Duchesne, Flemish Beauty, Tyson and White Doyenne. Those said to be somewhat self-sterile, and they include some of our most profitable commercial varieties, are as follows: Anjou, Bartlett, Boussock, Clairgeau, Clapp's Favorite, Columbia, Easter Beurre, Grey Doyenne, Howell, Jones, Lawrence, Louise Bonne de Jersey, Mt. Vernon, Pound, Sheldon, Souvenir du Congres, Superfine, Colonel Wilder and Winter Nelis. The Bartlett, Clapp's Favorite, Flemish Beauty and Seckel, bloom at about the same time, so that in planting the Bartlett it is easy to select a variety to fertilize it. But with the other prominent commercial varieties the task is not so easy. Mr. Coote, at this Station has made some extended observations along this line for several seasons, and with this season to verify them he hopes to be able to tabu-

late the blooming periods of the leading varieties of not only pears but of other fruits as well. We shall be glad to have the coöperation of all fruit growers in settling this question.

Varieties.—Bartlett and Winter Nelis are the favorite pears in Oregon and they reach their highest perfection in this state. Both are too well known to need description. We recommend them for home and market use. The question of varieties of pears is a local one, as it is with most fruits, and every grower must settle it for himself. Many good varieties of pears have not been tested thoroughly in Oregon yet, and in the following brief descriptions, the qualities given these varieties are those generally ascribed to them.

Tyson and Seckel are the favorite summer pears. Both are nearly free from blight; ship well; grow well; and look well. Though both are highly flavored, the Tyson is perhaps the better and is the handsomer one of the two.

For a fall pear, the Bartlett is, of course, the favorite. Its principal defect is that it generally yields only a partial crop in the "off" year. Clapp's and Flemish Beauty are second and third to Bartlett. Neither ship as well as the Bartlett. Sheldon is one of the best of the fall varieties. Beurre Bosc and Beurre Clairgeau are special favorites with some growers in Oregon. The former is a large, russety pear with a long neck; well flavored, melting and delicious. It ripens the first of October. It is a fairly good shipper. Beurre Clairgeau is yellow, shaded with red; well flavored; the tree grows well and is an early and prolific bearer; good for the market because it ships well; ripens in November.

Garber, Kieffer, and Le Conte are good for quantity and that is about all. A good price may be received for them at first, but the public will not be long imposed upon by fruit as tasteless and insipid as Garber, Kieffer, and Le Conte pear, and Ben Davis apple. All three of these pears are wonderfully prolific, and are quite free from blight. It is said they can well, and that they are fairly good when cooked. Considerable money is being made with them at present in some parts of the South.

In flavor, keeping and shipping qualities, the Winter Nelis is

far the best winter pear. It is, however, oftentimes a shy bearer and tender in growth. The tree has no beauty to recommend it. The Lawrence is one of the best late pears. The tree is very hardy, and an early and abundant bearer. Anjou is another good winter kind that will sell in any market.

U. P. HEDRICK.

Corvallis, Oregon, Feb. 1, 1896.

Oregon Agricultural

EXPERIMENT STATION.

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SPRAYING BULLETIN.

By U. P. HEDRICK,
AND
A. B. CORDLEY.

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The Bulletins of this Station are sent free to all residents of Oregon who request them.

FUNGICIDES FOR 1896.

U. P. HEDRICK.

THE fungous diseases of fruit trees have received attention in so many publications, that it is no longer necessary to give detailed descriptions of them. But spraying methods change from year to year, the results, in the aggregate of preceding years, being a guide for the current year. The purpose of this bulletin, then, is to bring the latest information concerning fungicides before the fruit growers of Oregon. First of all, however, I shall make some observations that occurred to me while making a somewhat extended survey of the fruit interests in the valleys of Western Oregon during the past fruit season.

Why spraying so often fails in Oregon.—One of the prime causes for the failure of spraying in Oregon is, as I conceive it, that Eastern methods of applying remedies have been relied upon too much. We have conditions in Oregon that are all our own, and only our own experience can be a proper guide. The same remedies will destroy the same pests that they do in the East, but there should be a radical difference as to the time to apply them, the strength of the solution, and the number of applications. A second cause of failure is that there are:—

Too many remedies.—The State Experiment Station, the State Board of Horticulture, the horticultural press and various commercial enterprises have recommended various chemical compounds and mixtures, much to the confusion of the fruit growers. This is not meant as a criticism but attention is called to the fault that a step may be taken toward remedying it. The Experiment Station recommends a movement, and is ready to take the initiative in it, that will reduce the number of remedies, and the complexity of their application, and that will evolve a few, simple, cheap, and effective fungicides and insecticides.

This having been done, the great bugbear, "spraying," will have lost half its terrors to the fruit growers. A third fault is:—

Spraying costs too much.—To say nothing of time and material wasted in applying remedies improperly, spraying, yet, costs far too much. Poor spraying apparatus is the chief cause of excessive cost. A good pump with a good tank, hose, extension rod, nozzle, *with every thing convenient*, will save in time and material far more than their cost. A good nozzle is all important. With a nozzle too coarse, material is being wasted. A nozzle should be used that will throw a spray just as fine as is compatible with doing the work well and quickly. This brings us to the matter of thoroughness.

Thoroughness in spraying.—It is worse to err on the side of getting too little of the spray on the tree than getting too much. A tree is well sprayed when its trunk, branches, and leaves are covered and ready to drip. Herein, many fail. Insects and fungi are not killed until the poison is on them, or within their reach. Thoroughness in applying, and economy in using material, though seemingly paradoxical, need always be kept in view by the operator of a spray pump. *Cost* must be considered in *all* the operations of spraying and reduced to a minimum. Another almost universal fault is:—

Ignorance of remedies and their effects.—Too many fruit growers spray to "spray." In a spurt of enthusiasm and with great expectations, many a man has sprayed his trees with a solution that might as well have been clear water. It is obvious that a man should know what he is spraying for before he begins to spray. There is no excuse for this ignorance as there is plenty of horticultural literature which gives pretty exact treatment for the various pests of the orchard. Another fault is:—

Mixtures are not properly made.—Negative results, and usually quite positive injuries, are the result of improperly made mixtures. Directions for preparing a remedy should be followed to the very letter, and to eliminate all chance, tests should be applied so that certainty is guaranteed. When the remedy is being applied the essential ingredients must be kept in solution by agitation.

When to Spray—Under the head of diseases the approximately proper time for spraying for each, will be given. But it

is desired to call attention here to the fact that most spraying for fungus diseases is preventive and *applications of fungicides must be made before the disease has made much headway*. Another point to keep in mind is that when the proper time for spraying comes the work should not be delayed. Unless it is actually raining spraying should go on, since, if the mixtures are well prepared, and have a short time to dry, they will stay on the foliage through a hard rainstorm. Cloudy weather should never hinder spraying. Trees should not be sprayed when in bloom, as the vitality of the bloom will be greatly injured. Lastly:—

* “*Spraying is only one of the requisites to success in fruit raising*.—Spraying has come into use so quickly and so much of the attention of teachers and experimenters has been given to it, that many people have come to look upon it as the means of salvation of our orchards. If spraying is to have the effect of obscuring or depreciating the importance of good cultivation and fertilizing, then it might better never have come into being. Trees must grow before they can bear, and this growth depends upon food and proper conditions of soil, more than it does upon the accident of immunity from insects and fungi. There are four fundamental operations upon which all permanent success in most kinds of orchard culture depend, and I think that their importance lies in the order in which I name them,—tillage, fertilizing, pruning, spraying. Spraying is the last to be understood, but this fact should not obscure the importance of the other three.”

FORMULAS FOR FUNGICIDES.

We shall recommend but three formulas for fungicides, believing these three to be sufficient for all practical purposes. Bordeaux mixture is the favorite fungicide. We hope the following directions will be clear and accurate enough that any one can make the mixture properly. The formula given is the latest and we believe it to be the best.

BORDEAUX MIXTURE.

Copper Sulphate.....	4 pounds.
Fresh lime (unslaked).....	3 pounds.
Water.....	40 gallons.

Directions for making:—Pulverize the copper sulphate; place

* L. H. Bailey, Bulletin No. 101, Cornell Experiment Station,

it in a coarse sack of burlap or other material and hang it in a quarter of the water to dissolve. Slowly slake the lime adding water only as fast as it is taken up; dilute until the lime water is of the consistency of milk or cream, and then strain through a sieve or a piece of burlap into the barrel containing the copper sulphate solution. When ready for use dilute to 40 gallons. The principal object in adding the lime is to neutralize the acid copper sulphate. If sufficient lime is not added the foliage will be injured. Therefore, *always test as follows*: Dissolve ten cents worth of ferro-cyanide of potassium, to be obtained at any drug store, in a small bottle of water. Add a few drops of this solution to the Bordeaux mixture and if a brownish discoloration appears in the water where the drops fell, add lime until such discoloration does not appear. A little surplus of lime is always desirable.

The strength of Bordeaux mixture can be much reduced and yet be efficient in some cases. For the third and fourth application 60 gallons of water may be used instead of 40. No fears of burning the foliage need be entertained if the lime is fresh, of proper amount, and carefully slaked. When needed, Paris green can be used as an insecticide with the Bordeaux, thus saving an extra spraying and neutralizing the burning effect of the Paris green. Some Oregon growers recommend a greater quantity of lime, thus adding to the sticking qualities of the mixture. Four pounds of molasses added to the mixture will be perhaps more effective in making the mixture stick than the added quantity of lime.

When a large orchard is to be sprayed, a stock solution should be made as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water. Slake 50 pounds of fresh lime in a box. When to be used add the lime to so many gallons of copper sulphate solution. A sufficient quantity is added when no change in color is produced by the test given above. Dilute with 10 times as much water.

Copper sulphate solution.—The second fungicide we shall recommend is the copper sulphate solution:

COPPER SULPHATE SOLUTION FOR A WINTER SPRAY.

Copper sulphate.....	1 pound.
Water.....	25 gallons.

The above is a cheap, simple, effective, winter and early

spring spray. Its effect on the fungi is the same as Bordeaux mixture though it is not so lasting. It is obvious that it should never be applied to any plant when the leaves are out.

COPPER SULPHATE SOLUTION FOR SUMMER SPRAY.

Copper sulphate.....	1 pound.
Water.....	250 gallons.

This is to be used when fruits are nearing their ripening period, when Bordeaux mixture would discolor them. This spray takes the place of the copper carbonate solution and is, we believe, preferable to it. It is too strong for any but the hardiest plants. For peaches there should be 500 gallons of water to 1 pound of copper sulphate.

Potassium sulphide.—This third fungicide is recommended for mildew in gooseberries and roses. It does not discolor the fruit and is perfectly harmless.

POTASSIUM SULPHIDE.

Potassium sulphide.. .. .	3 ounces.
Water	10 gallons.

FUNGIOUS DISEASES AND THEIR TREATMENT.

The following are the diseases most prevalent in Oregon. The directions given for their treatment are deduced in part from work done at the Experiment Station, but more largely from the experience of various prominent fruit growers in Western Oregon. The information given by Mr. M. O. Lownsdale of La-Fayette, derived from practical and successful work, has been especially valuable. The consensus of opinion of fruit growers, obtained in the recent partial survey of the fruit interests of Western Oregon, has had much to do with the formulating of the directions for treatment.

We are pleased to give these directions, and think them the best, because of the sources from which they have been obtained, that have yet been given the fruit growers of Oregon. If faithfully followed, we are sure good results will be the outcome. If success or failure attends the application of these fungicides the author will be glad to know of either, as the spraying bulletin for 1897 will be materially influenced by such reports.

Apple scab on apples and pears.—From two to four sprayings with Bordeaux mixture ought to keep this fungus com-

pletely in check. Failure to do so must be attributed to careless application or a poor mixture.

The first spraying should be given just before the buds swell in the spring. In some climates the serviceableness of this application is doubted but we feel sure it is needed in Oregon. I shall recommend that the second spraying be made as soon as possible after the blossoms drop; the third 12-16 days later, and the fourth if desired 12-16 days after that. The mixture for the third and fourth application should contain a third more water and a greater excess of lime, otherwise the Bordeaux may give the apples a roughish, russeted surface. If followed painstakingly, the above treatment, we feel sure, will be successful.

Other fungi on apples and pears.—For “canker” or “dead spot,” Mr. M. O. Lownsdale of LaFayette, who has given this disease and its treatment much attention, recommends a all spraying with Bordeaux, the application to be made soon after the leaves drop; and that the diseased wood be cut out very thoroughly, and the wound washed with copper sulphate and, if large, waxed. Canker is one of the most grievous of the Oregon orchard diseases. The life history of this fungus has not been well worked out, but before another spraying bulletin is published we hope to have the results of the investigations made by Mr. Pierce, the United States Government agent, who spent the summer of 1894 in Oregon studying the disease.

There are several minor fungous diseases on the apples and pears in Oregon, but we do not think it necessary to recommend special treatment, both because the extent of the damage done by them does not warrant it and because they will be well held in check by the treatment for the scab. Pear blight is widely disseminated throughout the state, but is not so virulent in character as elsewhere. The only remedy is to cut it out.

Spraying prunes and cherries.—There are several fungi doing damage to the prune and cherry trees in the state, but the only one that it will pay to make a business of spraying for, is the shot-hole fungus. We have yet to see a prune orchard in Willamette, Rogue, Umpqua, or Hood River valleys that is free from shot hole fungus. The disease is rampant everywhere and spraying must be resorted to or, by the defoliation and consequent weakening of the trees, great damage will be done not

only present prune crops but future ones. The same, to a lesser extent, holds true of the peach and cherry.

A little confusion seems to exist as to the identity of the disease. It may be easily known. Shothole fungus does not appear until the early part of the summer. Its first appearance is in the shape of small, dark brown or purple spots which turn brown and then drop out, the foliage thus appears to have been *riddled with shot*. If the fungus is very prevalent the trees are often nearly defoliated.

The disease is a midsummer one and applications for it must be made late in the season. We feel sure it can be controlled by the following treatment.

First. Apply Bordeaux mixture 10 days after the blossoms have fallen.

Second. Repeat in from 20-30 days, depending upon whether the season is dry or wet.

Third. If the disease was prevalent the preceding year, and if conditions seem favorable for the growth of the fungus, repeat as in the second.

"*Canker*" in *prunes*, and "*gummosis*" in *cherries*.—Treat as recommended for canker in apples. We touch lightly upon this disease because we are free to confess we know but little of it.

A disease new to Oregon prune orchards.—Several prunes affected by brown rot (*Oidium fructigena*, Kzl. and Schm.) were this year sent to the Station. Upon investigation it was found that *nearly the whole product of several orchards had been destroyed by this fungus*. No previous notice of its existence in Oregon is to be found in the state horticultural literature, nor do prune men seem to know of it, we assume therefore that it is new to this region.

Brown rot is very familiar to Eastern plum, peach, and cherry growers. In some seasons in Georgia, it takes a third of the peach crop. In Michigan the aggregate damage done to peaches, pears, and plums is as great as that of all other diseases, if we except peach yellows. Not only is the fruit on the tree attacked but after being picked oftentimes is destroyed. We cannot help but think that this fungus will prove as destructive to prune interests in Oregon, if allowed to go unchecked, as scab or codling moth is to the apple industry.

The following is a brief description of the disease. Leaves,

flowers, and fruit are attacked, but it is upon the fruit that it does most damage. The fungus enters the cells of the fruit and robs them of their contents, and rot ensues. The rot is easily distinguished from ordinary decay by the clusters, or tufts of ash-grey spores which cover the fruit, these in time disappear and the fruit shrivels and hangs in this condition upon the tree. It is most troublesome in warm, moist weather.

The sprayings which every prune grower should give for shothole fungus will help keep brown rot in check. If the disease is known to be present one or two applications of the weak copper sulphate solution when the fruit is maturing should be given. Collecting and destroying the rotting fruit is an excellent plan.

Spraying peaches.—Shothole fungus in peaches should be treated as recommended for plums. Curl leaf is our most troublesome peach fungus, but can be fairly well controlled by applying Bordeaux. Two sprayings, aside from those which peaches need for shothole fungus, should be given the trees; the first, from 4-6 weeks before the blossoms open; the second, 3-5 weeks later. This treatment has proved successful in numerous peach orchards in the state and may be depended upon.

INSECTICIDES.

A. B. CORDLEY.

It is not our purpose to record the results of original observations, nor to advocate the use of untried remedies, but rather to present to the fruit growers of the state, concise directions for using those sprays which experience has shown to be the most effective—prefacing the more practical part of the subject, by such remarks on the structure and habits of insects in general, as seem essential to a correct conception of the action of the various sprays.

Judging from the frequent reports of failure from the use of well known and reliable insecticides, probably the best advice to be given at this time is, study the insect you wish to control until you know what it is; and if in any case you are not absolutely certain, send us specimens and we will gladly determine

them for you. Then observe the different stages in its life history—the egg, the larva, the pupa, and the adult, and know when each occurs. Oftentimes an insect which is easily destroyed in one stage, is very difficult to combat in the stage in which it does the most damage. Above all, observe the nature of the injury it does. In this respect we can for all practical purposes divide insects into two great classes.

a. Those that actually chew and swallow the tissue of the plant or its fruit.

b. Those that pierce the surface of the plant with a long slender beak and suck up its juices, but eat none of the tissues.

To class “*a*,” belong all caterpillars, beetles, slugs, codling moth, etc.

To class “*b*,” belong the green aphid, the woolly aphid, the various scale insects, squash bugs, and other true bugs, the red spider, etc.

The injury caused by insects of class “*a*” is readily observed and hence is more apt to receive prompt attention, while on the other hand the injury caused by those of class “*b*,” although no less severe, is often less noticeable. Hence it is that insects of this class, which injure the plant simply by appropriating its juices, thus causing the foliage to become spotted or yellow, and finally to wither and die, are allowed to multiply to such an extent that the most energetic measures are required for their control.

A brief consideration of the above facts regarding the general habits of insects, will serve to convince one that while most insects belonging to class “*a*” are readily destroyed by the poison sprays, on the other hand insects belonging to class “*b*” are but little if at all affected by them, since they secure their food beneath the surface of the leaf and hence can not be made to eat any of the poison. It thus becomes necessary in order to successfully deal with these two classes of insects, to have two general classes of insecticides.

1st. The arsenites, as Paris green and London purple, which are to be used against insects of class “*a*,” but which are practically of no value against those of class “*b*.”

2d. Those substances which kill by contact, as kerosene emulsion, the resin wash, the lime, salt, and sulphur mixture,

whale-oil soap, lye, sulphur, etc., which are chiefly used against insects of class "b.",

THE ARSENITES.

The chief insecticides of this class are Paris green and London purple, which are so well known that but few words concerning them are necessary. Paris green is, we think, undoubtedly the better of the two. It is more uniform in strength, kills more quickly, and is less liable to burn the foliage. London purple is slightly cheaper, and, being more finely divided, is more easily kept from settling to the bottom of the spraying tank. For use against the codling moth, caterpillars, and most other insects of class "a," apply either, in the form of a spray, using the following proportions:

Paris green or London purple	1 pound.
Unslaked lime.....	2 pounds.
Water.....	160 to 200 gallons.

Slake the lime and while it is slaking stir in the Paris green. Then strain the mixture through a coarse sieve or piece of burlap, and dilute with the required amount of water. The Paris green and water can be used in the above proportion without the addition of the lime, but it is much safer to add the lime since it precipitates the soluble arsenic compounds, and thus prevents injury to the foliage. This is especially true in spraying such tender foliage as that of the peach.

If at any time, it is desirable to spray at the same time with an insecticide and a fungicide, either of the above poisons may safely be added to the Bordeaux mixture—the lime in the latter neutralizing all injurious effects of the poison upon the foliage. For most purposes these sprays should be used when the injury is first observed, and thereafter every ten days or two weeks as long as it continues; but in spraying for the codling moth, *we must begin before the injury is apparent*—about the time the moth is depositing her eggs upon the fruit. In ordinary seasons this should be about June 6, to June 12. (Washburn.)

In applying these sprays, we should not aim to drench the trees, but rather to cover every portion of them with as thin a film of the liquid as possible. Anything more is a needless waste of material. For this reason, that nozzle is the best for this purpose, which can be made to throw a very fine, mist-like spray.

CONTACT INSECTICIDES.

Kerosene Emulsion.—We consider this, one of the best insecticides to use against insects of class “*b.*” Kerosene kills by contact and its penetrating power is such that but few insects can resist it. The pure oil is, however, about as injurious to plants as to insects and thus it becomes necessary to emulsify it with some substance that it may readily be diluted with water. Soap or sour milk are the best of such substances. The emulsion with soap is made as follows:

Water.....	1 gallon.
Soap (preferably whale-oil soap).....	$\frac{1}{2}$ pound.
Kerosene oil.....	2 gallons.

Dissolve the soap in the water by boiling. Add the suds, still boiling hot, to the oil and violently agitate the mixture by pumping it back upon itself through a force pump. If hot, the emulsion should form in about five minutes, otherwise it may not emulsify at all without reheating. A perfect emulsion should have a creamy appearance, and should adhere to the surface of glass without oiliness. If not perfect, the oil will rise to the surface and much harm may result, especially if the emulsion is used as a dip for nursery stock or animals. Such an emulsion may be used immediately; or, if well made may be kept indefinitely as a stock mixture to be diluted and used as wanted.

An equally good emulsion may be made, without heat, by using sour milk instead of the soap and water.

Sour milk.....	1 gallon.
Kerosene oil.....	2 gallons.

These are to be mixed as in forming the kerosene soap emulsion. It has, however, the disadvantage that it will not keep for any length of time, hence must be made fresh for each application.

When ready for use, dilute the required amount of stock emulsion with 8 to 15 times its bulk of water, and use as a spray. The stronger mixture applied in the fall, has been found effective in destroying the pear-leaf blister-mite;—the weaker will, I think, be found sufficiently strong to destroy the young of the oyster-shell scale,—if applied to infested trees just after the blossoms fall, and will also prove effective in destroying green aphids,

woolly aphis, and red spider, if applied at any time when they are observed to be abundant.

While recommending the above emulsions, I am well aware that, in the past, they have not been the favorite sprays with Oregon fruit growers, but I still believe that careful and more extensive use of properly made emulsions will yet demonstrate that they are among the best, if not the best washes we have for controlling the above mentioned class of insects.

In California, as in Oregon, the favorite mixtures have been the resin wash and the lime, salt, and sulphur mixture; but numerous recent reports of the successful use of kerosene emulsion seem to indicate that on the Pacific coast it is slowly but surely attaining that popularity which it has held in the East for several years.

One of the chief objections urged against these emulsions is their cost, and yet when we consider the ease with which they are made and their effectiveness, we must, notwithstanding the exorbitant price of kerosene oil, still number them among our cheapest effective washes. Two gallons of kerosene and one gallon of strong suds will, in process of emulsifying, increase in volume to about four gallons of stock emulsion, which when diluted with water in the above indicated proportions will make from 32 to 60 gallons of spraying strength—the latter thus costing (at the present price of kerosene) from about $1\frac{1}{4}$ cents down to $\frac{3}{4}$ of a cent per gallon.

Believing as I do, that a multiplicity of spraying formulas are simply confusing, and that kerosene emulsion is one of the best, if not the best general purpose summer spray for this class of insects, I shall at this time recommend no other. There are, however, several scale insects, especially the San Jose scale, which can best be controlled by winter washes. For this purpose, I shall still advise the use of the lime, salt, and sulphur mixture, so long recommended by this station and by the State Board of Horticulture.

It is made as follows:—

Unslaked lime.....	25 pounds.
Sulphur.....	20 “
Salt.....	15 “

Boil the sulphur and 10 pounds of lime in 20 gallons of water *until the sulphur is completely dissolved*. It may take 3

to 5 hours of brisk boiling. Place in a cask 15 pounds of lime, and add enough hot water to slake it, and while it is slaking add the salt. When completely slaked, add the lime and salt to the sulphur and boil half an hour longer. Before using, add enough water to make 60 gallons. Apply while still warm in the form of a coarse spray.

Recent experiments conducted by Mr. L. C. Marlatt, assistant U. S. entomologist, prove conclusively that, under the conditions prevailing in the Eastern United States, the above mixture is not nearly so effective as a simple solution of whale-oil soap used in the proportions of $1\frac{1}{2}$ to 2 pounds per gallon of water. When one considers the many disagreeable features connected with the making and the application of the lime, salt, and sulphur mixture, it is to be hoped that equally good results from the use of whale-oil soap may be obtained on the Pacific coast. We shall if possible test the matter ourselves, and will be pleased to receive reports from any horticulturists who may see fit to try it.

A FEW INJURIOUS INSECTS AND THEIR TREATMENT.

The Codling Moth.—A small pinkish “worm” which burrows in the fruit of the apple and the pear, causing the disgusting condition known as “wormy fruit.”

The “worms” are the larvae of a small grayish brown moth with a bronze spot on the posterior portion of each front wing. In the east, the first brood of these moths appear about the time the apple-tree is in bloom, or shortly after, and deposits its eggs singly on the blossom end of the young fruit. In about a week, these eggs hatch and the small “worms” immediately begin to burrow towards the core of the fruit. Hence it is that *time* becomes an important element in spraying for this pest. A few days too early or too late, may make all the difference between success and failure. As soon as the “worms” have fairly entered the fruit, they are beyond the reach of all insecticides, but if a fine mist-like spray of Paris green and water be applied to the tree just when the eggs are hatching, the young larvæ are poisoned at the outset of their career. Just when this occurs, varies somewhat with the season and evidently more with the locality. In the east, the rule is to spray first, just after the blossoms fall, and this seems applicable to the conditions occur-

ring in eastern Washington, and probably eastern Oregon.* In the Willamette Valley, however, different climatic conditions seem to render a different procedure advisable. Prof. Washburn states, that here, the *first brood of moths does not appear until early in June*, and this is borne out by observation of Mr. M. O. Lownsdale, and other prominent fruit growers.

It therefore seems apparent that in this valley, the first spraying for the codling moth should be done between June 6th, and June 12th, while in the eastern part of the state it may be necessary to spray just after the blossoms fall. Whenever the first application is made, do not make it the last. In this valley, "repeat the spray about the first of July, and on late apples, Baldwins for instance, make two more applications, one late in July, and one about the middle of August." (Washburn.)

Plant lice.—Numerous species of plant lice attack our various fruit trees and shrubs, but for our present purpose it is sufficient to group them all under the popular terms "green aphid," and "black aphid." Both are very numerous and very destructive, probably causing a greater loss to Oregon fruit growers than any other insects, although they are among the easiest insects to destroy. The small, black, shining eggs, hatch soon after the buds burst in the spring, and thorough spraying at this time with kerosene emulsion, (1 part emulsion to 15 parts water,) will do much towards keeping the trees free for the remainder of the season. Later sprayings, however, should be done whenever the aphids become abundant.

San Jose Scale.—Where it has been introduced, this is the most destructive of Oregon insects and the most difficult to destroy. When comparatively scarce on a tree, their presence is indicated by a reddish discoloration of the bark about each insect. When very numerous, the tree looks as though covered with fine sifted ashes. The only practicable remedies are to spray the tree thoroughly with the lime, sulphur, and salt mixture, or with whale-oil soap solution. In either case, the application should be made in the winter, and the trees thoroughly drenched. It is advisable to make the first application early in the winter and then repeat in six or eight weeks, since it is impossible to be so thoroughly effective as to destroy all the scales with but one application.

* Piper, C. V. Bulletin 17, Wash. Ex. Sta. p. 14.

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Oregon Agricultural

EXPERIMENT STATION.

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Agricultural Department.

H. T. FRENCH.

FEEDING SHEAF WHEAT.

(a) Pigs. (b) Steers.

Feeding Potatoes to Pigs.

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The Bulletins of this Station are sent free to all residents
of Oregon who request them.

FEEDING SHEAF WHEAT.

H. T. FRENCH.

OBJECTS OF THE EXPERIMENTS.

Several inquiries have come to the Station, regarding the value of sheaf wheat as a stock food. This question is especially important to those people in the State, who can only get the use of threshing machines after considerable delay, and at quite an expense, owing to the distances over which the machines must be hauled. Then again, in any locality, however thickly populated, the expense of threshing and grinding grain is no small item. If this expense can be obviated, stock can be fed with a greater profit.

The above are points upon which information is frequently asked, and to throw some light upon these questions the following experiments were planned and carried out.

The third experiment, reported in this Bulletin, is one in which potatoes were fed to pigs to ascertain their value for fattening purposes as compared with grain. The details of the experiment will be found under the head of experiment No. 3.

The fourth experiment was planned for the purpose of determining the value of sheaf wheat for steers. This question, has been as important, apparently, as the feeding of sheaf wheat to pigs. If this method of feeding can be made profitable, then a large amount of grain, now threshed in certain sections of the state, will find its way into animal product without this extra expense. The results and conditions are set forth under the proper head.

EXPERIMENT No. 1.

CONDITIONS SURROUNDING THE EXPERIMENT.

In this experiment, sheaf wheat was fed to a lot of pigs with the view of testing its merits, as compared with a mixture of grains. Twelve pigs, which had been running on a stubble field since harvest, were selected for the experiment. The pigs were placed in two lots of six pigs each, and the work begun September 3rd. The pigs were nearly pure bred Berkshire,—the fraction of impurity being Poland China.

In weight and in all other characteristics, which could be determined by observation, the lots were very evenly balanced. The age of the pigs, when the feeding began, was about eight months. For weights of the pigs, the reader is referred to Table No. I. showing results by periods. The feeding will be discussed under the heads of Lots 1. and 2. Lot 1, being the pigs to which were fed the mixture of grains, and Lot 2. the ones to which the sheaf wheat was fed. The pigs were fed twice daily, at eight o'clock in the morning, and five o'clock in the evening. Each ration was weighed; and the mixed ration was soaked in cold water from nine to fifteen hours. The pigs were given the use of a small yard, until the ground became muddy, when they were confined to the pen. The pens are built with two compartments, and are provided with plenty of clean straw for bedding. It is just as important to keep a pig in clean comfortable quarters, as any other kind of stock, if the best returns in quantity and quality of product are realized. Charcoal and ashes were in the pens continuously, and salt was mixed with each feed of chopped grain, and was given to the sheaf wheat lot at regular intervals.

For the purpose of answering inquiries, in which people have expressed a doubt, as to the advisability of feeding salt to pigs, we would say that salt will not injure pigs; but on the other hand is relished by them, when fed regularly and not in excessive quantities. Plenty of clean water was given the pigs of each lot. Those fed on sheaf wheat drank considerable water. No more perhaps than those fed on chopped grain; but the latter, took a large portion of theirs with their feed.

The pigs were weighed every 14 days, and were weighed

two days in succession at the same hour each day. The mean of the two weights was taken for the record. There has been some criticism upon single daily weights being recorded. The criticism is just, no doubt, and one which every experimenter in stock feeding should heed; but, in case of the pigs in this experiment, and four others, in another similar experiment, which were weighed three days in succession, and the mean taken, there was very little variation. With very few exceptions, the daily weights did not vary more than the amount of daily gain. These exceptions however, were sufficient to warrant the extra pains of making several weights and taking a mean, rather than to publish the single daily weight. This is especially important in experimental work.

RESULTS.

The results are given in table No. I, in periods of 14 days each. A summary of results is found in table No. II.

Lot 1 was fed a mixture, made up of 3 parts chopped wheat, 1 part shorts and 1 part ground oats. The chopped wheat was valued at \$16.00 per ton, shorts \$11.00, and oats \$10.00, making the mixture \$13.80 per ton.

This lot made a very rapid gain the first period, making over 3.4 lbs. per day. This is probably due to bringing the pigs in, from the stubble pasture, where they had not received such a liberal diet. The second, and all subsequent periods the gain is less. The average daily gain for the whole time, for each pig, was 2.68 pounds. This is shown in table giving summary. For large pigs this is a very fair increase.

The amount of food to make a pound of gain increases gradually, from the first period to the last, except in the 2d period, where there is a sharp rise owing to the falling off in the gain. The pigs were fed a little too much at the outset, so that during the second period they got "off their feed." The average amount of food to make a pound of gain is 4.17 pounds. This is the most favorable result that has been reached in our pig feeding experiments.

The average cost of producing a hundred pounds of live weight, without reckoning the cost of labor, is \$2.88. This leaves a margin of profit, when pigs sell for 3 cents on foot, the

price paid for this lot, at the close of the experiment. The profits would have been greater, if the pigs had been sold a month earlier.

As regards lot 2, or those fed on sheaf wheat, the results are not so favorable. These pigs were fed on sheaf wheat which had been cut and bound in the ordinary way with a binder. The grain was cut as high as the binder could be operated, yet the sheaves contained a large amount of straw. Several samples were threshed, and an average made of the yield of grain to straw. It was found that the wheat yielded 35 per cent of grain, or a trifle over one-third. The wheat was weighed in the sheaf and thrown to the pigs, at the same time that the other lot was fed.

During the first period the pigs in this pen gained 74 pounds against $288\frac{1}{2}$ gained by lot 1. They consumed 1360 pounds of sheaf wheat, which contained 476 pounds of grain. This is 288 pounds less, than lot 1 consumed of the mixture, although the pigs in both cases were given all that they would eat. In the one case, it required 2.6 pounds of grain to make a pound of gain, while in the other it took 6.43 pounds of grain. A bushel of wheat at this rate produced 9.33 pounds of live weight, while 60 pounds of the mixture produced 22.7 pounds of gain.

The cost of producing a pound of gain in lot 2, was 4.28 cents, while in lot 1, it only cost 1.83 cents. The cost of producing a pound of gain, in lot 1, gradually increases through the periods, making an average cost, during the whole time of 4.96 cents, while the average cost in lot 1 was 2.88 cents.

It required 7.44 pounds of grain in the sheaf to make a pound of live weight, while it only required 3.97 pounds of the mixture to make a pound of gain. Then 60 pounds of wheat in the sheaf, made 8.06 pounds of live weight, while 60 pounds of the mixture made 15.11 pounds. At three cents per pound live weight there would be a difference, in favor of the mixture, of 21 cents per bushel. This will pay for the threshing and grinding even under adverse circumstances.

SOME OBSERVATIONS.

1.—It was plainly seen, that the pigs fed on sheaf wheat

did not relish their food. This interfered very materially in obtaining good results. An animal will not make rapid gains in flesh, when it is compelled to work for its food. This is especially true of the pig. The pigs worked from three to four hours daily, in getting their food from the straw. In case of other animals this might not be as apparent, for they might require some of the coarse food along with the grain, and hence would not separate the wheat from the straw and chaff. The pigs fed on the mixture would eat their ration in a few minutes, and then lie down; and hence all the food consumed became effective in the production of fat. On the other hand in lot 2, rapid assimilation was prevented, by length of time employed in securing the food.

2.—Much of the grain eaten by the pigs fed on sheaf wheat was found whole in the excreta. It was not masticated. The amount found whole in the excreta, was not as great as when pigs are fed on clean threshed grain; but there was enough to account for considerable of the loss in the weights.

3.—The pigs fed on sheaf wheat were not quiet in their pens. Their appetites seemed to never be fully appeased. Hence, they were in constant expectancy for something. This unrest prevented the proper digestion and assimilation of the food received.

4.—More time is required in caring for animals fed in this way, in clearing the straw from the pens.

5.—The feed can not be stored in as small quarters as the threshed grain. Mice, rats, and other vermin will destroy more of the wheat in the straw than when threshed and properly stored in bins.

These are some of the points noted during the process of the experiment, and while some of them might be obviated, they seem to us to be serious objections to feeding pigs on sheaf wheat

TABLE No. I.

Results by periods of 14 days each.	No. of Pig.	Weight Sept. 3.	Weight Sept. 17.	Gain. lbs.	REMARKS.
1st period Lot 1.....	11	224½	276½	52	Chop'd wheat \$16.00 per ton.
	12	186½	241	54½	Shorts, \$11.00 per ton.
	13	169	215	46	Oats, \$10.00 per ton.
	14	200	240	40	Mixture, \$13.80 per ton.
	15	187½	239	52½	
	16	154½	198	43½	
Total gain.....	.....	.....	.....	288½	
Amt. food consumed.....	.....	.....	.....	764	
Food for 1 lb. gain.....	.....	.....	.....	2.64	
Cost 100 lb. gain.....	.....	.....	.....	\$1.83	
Sept 17. Oct. 1.					
2d period, Lot 1.....	11	276½	309	32½	
	12	241	266	25	
	13	215	237	22	
	14	240	264	24	
	15	239	269	30	
	16	198	220	22	
Total gain.....	.....	.....	.....	155½	
Amt. food consumed.....	.....	.....	.....	780	
Food for 1 lb. gain.....	.....	.....	.....	5.01	
Cost 100 lb. gain.....	.....	.....	.....	\$3.46	
Oct. 1. Oct. 15.					
3d period, Lot 1.....	11	309	350	41	
	12	266	318	52	
	13	237	275	38	
	14	264	306	32	
	15	269	320	51	
	16	220	259	39	
Total gain.....	.....	.....	.....	253	
Amt. food consumed.....	.....	.....	.....	980	
Food for 1 lb. gain.....	.....	.....	.....	3.87	
Cost 100 lb. gain.....	.....	.....	.....	\$2.67	
Oct. 15. Oct. 29.					
4th period, Lot 1.....	11	350	385	35	
	12	318	352	34	
	13	275	310	35	
	14	306	335	29	
	15	320	357	37	
	16	259	294	35	
Total gain.....	.....	.....	.....	205	
Amt. food consumed.....	.....	.....	.....	1063	
Food for 1 lb. gain.....	.....	.....	.....	5.18	
Cost 100 lb. gain.....	.....	.....	.....	\$3.57	

TABLE No. II.

Sheaf Wheat.	No. of Pig.	Weight Sept. 3.	Weight Sept. 17.	Gain. lbs.	REMARKS.
1st period, Lot 2.....	5	189½	202	12½	
	6	173	189	16	
	7	154½	169	14½	
	8	261	265	4	
	9	186	200	13½	
	10	163	177	14	
Total gain.....				74	
Amt. sheaf wheat fed				1360	
Amt. grain in wheat.				746	35 per cent. of sheaf wheat.
Grain for 1 lb. gain....				6.43	
Cost of 100 lb. gain....				\$4.28	Wheat 40 cents per bushel.

Sept. 17. Oct. 1.

2d period Lot 2.....	5	202	213	11	
	6	189	201	12	
	7	169	174	5	
	8	265	279	14	
	9	200	209	9	
	10	177	187	10	
Total gain.....				61	
Amt. sheaf wheat fed				1300	
Amt. grain in wheat.				455	
Grain for 1 lb. gain....				7.46	
Cost of 100 lb. gain....				\$4.96	

Oct. 1. Oct. 15.

3d period, Lot 2.....	5	213	222	9	
	6	201	212	11	
	7	174	184	10	
	8	279	291	12	
	9	209	226	17	
	10	187	200	13	
Total gain.....				72	
Amt. sheaf wheat fed				1400	
Amt. grain in wheat.				490	
Grain for 1 lb. gain....				6.80	
Cost of 100 lb. gain....				\$4.53	

Oct. 15. Oct. 25.

4th period, Lot 2.....	5	222	231	9	
	6	212	225	13	
	7	184	195	11	
	8	291	303	12	
	9	226	233	7	
	10	200	208	8	
Total gain.....				60	
Amt. sheaf wheat fed				1620	
Amt. grain in wheat.				567	
Grain for 1 lb. gain....				9.45	
Cost of 100 lb. gain....				\$6.30	

TABLE No. III.

SUMMARY.

Total gain Lot 1, from Sept. 3, to Oct. 29	902 lbs.
" " Lot 2	267 "
Gain of Lot 1, over Lot 2	635 "
Total food consumed by Lot 1.....	3587 "
Amount of sheaf wheat fed to Lot 2.....	5680 "
Amount of grain in wheat 35 per cent, or.	1988 "
Amount of grain for 1 pound of gain, Lot 1.....	3.97 "
Amount of grain for 1 pound of gain, Lot 2.....	7.44 "
Average daily gain Lot 1.....	2.68 "
Average daily gain Lot 2.	.79 "
Cost of 1 pound of gain Lot 1.....	2.88 cents.
Cost of 1 pound of gain Lot 2	4.96 "
Gain from 60 pounds of grain Lot 1.....	15.11
Gain from 60 pounds of grain Lot 2.....	8.06 lbs.
At 3 cents per pound live weight, the difference in favor of 60 pounds of the mixture is	21 cents,

EXPERIMENT No. 2.

OBJECT OF THE EXPERIMENT.

This experiment was carried on for the purpose of comparing the feeding value of wheat in the sheaf with pure chopped wheat. In the first experiment the object was to compare wheat in the sheaf with an economical mixture of grains. In this experiment economy of food is not so much considered, as a comparative test of wheat in the two forms.

There is a tendency among farmers, since wheat has become a common food for stock, to feed wheat alone rather than to make a mixture with other grains. In this experiment, and in others reported in previous Bulletins, we have shown quite clearly that a mixture is more economical. Oats, when ground and combined with other finer grains, are very good for pig feeding, and are economical, especially when the price falls so low as during the past season,

CONDITIONS OF EXPERIMENT.

Four cross bred Berkshire-Poland-china pigs were selected for this work. They were of the same litter, and were very uniform in weight and external conformation. In three of them there was only four pounds of difference in weight, while the fourth was 13 pounds heavier than the lightest one. The pigs were four months old when the feeding began. They were farrowed April 8th. The feed, previous to the time of experimental feeding, and after the weaning period, which was at

about eight weeks of age, consisted of shorts and water. The pigs were confined to the pens and yards, the same as those in experiment No. 1. The feeding was conducted as in the previous experiment. The pigs were fed twice each day, at eight in the morning, and four in the evening. The chopped wheat was soaked from 8 to 12 hours, before feeding. Ear tags numbering 1, 2, 3, and 4, were inserted and these numbers are followed in the tables giving weights by periods. The pigs were weighed every 14 days; and they were weighed three days in succession, and a mean of those weights taken for the record. They were weighed the day preceeding the 14th. day, on the 14th day, and the day following.

RESULTS.

The results are given in periods of fourteen days each, as seen in tables 4 and 5. The results are summerized in table 6. During the first period, lot 1, those fed on sheaf wheat, there was an actual falling off of three pounds in weight. This is partially due to the fact, that the pigs did not take well to the feed, only consuming 3 pounds a piece per day. The pigs were not as contented, as those in pen No. 2. In pen No. 2, there was a gain of 26 pounds during the same period. As the experiment progressed the pigs became better accustomed to the sheaf wheat, and made slight gains, until the end of the experiment. The total gain in live weight made by lot 1, was 346 pounds in 126 days, or .6 of a pound per day. Lot 2 made a total gain of 592 pounds in 126 days, or 1.56 pounds per day. This is not as great a gain per day as might have been made by a mixture of grains, basing our opinion upon previous experiments. In experiment No 1, reported in this Bulletin, it will be seen that the daily gain far exceeds that made in this experiment, especially by those fed on the mixture. While a portion of the increase in gain, in experiment No. 1 might be due to individual characteristics, yet a large per cent of it can only be accounted for in a better prepared ration. The sheaf wheat fed to lot 1, weighed 3319 poands, and 35 per cent of this, or 1161.6 pounds, would represent the grain in the sheaf. Lot 2, consumed 1871 pounds of chopped wheat. This makes 7.54 pounds of grain, to produce a pound of live weight, in lot 1, and 4.74 pounds of grain in lot 2. Valuing the chopped grain

at \$16.00 per ton, and the wheat in the sheaf at 40 cents per bushel, or \$13.46 per ton, the cost of food consumed by lot 1, would be \$7.74, and \$14.96 in case of lot 2. At this rate the cost of making 100 pounds of gain in live weight in lot 1, was \$5.00, and in lot 2, \$3.80. A bushel of wheat in the sheaf produced a gain of 7.95 pounds, while a bushel of the chopped grain made 12.65 pounds gain in live weight. This makes a difference, in favor of the chopped grain, of 4.70 pounds, which at 3 cents per pound, the price paid for pork on foot, would amount to 13 cents. This is a sufficient margin to more than pay for the threshing and grinding.

There is another consideration in feeding the sheaf wheat, viz.—that the pigs are very poorly fitted for market, when thus fed. The pigs fed on sheaf wheat in this experiment, would not bring as much as those fed on chopped grain, by $\frac{1}{2}$ cent per pound. The pigs were not well filled out; they were lank and lean, better fitted for racing than for the packing house. The small amount of gain made by them, was largely bone, muscle, and sinew, rather than adipose tissue.

From observations and facts, obtained in both of these experiments in feeding sheaf wheat to pigs, we are led to conclude that:

1. Pigs do not like sheaf wheat.
2. The wheat is not well digested.
3. It cost more to put on fat with sheaf wheat than with ground grain.
4. That a proper mixture of grains will give better results than a single grain.
5. The animal can be better matured when fed with ground grain.
6. More rapid gains can be made with ground grain than with grain in the sheaf.
7. The animal product will command a higher price, when the animal has been fed on ground grain, because it will be better matured. A fat hog is worth more in the market than a lean hog.

TABLE No. IV.

Fed on sheaf wheat. Wheat 40 cents per bushel in sheaf.

RESULTS BY PERIODS OF 14 DAYS.

	No. of Pig	Weight Aug. 1. lbs.	Weight Aug. 15. lbs.	Gain. lbs.
1st period Lot 1.....	1	96	96	00
“ “ Lot 1.....	2	96	93	—3
Total gain.....				—3
Grain consumed.....				83.6
Cost of food.....				\$.55
2d period, Lot 1.....	1	Aug. 15. 96	Aug. 29. 103	7
2d period, Lot 1.....	2	93	107	14
Total gain.....				21
Grain consumed.....				116
Cost of food.....				\$.76
3d period, Lot 1.....	1	Aug. 29. 103	Sept. 12. 119	16
3d period, Lot 1.....	2	107	114	7
Total Gain.....				23
Grain consumed.....				123½
Cost of food.....				\$.82
4th period, Lot 1.....	1	Sept. 12. 119	Sept. 26. 130	11
4th period, Lot 1.....	2	114	120	6
Total gain.....				17
Grain consumed.....				98
Cost of food.....				\$.65
5th period, Lot 1.....	1	Sept. 26. 130	Oct. 10. 139	9
5th period, Lot 1.....	2	120	127	7
Total gain.....				16
Grain consumed.....				120½
Cost of food.....				\$.80
6th period, Lot 1.....	1	Oct. 10. 139	Oct. 24. 149	10
6th period, Lot 1.....	2	127	138	11
Total gain.....				21
Grain consumed.....				149
Cost of food.....				\$.99
7th period, Lot 1.....	1	Oct. 24. 149	Nov. 7. 162	13
7th period, Lot 1.....	2	138	146	8
Total gain.....				21
Grain consumed.....				157
Cost of food.....				\$1.04
8th period, Lot 1.....	1	Nov. 7. 162	Nov. 21. 174	12
8th period, Lot 1.....	2	146	158	12
Total gain.....				24
Grain consumed.....				157
Cost of food.....				\$1.04
9th period, Lot 1.....	1	Nov. 21. 174	Dec. 5. 182	8
9th period, Lot 1.....	2	158	164	6
Total gain.....				14
Grain consumed.....				157
Cost of food.....				\$1.04

TABLE No. V.

Fed on chopped wheat, reckoned at \$16.00 per ton.

RESULTS IN PERIODS OF 14 DAYS.

	No. of Pig	Weight Aug. 12. lbs.	Weight Aug. 15. lbs.	Gain. lbs.
1st period, Lot 2.....	3	92	101	9
1st period, Lot 2.....	4	105	122	17
Total gain.....				26
Grain consumed.....				133
Cost of food.....				\$1.06
2d period, Lot 2.....	3	Aug. 15. 101	Aug. 29, 118	17
2d period, Lot 2.....	4	122	144	22
Total gain.....				39
Grain consumed.....				160
Cost of food.....				\$1.28
3d period, Lot 2.....	3	Aug. 29 118	Sept. 12. 138	20
3d period, Lot 2.....	4	144	169	25
Total gain.....				45
Grain consumed.....				187
Cost of food.....				\$1.49
4th period, Lot 2.....	3	Sept. 12. 138	Sept. 26. 157	19
4th period, Lot 2.....	4	169	188	19
Total gain.....				38
Grain consumed.....				196
Cost of food.....				\$1.57
5th period, Lot 2.....	3	Sept. 26. 157	Oct. 10. 174	17
5th period, Lot 2.....	4	188	215	27
Total gain.....				44
Grain consumed.....				216
Cost of food.....				\$1.73
6th period, Lot 2.....	3	Oct. 19. 174	Oct. 24. 195	21
6th period, Lot 2.....	4	215	243	28
Total gain.....				49
Grain consumed.....				224
Cost of food.....				\$1.79
7th period, Lot 2.....	3	Oct. 24. 195	Nov. 7. 223	28
7th period, Lot 2.....	4	243	269	26
Total gain.....				54
Grain consumed.....				224
Cost of food.....				\$1.79
8th period, Lot 2.....	3	Nov. 7. 223	Nov. 21. 247	24
8th period, Lot 2.....	4	269	297	28
Total gain.....				52
Grain consumed.....				251
Cost of food.....				\$2.00
9th period, Lot 2.....	3	Nov. 21. 247	Dec. 5. 268	21
9th period, Lot 2.....	4	297	324	27
Total gain.....				48
Grain consumed.....				280
Cost of food.....				\$2.24

TABLE No. VI.

SUMMARY.

	lbs.
Total weight Lot 1, Aug. 1st. Sheaf wheat lot.....	192
“ “ “ 2, “ “ Chopped wheat lot.....	197
“ “ “ 1, Dec. 5th	346
“ “ “ 2, “ “	592
Total gain Lot 1 Aug. 1 to Dec. 5.....	154
“ “ “ 2 “ “ “ “	395
Average daily gain for each pig Lot 1.....	.61
“ “ “ “ “ 2.....	1.56
*Grain consumed by Lot 1.....	1161.6
“ “ “ “ 2.....	1871
Amount of grain for 1 pound gain, Lot 1.....	7.54
“ “ “ “ “ 2.....	4.74
Cost of food consumed, Lot 1.....	\$7.74
“ “ “ “ 2.....	\$14.96
Cost of 100 pounds gain in live weight, Lot 1.....	\$5.00
“ “ “ “ “ 2.....	\$3.80
60 pounds of wheat in sheaf produced in gain.....	7.95
60 pounds of chopped wheat produced in gain.....	12.65

* 35 per cent of weight of sheaf wheat.

EXPERIMENT No. 3.

FEEDING POTATOES TO PIGS.

During the past two years there have been a great many inquiries made regarding the value of potatoes in fattening pigs. The low price which has prevailed a portion of the time, has made the question of still greater importance. Often the farmer finds himself overstocked with potatoes, which cannot be sold at any price. Under such circumstances the question of feeding them to animals becomes an important consideration.

In many portions of the state the conditions are so favorable for the growth of potatoes, that farmers are considering the advisability of growing potatoes for no other purpose than as a stock food. It is a common practice among farmers to feed potatoes to pigs; but there is very little reliable data as to the real benefit derived from such food. That it is important to know, just to what extent, and in what manner, we may feed potatoes and other coarse products of the farm to animals and realize a profit, goes without saying. It is a serious question which confronts the farmer many times, to know how to utilize the by-products of the farm. If we can solve the problem, of how to “gather up the fragments,” and turn them to account, we shall have performed an important office.

As a fore-runner of future work along this line, the following

experiment was carried out. Having a small lot of potatoes on hand, for which there was little demand, we determined to feed them to pigs, and the record of the results is here published.

Ten pigs, eight of one litter and two of another, were separated into two lots of five pigs each. The pigs were weighed and placed in pens making the two lots as nearly equal as possible. The pigs previous to the time of the experiment were fed chopped grain and shorts. The conditions, with reference to the pens in which they were confined, and the time of feeding, were the same as in the previous experiment reported in this Bulletin.

Lot 1, was fed with a mixture of shorts and chopped oats. The grain was wet with cold water and permitted to stand from 8 to 12 hours before feeding. In case of Lot 2, the potatoes were cooked, and the grain was mixed with the potatoes. Enough potatoes were cooked each day for the following day's ration. The grain was weighed and mixed with the potatoes while they were still hot. The potatoes were cooked until they could be readily mashed. This is important for we noticed that the potatoes only partially cooked were not relished so well by the pigs.

Several letters of inquiry have come to the department during the past year, asking about the necessity of cooking vegetables for pigs. It is generally conceded I believe, that all vegetables such as potatoes, cabbages, squashes, pumpkins, etc., should be cooked before being fed. Pigs may eat them without being cooked but with not so much relish.

Another question has been asked, will such vegetables, when cooked, make a complete ration? To get the best results, grain should be fed with the vegetables. Most vegetables, and especially potatoes, contain a large proportion of starch which in itself is not a complete ration. There should be some nitrogenous material fed with the vegetables, and if mixed with the feed so much the better. In the experiment under discussion, it is a question whether better results would not have been realized, if more nitrogenous material, such as oil meal, oats, or bran would not have given better results than shorts alone. These substances will be tested in future work along this line.

RESULTS.

Lot 1, received a mixture of one part shorts and two parts chopped oats. This was maintained throughout the experiment. The pigs consumed 6.8 pounds each per day and made a daily gain of 1.8 pounds, or one pound of gain for every 3.8 pounds of food consumed. This is a very good gain for the amount of food eaten, although the average daily gain is not equal to that made by Lot 1, in experiment No. 1, shown in table No. 3.

The cost of producing 100 pounds of gain in live weight in lot 1, is \$2.18. This is 78 cents per hundred less than in lot 1, of the previous experiment; and is due to the larger proportion of oats that entered into the ration, The oats were cheaper than either shorts or wheat.

The pigs in Lot 2 consumed 12.4 pounds of potatoes and 2.8 pounds of shorts each per day. They gained 1.3 pounds per day. This is .5 of a pound less than the gain made by the pigs in lot 1. If we subtract the amount of grain each pig in lot 2 consumed each day from the grain eaten by lot 1, we shall have 4 pounds which offsets the 12.4 pounds of potatoes eaten by each pig in lot 2. At ten cents per bushel for the potatoes, the price at which they are reckoned in this experiment, then there will be one-half a cent difference in the cost of a days ration in favor of the grain ration. But the grain ration produced one-half a pound more in gain so there is $1\frac{1}{2}$ cents more to be added to this making 2 cents in favor of the grain ration, in the cost of a days feed for one pig.

It cost \$2.18 to produce 100 pounds in lot 1, while it cost \$2.86 in lot 2. From this experiment, where the potatoes were reckoned at 10 cents per bushel, there was no profit in feeding them. The gain made by lot 2 on potatoes and grain is very satisfactory. The pigs were well matured although the growth was not as great as in lot 1.

An effort was made to increase the amount of potatoes consumed, but the pigs would not eat any more than the amount that was given them. To obtain the best results the ration of potatoes should be decreased and more grain substituted.

CONCLUSIONS.

1. The pigs made very good gains and were well matured.
2. The grain ration at the prices mentioned gave better results than the potatoes and grain.
3. That a less proportion of potatoes would give better results.
4. That a mixture of grain fed with potatoes would be better than shorts alone.

TABLE No. VII

Pigs fed mixture Chopped Oats, 1 part. Shorts, 2 parts.	No. Pig.	Weight Dec. 13	Weight Dec. 27	Gain lbs
1st period, Lot 1.....	17	190	217	27
	18	198	227	29
	19	171	191	21
	20	186	199	13
	21	177	198	21
Total gain.....				111
Grain consumed				437
Food for 1 pound of gain.....				3.93
Cost of 100 pounds gain.....				\$2.13
Dec. 27. Jan. 10 Gain				
2d period, Lot 1.....	17	217	243	26
	18	227	253	26
	19	191	216	25
	20	199	230	31
	21	198	233	35
Total gain.....				143
Grain consumed				504
Food for 1 pound gain.....				3.52
Cost of 100 pounds gain.....				\$2.10
Jan. 10. Jan. 24. Gain.				
3d period, Lot 1.....	17	243	268	25
	18	253	286	33
	19	216	234	18
	20	230	255	25
	21	233	263	30
Total gain.....				131
Grain consumed.....				504
Food for 1 pound gain.....				3.84
Cost of 100 pounds gain.....				\$2.30

TABLE No. VIII.

Pigs fed on Potatoes at 10 cents per bushel, Shorts \$11.00 per ton, Oats \$10.00 per ton.		No. Pig.	Weight Dec. 13.	Weight Dec. 27.	Gain lbs.
1st period, Lot 2.....		22	192	208	16
		23	171	182	11
		24	168	185	17
		25	191	209	18
		26	183	194	11
Total gain.....					73
Food {	Potatoes.....				840
	Shorts ..				112
	Chopped oats.....				61
Total food.....					1013
Food for 1 pound gain.....					13.8
Cost of 100 pounds gain.....					\$3.16
			Dec. 27.	Jan. 10	
2d period, Lot 2.....		22	208	224	16
		23	182	208	26
		24	185	195	10
		25	209	217	8
		26	194	215	21
Total gain.....					81
Food {	Potatoes.....				850
	Shorts ..				140
	Chopped oats.....				70
Total food.....					1060
Food for 1 pound gain.....					13.08
Cost of 100 pounds gain.....					\$3.12
			Jan. 10.	Jan. 24.	
3d period, Lot 2.....		22	224	260	36
		23	208	232	24
		24	195	210	15
		25	217	235	18
		26	215	236	21
Total gain.....					114
Food {	Potatoes.....				910
	Shorts ..				140
	Chopped oats.....				70
Total food.....					1120
Food for 1 pound gain.....					9.87
Cost of 100 pounds gain.....					\$2.30

TABLE No. IX.

SUMMARY.

Total gain Lot 1, Dec. 13 to Jan. 24.	Mixture of grains.....	385
Total gain Lot 2, Dec 13 to Jan. 24.	Potatoes & grain.....	268
Total grain consumed by Lot 1.....		1445
Amount of grain for each pig per day.....		6.8
Total grain consumed by Lot 2.....		593
Amount of Potatoes consumed by Lot 2.....		2600
Amount of Potatoes for each pig per day.....		12.4
Amount of grain for each pig per day.....		2.8
Average daily gain by each pig Lot 1.....		1.8
Average daily gain by each pig Lot 2.....		1.3
Cost of food for 100 pounds gain in Lot 1.....		\$2.18
Cost of food for 100 pounds gain in Lot 2.....		\$2.86
Potatoes are reckoned, per bushel.....		\$.10
Shorts are reckoned, per ton.....		\$11.00
Chopped Oats are reckoned, per ton.....		\$10.00

FEEDING SHEAF WHEAT TO STEERS.

Some writers in agricultural journals, have advocated the feeding of sheaf wheat to steers, and their opinions have been substantiated by actual feeding tests of this kind. In order that more definite knowledge might be obtained regarding this question, the following feed tests were made, and a summary of results are here presented.

Four grade Polled Angus steers, uniform in quality and general characteristics, were selected and placed in stalls for the feeding operations. They were tied with chains about the neck in stalls three feet in width. This is the method of tying which we have adopted for all the cattle on the farm. The cattle were placed in their stalls a month before the experimental feeding began, so that they would become accustomed to their quarters. These animals had never been tied in stalls before, and some of them probably had never been inside of a barn before. They were what is termed, "long two year olds." That is, they were about 2 years and 9 months old.

For the first month the steers fell off in weight, owing to their shyness, and not being accustomed to the feed. They did not know how to eat grain. They were like one who had never eaten anything but rye bread and beans, being required to eat a dish of oysters. Their stomachs were not adjusted to such living. It requires much patience on the part of the feeder, to induce such animals to take their food. Great care must be exercised in not giving them more than they will eat. A single handful eaten is better than a manger full nosed over, and left to sour, and to become a sickening sight, even to a dumb brute. Water was carried to the animals in the stall. They were not permitted to leave the stall, except when led out to be weighed. The feeding began November 21st, and was continued until February 4th, making 75 days.

The steers fed on sheaf wheat were given corn silage and clover hay with the wheat. They consumed an average of 21.9 pounds each of sheaf wheat per day, 20.2 pounds of silage, and 4.9 pounds of clover hay. The sheaf wheat was fed to them in the bundle just as it came from the field, except the bands were cut before placing it in the manger. The sheaf wheat yielded 35 per cent of grain, hence the actual grain consumed by the

steers each day was 35 per cent of 21.9 pounds or 7.66 pounds. This is all the animals would eat, Less wheat was wasted by the steers than one might expect. The steers would eat the heads off the wheat, and leave the straw which served as bedding, very little of the straw was eaten.

The steers weighed November 21st, 885 pounds, and 890 pounds respectively, or a total weight of 1775 pounds. February 4th they weighed 960 pounds, and 962 pounds, or a total weight of 1922 pounds. This makes a gain of 75 pounds, and 72 pounds or a total gain of 147 pounds. The average daily gain, for each animal was .96 of a pound. It is somewhat remarkable that the animals should keep so closely together in the gains made. There was 5 pounds difference at the beginning, and three pounds at the close of the experiment.

The wheat was not well masticated by the steers, much of it passing off in the excreta. The wheat had a tendency to scour the animals more than the ground grain. Two of the steers were fed on chopped grain, clover hay, corn silage, and oil meal. These were fed under the same conditions as those which were given the sheaf wheat, with a view of comparing the results. The steers were not as promising in their external conformation, as those fed on sheaf wheat. They were 60 pounds lighter in weight, and not as quiet in disposition as the former.

These steers weighed, November 21st, 930, and 785 pounds, or a total weight of 1715 pounds. At the close of the period they weighed 1050, and 917 pounds, or a total weight of 1967 pounds. This gives a gain of 222 pounds or an average daily gain for each animal, of 1.96 pounds. In comparing this with those fed on sheaf wheat there is an increase of .73 pounds per day, in favor of the steers fed on the chopped grain.

In the amount of feed consumed, it required 7.82 pounds of grain in the sheaf wheat, to make a pound of gain, and 6.01 pounds of grain to make a pound of gain in case of the steers fed with chopped grain. The steers which were fed on sheaf wheat consumed 760 pounds of clover hay, and 3040 pounds of corn silage. Reckoning the cost of the hay at \$4.00 per ton, the silage at \$1.00, and the wheat in the sheaf at \$13.00 per ton, the total cost of feed consumed would be \$10.50. This divided

by the number of pounds gain, 147, would give \$7.13 as the cost of feed to produce 100 pounds gain in live weight.

The steers fed on ground grain consumed 1120 pounds of clover hay, 3040 pounds of corn silage, 1212 pounds of chopped wheat and oats, and 304 pounds of oil meal. Reckoning the clover hay and silage as above, chopped grain at \$12.00, and the oil meal at \$20.00 per ton, the total cost of feed would be \$11.83. This divided by the total gain 252 pounds would give \$4.69, the cost of feed for 100 pounds of gain in live weight. Subtract this from \$7.13 the cost of 100 pounds gain by steers fed on sheaf wheat, leaves \$2.44 per hundred in favor of the ground grain. The cost in either case is too great for profit, but for the sake of comparison the results are valuable.

The object in feeding sheaf wheat alone as a grain ration, was to show that the results, whatever they might be, could be attributed to no other feed. The clover hay in the experiment with the ground grain reckoned at \$4.00 per ton, is above the cost of production. All of the food materials are reckoned at the market value. From a practical point of view the feeding of steers is more profitable than this would indicate, from the fact that they will convert the coarse material of the farm into a condensed product in the beef produced, and in this way make it marketable, whereas, it is often the case, there is no demand for the coarse products of the farm at any price. These points have been brought out in previous reports on the subject.

A bushel of grain in the sheaf wheat experiment, made a gain of 7.67 pounds, while 60 pounds of the mixed grain produced a gain of 9.98 in live weight. At \$3.05 per hundred, the price realized for the beef on foot, it makes a difference in favor of the chopped grain of 7 cents per 60 pounds, or 7 cents on a bushel of wheat. If the wheat can be threshed and ground for 7 cents, then it will pay to take this trouble, if there were no other considerations to be taken into account.

A still more important consideration, however, exists in the fact that animals thus fed are poorly fitted for market. It was apparent to all who saw the animals, that the steers fed on sheaf wheat were not in good condition. They did not mature, and fill out with fat as rapidly as those fed on the chopped grain. Their coats were rough, and their horns were prominent. I be-

lieve headed wheat would give much better results than wheat in the sheaf. It was not the chaff and fine parts of the straw that gave the steers so much concern, as it was the coarse straw which they were compelled to work over.

CONCLUSIONS.

1. That steers will not gain as rapidly on sheaf wheat as when fed on ground grain.
2. That the animals do not relish the sheaf wheat.
3. It costs more to make 100 pounds of gain in live weight on sheaf wheat, than on ground grain.
4. The difference under all ordinary circumstances is sufficient to pay for threshing and grinding.
5. The animals can not be as well matured on wheat in the sheaf as when fed ground grain, hence a less price will be received for the finished product.
6. The same objections to storing grain in this way, mentioned under pig feeding experiments, will hold true when feeding steers.
7. Better results can be obtained by feeding sheaf wheat to steers than to pigs.
8. Much of the grain consumed is not digested. It has a tendency to scour the animals.

FEEDING VETCH HAY.

As a preliminary report for the purpose of answering some questions regarding the feeding of vetch hay, I present a brief summary of results of our experience in feeding this material. We have fed the vetch hay to fattening steers, and to cows giving milk, and in both cases the results have been very satisfactory. It was compared with clover hay in both instances. The steers made good gains when receiving vetch hay as the only dry food, except the grain. Two steers were fed 42 days on the vetch hay, and gained 3.07 pounds, and 2.07 pounds respectively, per day. Those fed on clover hay gained 2.16 pounds, and 2.56 pounds respectively.

The vetch when properly cured is relished by all kinds of stock. It must not stand until too ripe before cutting. When fed to milch cows the flow of milk and per cent of butter fat was maintained throughout the test, which extended over a period of 45 days.

As a cheap substitute for clover hay the vetch seems to answer the demand very satisfactorily. It is an annual, consequently must be sown every year. In this respect it can not be compared with clover. As a fertiltzing crop, it is not as good as clover for it does not root as deeply, nor loosen the soil as completely as clover.

This report is only preliminary, and is not intended to take the place of more complete reports regarding experimental feeding of vetch hay later on.

Much credit is due Mr. S. B. Smith, Farm foreman, class of '95, who did the feeding during these experiments.

H. T. FRENCH.

Oregon Agricultural
EXPERIMENT STATION.

Bulletin No. 43. February, 1897.

AGRICULTURE.

FLAX CULTURE.

H. T. FRENCH, Agriculturist.

The Bulletins of this Station are sent free to all residents of Oregon
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OREGON FLAX FIBER EXHIBITED BY PARRISH & MILLER
AT CENTENNIAL EXPOSITION 1876.

FLAX CULTURE.

H. T. FRENCH.

INTRODUCTION.

Flax culture might well be classified in this country among the lost arts. The time when flax was grown and manufactured into home-spun garments is fresh however in the memory of many who are living to-day. We may well ask ourselves the question, as to whether the natural conditions which made the growing of flax fiber possible, in those early days, have changed thus making it an unprofitable, and, in the minds of some, an impossible crop for the farmers of this country to raise at the present time.

Is it possible that within the boundaries of this country where such a variety of soil, and climatic conditions exist, we have not the possibilities for growing flax for fiber?

With the knowledge which recent investigation has revealed upon the subject we are led to think, that possibly within our own state, there is hidden an immense resource which only awaits the touch of modern invention and enterprise to develop. We boast much of the delightful climate of Oregon, and of the inexhaustible fertility of her soil. Admitting these claims to be based upon actual fact, is it not important that such conditions should be made to contribute more to the needs of the people? Grain growing was in the past highly remunerative, but that time has gone by, possibly never to return, at least to the degree that it once enjoyed. The wide-awake agriculturist is looking about him for a new source of revenue. Some are converting their farms into fruit orchards while others are looking to the creamery for relief. These are wise moves, and when intelligently followed, will bring much relief and enjoyment to the tillers of the soil. If in addition to these industries we may add another, which will bring employment to manufacturer, as well as to producer, then we shall have increased the resources of our state very materially.

The question of home production is a very important one, and has many advantages which are apparent to all; but we can

better understand its benefits when we have brought it about in our own midst.

In this report we shall present some information based upon facts which have been determined by actual experience, and experimentation in other states and countries. Only a very little has been done at the Oregon Experiment Station; but we expect to enter into an exhaustive line of experiments, touching the possibilities of the flax industry in this state.

FLAX FOR FIBER IN OREGON.

In entering upon any undertaking, it is well to know what has been done in the past along the special line which we propose following. The first question naturally presenting itself is, what are the possibilities indicated by past attainments?

Some twenty-five years ago there was a firm organized in the Willamette valley, for the purpose of manufacturing linen twine from flax produced on the farms of the valley. The factory was started, after overcoming great difficulties, due very largely to the lack of transportation facilities, and the results were highly satisfactory so far as quality of product was concerned. Misfortune overtook the firm in the way of fire, bad management and spiteful competition on the part of Eastern manufacturing interests, until the enterprise was abandoned. In those days labor was very dear and a large portion of the work that may now be done by machinery was done by hand. There were no transportation facilities for either the raw material or the finished product.

Mr. Chas. Miller, the surviving member of the firm of Parrish & Miller, has kindly given us permission to produce a cut of the medal which was awarded to them at the Centennial Exposition in 1876. It is an interesting, as well as an encouraging fact, that the exhibits of flax in its various stages of preparation, made by this firm, won first prizes over all competitors at this exhibition. The competing exhibits were from the flax growing countries of Europe, as well as from other states of the union.

The samples of straw and fiber from Oregon were given first place by all of the nine judges, each individual passing upon the samples separately, and without a knowledge of the action of the other judges. Several of the judges were from foreign countries

and all were experts in the handling of flax.

The accompanying half-tone cuts of the fiber, the award, the diploma, and the medal are presented as a matter of interest and pride in the success of the Oregon product at this early date, and under such conditions as then existed.

Dr. A. W. Thornton, of West Ferndale, Wash., has made some very exhaustive investigations in the culture of flax for the Department of Agriculture at Washington, D. C. Seed was furnished him by the Department from which he grew and prepared a ton of straw. This was forwarded to a firm at Liburn, Ireland, where it was prepared and manufactured into linen products. The results are briefly given below as recently furnished by Dr. Thornton for publication in the Oregonian.

"We congratulate you on the success of this experiment, which far exceeds our expectation. We believe there is a great future before flax growers in west of America. The flax is eminently adapted for thread-making and warp yarn spinning purposes. It is exceedingly strong, and works very well on the machines. If flax is grown and manipulated under proper conditions on Puget sound, we are convinced it will be of the greatest importance, and in a short time rival the great Belgian district of Corutrai. FRANK BARBOUR, (Liburn, Ireland)

General Manager.

"Commenting on the report, Dr. Thornton says: "The too thin seeding (two bushels per acre) was in accordance with specific instructions from the Department of Agriculture, and the over-ripeness arose from the six weeks in receiving the seed from Europe, which forced the crop into the drier summer months, causing an abnormal rapidity in ripening—both, it will be observed, preventable causes in the future. I have no hesitation in saying that had those adverse conditions not been present this flax would have reached a market value of \$500 per ton. It is worthy of notice that the Belgian system of double retting possesses great superiority over the Irish system of single retting, not only in securing a larger yield of fiber, but also the higher quality and more favorable percentages. This report is very encouraging and highly satisfactory, and very specific in all its details, showing that great care and attention have been given to the experiment in all its stages, and, coming from so high an authority as Mr. Barbour, cannot be disputed or gainsaid." "

In 1892, three samples of flax were grown by the writer at the Oregon Experiment Station in cooperation with the Department of Agriculture at Washington, D. C. Mr. Dodge makes the

following statement in his report regarding the samples sent to the Department from this Station :

Oregon (Agricultural Experiment Station).—A careful report was also received from this state, with a lot of admirable samples, closely resembling the preceding, (those from Minnesota). These were of good length, some of the straw quite coarse, but well grown and cured, giving an abundance of clean silky fiber of superb strength. Well prepared it would make a superior fiber, fit for fine linen. This comes nearest to the Courtrai straw, in appearance, of any examined from the United States ; among the best and strongest received.

These samples were grown on soil without manure that had produced five crops of wheat previous to growing the flax. The soil was the grey, clay loam which is common throughout the Willamette valley. It was not, however, what is known as *white land*. Mr. Dodge states in his report that "the very best samples of straw received came from Oregon and California, where the experiments were conducted in heavy soils." A further discussion of soils will be found under its proper heading in this bulletin.

The success of the flax industry is controlled very largely by natural conditions. There are only a few localities in the world where the highest degree of success can be attained ; and some of these localities are losing their prestige on account of being no longer capable of producing the most desirable results.

The conditions of soil and climate, during the period of growth, and extending through the preparation of the fiber for manufacturing purposes, have a marked influence upon the quality of the product.

The fiber from which the fabric is finally wrought is a delicate vegetable organism which is easily ruined by bad management or unfavorable conditions. Like the growth of the sugar beet for the production of sugar, there is a certain amount of skill necessary to bring about the best results. If we have soil and climatic conditions well adapted to the industry, the skill required in handling the crop will soon be developed. It is not expected that the farmer will go farther than to raise the straw. From this stage the work can better be handled by the manufacturer, or in plants established for the purpose of preparing the fiber for manufacturing into linen fabrics. Invention and genius must step

in to assist, and they are ever willing wherever there is an open door and an inducement indicated by favorable natural conditions.

CLIMATIC CONDITIONS.

Our climatic conditions are very much the same as those which exist in the great flax growing districts of Europe. A cool, moist climate during the growing season is conceded to be the very best natural condition for the most rapid and healthy development of the flax plant. This description applies to Western Oregon and Washington. The elevation of the Willamette valley above the sea, compares very favorably with that of many foreign flax districts. In Ireland, where a large portion of the crop is grown, the elevation is 250 feet. The mean elevation of the Willamette valley will not vary much from these figures.

The absence of severe wind and rain storms throughout western Oregon and Washington, is of very great advantage; for the crop is often severely injured, and frequently destroyed in flax growing regions, by these climatic disturbances. Another advantage possessed by our climate, is the absence of rain during the harvesting season. The crop will be ready to harvest from August first to fifteenth. During this time there is no danger of injurious rain storms.

For the sake of comparison a table is here presented showing the mean temperature taken from the Weather Bureau reports of this state, and from similar records of flax growing countries. *From records of the Weather Bureau compiled by the Dept. of Agriculture.*

	Temperature.		Humidity.	
	Average* 3 months.	Average annual.	Average 3 months.	Average annual.
	Degrees.	Degrees.	Per cent.	Per cent.
Foreign stations :				
Belfast, Ireland.....	52.2	48.8	.....	.....
Brussels, Belgium.....	55.9	.....	77.4	83.4
Prague, Bohemia.....	54.6	48.1	66	74
Cologne, Germany...	55.7	50.6	67.1	74

*April, May, and June.

Willamette Valley :

Mean Temperature.

May.....	56.6°
June.....	58.8
July.....	64.3
Average for 3 months.....	59.9

Taking the corresponding months, April, May, and June the mean temperature is 54.4°, very nearly the same as that of the countries given above. The months of May, June, and July

are taken because we believe these are the months in which the crop will be grown in this locality.

The mean relative humidity at Portland, Oregon, for May is 67.0 per cent; June, 66.9 per cent, and July 64.3 per cent, making an average of 66.1 per cent. This, it will be seen by referring to the table, compares very favorably with the same data from foreign countries.

From the foregoing data, and from all other information at our command, there seems to be no doubt as to the adaptability of the climatic conditions of Western Oregon, and Washington, to the growing of flax.

FLAX CULTURE.

Paper presented by Mrs. W. P. LORD at Farmers' Institutes
held at Turner, Marion Co. Oregon, and Tangent,
Linn Co., Oregon.

We are fortunate to live in a state of such boundless resources, that locations can be found that will suit any crop grown in the United States, except the purely tropical. And if we take the report of the Department of Agriculture, we have one specialty in the growing of flax for fine fiber, that no other state but Washington shares with us. We will see what Mr. Dodge says of it. To preface his remarks; In '91 an order was issued by the Government to every Agricultural College, that a test should be made of flax for fiber. The Department, of course, was aware that many of the states could not grow it with profit, but there was a wish to determine the most favorable localities. While many states sent in fairly good fiber at the season's close, it was the fiber from Oregon that received the special commendation of the department. Mr. Dodge said: "A careful report was received from this State, with a lot of admirable samples. These were of good length, some of the straw quite coarse but well grown and cured, giving an abundance of clean, silky fibre of superb strength. Well prepared, it would make a superior fiber fit for fine linen. This comes nearest to the Courtraï straw, of any examined from the United States. And then again, regarding the Pacific Coast samples; I can only say, judging from the straw submitted, in comparison with the samples grown east of the Rocky Mountains, that they are remarkably fine; and, if such flax straw can be produced economically, we need not be troubled concerning future supplies of fiber for the manufacture of fine linen in this country. The

INTERNATIONAL EXHIBITION
1876
CENTENNIAL AWARD

PARRISH & MILLER

JEFFERSON MARION CO. OREGON

FLAX IN THE STRAW AND LINT

EXHIBIT GROUP VIII

UNITED STATES CENTENNIAL COMMISSION

*In accordance with the Act of Congress,
March 3rd, 1876, Philadelphia, October 29th 1876.*

Wm. B. Ewing
Secretary

John L. G. ...
Secretary

Wm. B. Ewing
Secretary

HALF-TONE CUT OF CERTIFICATE OF AWARD.

Oregon samples are of such superb color, that, if river retted to preserve the color, the fiber would resemble the flax of Courtrai."

Every housewife delights in fine linen; to have a well filled closet of various grades for the table and bedroom, is her ambition. It is the oldest fabric known—the first to be spoken of in the Bible. Look in the books of Genesis and Exodus to see how highly linen was thought of, and how God commanded the priests to wear it, in serving in the tabernacle. In one place wool for personal wear is condemned and the command is given, "no wool shall be upon them." And right here we may say, that scientists, both of this country and of Europe, are of late years paying great attention to this matter of what shall be worn next to the skin. The feeling is growing rapidly that the wearing of woolen underwear is all a mistake. This woolen underwear fad has sprung into existence in the last forty or fifty years. Our pilgrim fathers and mothers wore linen from their own home-grown flax, spun by hand and woven on looms in their own houses. That we all know, and we all have traditions that they were a hardier race than the present. An eminent doctor of Boston makes the startling statement, that the continued use of wool as underwear will eventually wipe the nations from the face of the earth. Famous doctors of London are urging the returning to linen for underwear, as a matter of health. They have compiled in defense of their arguments some interesting statistics. In 1889, the latest date included in the Registrar General's report, 63,572 people died in England of bronchitis, 1,580 of pleurisy, and 33,206 of pneumonia—almost 100,000. Though the medical men of the present day so ably treat these diseases, and while their resources were so inadequate in the time when people wore linen yet comparatively far fewer persons died of these diseases in those earlier days. And yet the woollens now so universally worn are said to be a material protection against these diseases. If linen possessed the direful qualities ascribed to it by the advocates of woollens, either the whole population would have perished in those days, or have been reduced to a very small remnant, the detestation of woolen being for a very long time widespread and, as these London doctors think, well founded.

I hope you will pardon my digression as it is in the hope of

emphasizing the fact that the use of linen is on the increase, and the future demand for it is likely to be very great. The pioneer in this crusade against wool is a priest of Bavaria, who was in his youth, a weaver's apprentice. I have made the following extract from a foreign journal, that you may judge of the extent of this fad, or rather progressive education in the laws of health.

"The popularity of this Bavarian village priest, who, by the way began life as a weaver's apprentice, is really remarkable and we are told that his name has become a household word throughout Germany and Austria. Kneipp bread and Kneipp linens are advertised everywhere, and so great has been the crush of patients to Worishofen, that it has been filled month after month to overflowing, and establishments have been set up in various places to carry out Kneipp methods and treatment. His book, 'My Water Cure,' has run through 30 German editions and been published in English form with equal success. In the book is a forcible plea for the use and advantages of good linens, and so, particularly interesting from our point of view. No rubbing, no friction, says pastor Kneipp, but plenty of bathing and cold water, and then clothes for warmth, putting on linen first, without drying the skin, when the action of the coarse linen shirt upon the damp skin fulfills the second condition of opening the pores and restoring activity to the epidermis, having the advantage of keeping up a gentle friction night and day, without waste of time and trouble. The volume serves to remind us of an equal success in English literature, when John Wesley's Primitive Physic sold by the thousands. Both enjoin plain and simple living.

"Wesley would have those who cared for the preservation of their health, be as clean and sweet as possible, in their houses, clothes and furniture, and thought the fewer clothes one uses by day and night, the hardier will be. It is certain he would have nothing to do with the indulgent, and enervating all-wool theory. Pastor Kneipp expressly condemns flannel or wool coming in direct contact with the skin. Wool, he says, only tends to absorb heat from our bodies, aggravating the poverty of blood of our weak and nerveless generation."

Many people, especially in the eastern states, are interested in the Kneipp laws of health, and are following them, and the manufacturer of Kneipp linens for underwear finds himself overcrowded with orders. A sample of the linen mesh came to us in the spring, and the thought at once occurred, if flax fiber should ever become a leading crop, here is an article for which there will be great demand, and of a simple weave, which could

easily be acquired by unskilled labor, while the intricacies of damask require a technical skill demanding years of study. I wrote to the New York office, 409—415 Pearl Street, calling the attention of the manufacturers to the possibility of procuring flax fiber in Oregon, and that, with the coming change in administrations, favoring protection to American industries, a manufacturer would find it to his interest to be located where he could procure raw material in unlimited quantity. Four months passed before the reply came, and I had abandoned all hope of hearing from the firm, when, to my surprise, came a letter from the head of the firm, saying he had just arrived at his New York office and had found my letter, which was of great importance. The growing demand for his goods made it extremely difficult to obtain the fiber necessary for his looms, and he was convinced that Oregon could grow the finest fiber "the world had ever seen," and now the question is: Will she do it? Here is the question for the farmers of Oregon to consider, and very promptly. Manufacturers are looking for locations; here is the opportunity we must improve. As a state we will never be prosperous until our manufacturing interests are developed: they must go hand in hand with the agricultural interests. Consider Belfast, originally a town of the size of Salem, now the home of 300,000, with 30,000 operatives in its linen mills. Aside from the fiber used in the mill grown by the Irish farmers, they require great quantities from other countries. On an average less than 100,000 acres are devoted to the flax culture in Ireland, for much of that country is a peat bog, not adapted to its growth. Ulster county raises the main part of the crop. I cull the following from Irish reports of 1888:

Acreage of Oats, 1,280,858 acres—value, £7,052,255—£5, 10 s. per acre. Flax, 113,613 acres—value, £1,318,280—£11, 12 s. per acre.

Land in Ulster county has been known to pay \$160 per acre for a high grade of flax straw—that, of course, means what our city amateurs call intensified farming.

Our Canadian neighbors are alive to the possibilities in flax fiber. This last year they have had under cultivation, 80,000 acres in flax. Part of this is raised for linseed oil. There are 36 scutching mills, reducing the flax straw to fiber, the product

being shipped to Chicago : there it is made into twines and coarse crashes. (One scatch mill will use the prouct of from 500 to 600 acres yearly.) The grade of fiber is coarse; the climate is not suited to the finer grades, such as we can raise, but they find the crop quite profitable. They have been able to pay \$1.50 a day for ordinary field labor, and 50 cts. a day for children. And right here it will be well to note the difference between the labor required for flax and for sugar beets. The flax crop is of quick growth, requiring only from 3 to 3½ months,—can be planted early in the spring (in ordinary seasons by the first of April) and harvested early in July. This is a season when it is a delight to be out of doors and at work in the fields, before the strong heat of summer. Beet fields require much longer attention, up to the fall months (if I am rightly informed). In connection with the flax industry many others spring into existence. The oil of the seed, while not equal to the product of flax, grown exclusively for the oil, can be made to pay; and oil-cake will build up the dairy interest. Refuse and waste from the mills can be utilized in a tub, pail and flower pot factory. Nor is this all: paper mills can utilize the waste.

At the present time experiments are being made in the line of fruit jars, that an inventive genius has already suggested, asserting that paper cans will supplant tin, the latter being unfit for the preservation of acid fruits. Glass, on account of its fragile nature, is seldom used by canners. But, note this, if the refuse flax can be utilized for cans, our fruit industry will receive an impetus. I assert what is known, that the refuse of beets will not pay for the hauling from the mill; it would require too much time.

The field labor required, will be equal to that demanded for flax, but, when the crop is harvested, that labor will have no employment until the following season. A sugar mill requires but few men, but the linen mill will require 20 operatives to every farmer growing flax. This industry when established, would give profitable employment for our labor, and provide a home market for our farmers.

In what I have said about the flax industry, I do not wish to be understood that it will conflict with the wool industry. Wool has its place—and a large place—in the utilities of life.

which no other product can displace. Both can be made to flourish among our industries and increase the material wealth of our state. Both have uses which neither can supply alone, and therefore both may, and ought to, become leading industries in our state.

HISTORY OF THE PLANT.

The flax plant is known botanically by the name of *Linum usitatissimum*. From the word *Linum* comes our English words lint, linen and linseed. The specific name signifies great usefulness from the fact that the plant supplied human beings with many useful articles of clothing. The use of flax fiber is ancient, indicated by the records found in sacred writings, and by the linen wrapped about the Egyptian mummies. There are several wild species of the plant as well as domesticated varieties.

KIND OF SEED.

Regarding the varieties recommended for fiber the following remarks are taken from the Department report, Bulletin No. 27.

"Mr. J. R. Proctor, of Kentucky, writing upon this subject many years ago, advocated the white blossom Dutch as the best seed for American flax growers. Mr. Eugene Bosse, a practical flax grower, states that his preference, based upon several years' experience, is for (1) 'Riga seed, once sown in Belgium'—that is to say, imported seed grown on Belgian soil from seed procured in Riga; (2) seed imported direct from Riga, but it must be Riga and not Finland seed; (3) Dutch (Rotterdam) seed, and (4) American seed, which he reports "as good as Nos. 2 and 3 when well cultivated, though it will not stand the drought as well." Mr Bosse states that No. 1 will produce about 8 bushels of seed to the acre; No. 2, 10 bushels, and No. 3 between 8 and 10 bushels."

Experiments will be conducted during the present year to determine the best varieties for this locality. Until experiments demonstrate otherwise the foregoing remarks are fully indorsed. The value of the fiber produced is very largely governed by the kind and quality of the seed, hence much stress must be placed upon getting the seed from reliable sources. It will be safest probably, to use imported seed in the out-set; but we may be able to produce seed from the imported samples that will equal, and possibly surpass the foreign seed. Three varieties were grown in 1892 for the Department of Agriculture. They were

the Pure Riga or Russian, White Blossom Dutch., and a variety called the Belgian. This last variety is produced from Riga seed grown on Belgian soil. The Pure Riga gave the best results in these experiments.

Fiber can be successfully grown only from seed which is adapted to the production of fiber. There is something in the *habît* of the plant, if we may use that term. The following statement is taken from the Department report.

“Imported seed gives the best results, but if this cannot be obtained, seed must be sown that has been produced from plants grown for their fiber, also from selected seed.”

Whatever the source of seed great care must be taken in securing clean seed. Weed seeds would render the flax seed worthless. The supply must be fresh for old seed loses its vitality. Seed should be carefully tested before using so that the exact per cent of germination may be known. If only 60 per cent of the seed will grow then, evidently, more of it must be sown per acre. The higher the per cent of germination the better. Seed that, under favorable conditions, will germinate only 50 to 75 per cent would not be desirable.

Some apprehension has been expressed as to the danger of importing weeds with the flax seed ; but with proper precautions in procuring seed from reliable sources this danger will be largely obviated.

SOIL.

A retentive soil is best adapted to the growing of flax, other physical and chemical properties being favorable. Soils that will produce good crops of grain are usually good flax lands. The state of cultivation is more essential, however, in growing the flax plant than in growing a grain crop. The flax plant makes its growth very quickly, and during a time when there is no rain or frost to assist in pulverizing the soil, thereby rendering available the inert plant food. Wheat sown on a comparatively cloddy soil will often make a good growth ; for, during the long period of growth, the clods are broken up and washed down by the elements.

The composition of the best flax soil, as given by the chemist of the Minnesota Experiment Station, in Bulletin No. 47, is as follows : “The best flax soils are those that contain 25 per cent of medium sand, 20 to 25 per cent of fine and very fine

sand, 35 to 40 per cent of silt and 12 per cent of clay. A soil of this kind, known as a loam soil, is put together in such a way so as not to offer too great a resistance to the development of flax roots, and at the same time the soil is capable of holding and supplying the proper amount of water for the growing crop." The same report states that "flax soils should be well supplied with humus (decayed animal or vegetable matter). The best flax soils which have been analyzed usually show 0.2 of one per cent or more of nitrogen. This nitrogen must be in the most available forms, otherwise the flax crop will be unable to obtain its necessary supply."

Flax will not do well on lands where water stands within a few inches of the surface. The low white lands of the Willamette valley will hardly be expected to produce a profitable yield of flax until they are improved by tile drainage and careful cultivation.

It is safe to say that the best grain lands of the Willamette valley are well adapted to the growing of flax. The best evidence we have of this is in the fact that flax has been successfully grown on such soils. We learn from a report recently received that a field of flax, grown in Polk county the past season, made a remarkable growth. The report states that much of it was as high as a man's shoulders. This does not necessarily mean that this rank growth is desirable for fiber production, but it signifies that, that soil possessed the necessary conditions to produce a healthy growth, and from the descriptions given, we are well aware that there are vast areas of equally good soil in the valley. Mr. Charles Miller, of Jefferson, Oregon, who has had more experience than any other man in Oregon in growing flax for fiber, says, "that any of the soil of the valley which will produce good crops of grain will produce abundant crops of flax, provided the soil is properly prepared before the seed is sown."

Preparation of Soil.

All authorities on the subject of flax culture agree, that good culture is indispensable if success is to crown the efforts of the grower. As to the proper methods of cultivation, to produce the desired end, there is a difference of opinion largely due to the local conditions which surround the undertaking. One thing may be said however, that there is nothing connected with the

growing of flax which the ordinary farmer cannot understand, and carry on successfully. A few general observations will be made, and the details will be left to the intelligence of those who undertake the work.

When the fact that the flax plant reaches maturity in 60 to 100 days, and must take its supply of food from the soil in a much less time, is considered, the matter of thorough preparation of the soil has more significance. Prof. Snyder of Minnesota, found by experiment, that 75 to 90 per cent of the principal elements of plant food were taken from the soil during the first 45 to 50 days. The flax plant is not a strong rooted plant. It does not send out a large number of feeders compared with other plants. The root is the counterpart of the stem, hence it is straight and long sending out few branches.

Soil intended for flax growing should be plowed as deep as possible in fall or winter, and cross plowed again in the spring to a depth of 5 or 6 inches. If possible subsoiling should be practiced, for by this means better drainage will be secured, and a deeper soil will be provided for the flax roots. In case the plowing is delayed until spring it should be done as early as possible. If the work is performed late in the season there is danger of the soil getting too dry to break up loose and friable.

The ground should be permitted to lie idle long enough to allow the weeds to start before the final fitting for the seed. In this way a large portion of the weed seeds will germinate, and can be destroyed before the flax seed is sown. Weeds must not be permitted in the flax field. It is a common practice in flax growing districts to hand pull the weeds which appear in the flax fields. In the Northwest this must be avoided as far as possible on account of the higher wages which must be paid for labor.

The surface of the soil should be thoroughly pulverized before seeding. There are many useful harrows which can be used to bring the clods to the surface where they can be crushed with a clod-masher. If the soil is worked at the proper stage there will be few clods with which to contend. We find the spring-tooth harrow a very useful implement in bringing the clods to the surface.

Rolling the ground is often practiced after the flax seed is

HALF-TONE CUTS OF MEDAL AWARDED PARRISH & MILLER FOR BEST
SAMPLES OF FLAX IN STRAW AND FIBER.

about to germinate. This will not do, however, if there is likely to be enough rain to pack the ground, and form a crust over the surface. It is only safe to roll late in the season, after the time is past when heavy rains might occur.

The conditions which prevail here are very favorable to a thorough preparation of the soil. The mild winter affords an opportunity to plow, and the early springs are favorable to cleaning, and preparing the surface of the soil for the seed.

ROTATION OF CROPS.

In growing flax the same facts will hold true regarding the advantages of a rotation of crops, as in growing any other crop, and in a more intensified way. Good fiber cannot well be produced from flax grown year after year on the same soil. As stated elsewhere in this report flax fiber is a delicate vegetable organism which can only be produced in its perfection by careful cultivation and attention. The plant is a delicate feeder, and must have its food ready prepared, as it were, and to do this in an economical way, rotation of crops must be considered. In European countries where flax is grown on the same soil for any length of time the supply of food is maintained by applying commercial fertilizers. This is expensive and of doubtful practical benefit under the conditions which exist in this western country.

In a majority of the flax growing districts of Europe flax is returned to the same soil after intervals of five to nine years, and in some cases fifteen to eighteen years elapse before flax is again grown on the same soil.

The following systems of rotation are taken from the Agricultural Department Report on flax culture for fiber. They represent those crops which are actually grown in flax districts.

1	2	3	4	5
Potatoes	Clover	Oats	Root crops	Barley
Wheat	Pasture	Turnips	Barley	Clover and
Clover	Oats	Wheat	Clover	grass
Pasture	Potatoes	Clover	Grass	Grazing
Oats	Wheat	Oats	Wheat	Wheat
Flax	Flax	Potatoes	Flax, half	Flax, half
		Flax	field	field

Clover is undoubtedly a very essential crop in the rotation. Some flax growers claim that it should precede the flax with no intervening crop; but from a majority of reports on the subject

we find that the clover crop occupies a midway place in the rotation.

The following rotation is presented by the writer as one which is believed to be best adapted to this locality:—(1) Wheat, (2) Oats and Barley, (3) Clover and Grasses, (4) Clover and Grasses, (5) Corn and Potatoes, (6) Flax.

The object of the cultivated crops in the rotation is to clean the ground of weeds. And by placing such crops just preceding the flax this object will be better obtained than when they occur earlier in the course.

The wild oat is one of the worst weeds with which the flax grower will have to contend. This will gradually disappear, however, under a uniform system of rotation, as we have proven by such a system on the Experiment Station farm.

Barley is a very good crop with which to seed to clover and grasses, if the seeding is done in the spring. And if the seeding is done in early fall, as we believe it can be successfully, then the oat and barley stubble will offer a good seed-bed for the grass seed. The stubble will act as a mulch for the clover and grass seed, and a good crop of hay may be harvested the following season.

This rotation would not necessarily cover the whole farm, for only a small area of flax can well be cared for by any individual. In fact the rotation of crops implies that the farm will be divided into small tracts or fields, which will in time be occupied by the various crops, provided the soil is adapted to the growing of the crops which are in the list.

In following potatoes and corn, or other hoed crops, with flax the old clover sod turned back to the surface will make a good seed-bed for the flax. As stated elsewhere in this Bulletin, it is necessary to have a good, rich surface soil for flax. A large portion of the nitrogen stored up in the soil will, by this plan, be near the surface.

If the growing of flax will induce the farmers of Oregon, to adopt a system of rotation of crops, which will do away with the naked summer fallow, there will be a great saving of the fertility of the soil. A long stride will be taken toward successful farming. The farmer says his land needs resting, when there is no such thing in nature, and especially during the growing season. Nature knows no rest. As soon as the farmer leaves the field

free from a crop, nature attempts to cover the ground with weeds and wild plants. Then there are unseen, but none the less potent, forces which are being exerted in the soil during the growing season. The soil is teeming with micro-organisms which are exerting a wonderful force in transforming the crude material of the soil into plant food. This matter of rotation of crops, with a view of doing away with the naked summer fallow, is a question which should demand the earnest thought of every tiller of the soil. He who does this, and thereby conserves the fertility of the soil, can confidently look forward to the time when coming generations will rise up and call him blessed.

MANURING FLAX.

Manure which is intended to benefit the flax crop should be applied to the crop preceding the flax, unless some commercial fertilizer is used, and in this case the manure should be thoroughly incorporated with the soil before the flax seed is sown. Commercial fertilizers are quite extensively used in the flax districts of the Old World; but the farms of Oregon are not in such a state of exhaustion as many of these older lands. Green manuring, and the plowing in of clover stubble, will be the most economical method of keeping up the fertility of flax land. If barnyard manure is used at all, it should be well rotted. The following extract is taken from Farmers' Bulletin No. 27 of the Department of Agriculture:

"Regarding the use of stable manure, it should be stated that well-rotted (composted) manure is preferable to the coarse barnyard manures, which are liable to make rank growth at the expense of fiber. Another reason for using well-rotted manures is to avoid fouling the crops with weeds, as the coarse manures are liable to be filled with the seeds of weeds which germinate and grow with the flax."

We are satisfied that successful crops of flax can be produced on the best grain lands of the Willamette valley, without the aid of artificial fertilizers.

EXHAUSTION OF SOIL.

It is a common belief that flax is a wonderfully exhaustive crop; but from recent investigations we are led to abandon some of the extravagant ideas which we once possessed regarding this matter. In a recent bulletin, No. 47 from the Minnesota Station,

giving the results of Prof. Snyder's investigations, is found the following statement:

"Flax belongs to the dainty or weak feeding crops. It does not take a great deal of fertility from the soil, but the small amount which it does take must be in the very best and most available forms. Mangels on the other hand belong to the gross feeding farm crops. Mangels, and in fact nearly all farm crops, are capable of taking their food in cruder forms, and with far less difficulty than flax. A heavy crop of mangels will remove five times more potash, twice as much phosphoric acid and nearly one and a half times more nitrogen than a crop of flax.

"A corn crop removes a half more nitrogen, twice as much potash, and about the same amount of phosphoric acid, while a good oat crop removes practically the same amount of nitrogen and phosphoric acid and about three quarters more potash than the flax crop. Compared with wheat, flax removes less phosphoric acid and potash per acre, and about a half more nitrogen. Potatoes remove about the same amount of phosphoric acid, about one-third less nitrogen, and nearly three times more potash per acre than an average crop of flax." It is further stated, "that in flax growing the heaviest draft falls upon the nitrogen, but when clover is grown this loss of nitrogen is not a serious matter, because one fair crop of clover will more than return all the nitrogen removed in two crops of flax."

From all the sources of information at our command it is safe to conclude that the flax crop has been charged with a greater power of exhausting the soil than it really possesses. On the other hand, on account of its delicate feeding propensities, it should not be compelled to search for its food where only a scanty supply is found.

AMOUNT OF SEED TO THE ACRE.

The amount of seed sown to the acre will depend somewhat on the germinating qualities of the seed, and the condition of the soil. The stronger the soil the more seed will be required. A recent report received from Belfast, Ireland, states that $1\frac{3}{4}$ bushels of seed, 95 per cent growing, will seed an English acre well, whereas $2\frac{1}{4}$ bushels, germinating only 70 to 75 per cent, will scarcely be enough. If the seeding is too thin the plants will branch, making them unfit for fiber. As little branching as possible is necessary for the production of fiber. A straight slender stem 18 to 30 inches high, with a ball of seed at the top, is an ideal stalk for fiber. When flax is grown for seed alone, $\frac{3}{4}$

of a bushel of seed per acre is sufficient.

In our experiments in 1892, in growing flax for fiber, 2 bushels of seed per acre were sown. The results were very satisfactory, and are mentioned in the first pages of this Bulletin. The straw was a little coarse which condition would have been obviated by sowing more seed.

From the latest information at our command we would conclude, that not less than two bushels per acre should be sown, and we are inclined to think that on the best grain lands of the Willamette valley, 2 ½ bushels will give better results than less.

Experiments will be carried on at the Station this season in growing flax from various amounts of seed per acre.

MANNER OF SOWING.

Broad-cast seeding is generally recommended. This may be done by hand or by using some kind of broad-cast seeder. The Thompson wheel-barrow seeder was used at the Station in 1892. The seed is usually sown by hand in the flax districts of Europe. Men go from farm to farm sowing flax seed during the planting season. In this country, where considerable grain is sown by hand, there would be little difficulty in procuring experts for the sowing of flax.

It is difficult to grow a uniform sample of flax for fiber, when the seed is sown in drills. Some of the stems will branch more or less on the sides of the drills. Weeds will grow more readily between the drills.

A light smoothing harrow is sufficient to cover the seed; but if the ground is not thoroughly pulverized a second harrowing may be applied. It is better, however, to fit the ground before seeding. This may be followed by the roller, if the season is well advanced so there will be no danger of heavy rain storms. The roller firms the earth about the seed, and thus hastens its germination. It is important that the plants should come up as evenly as possible; for, if they do not the crop will make an uneven growth, and thus the plants will not all mature at the same time.

TIME TO SOW.

The conditions of the season will largely govern the time of sowing. In the experiments of 1892, the seed was sown May 18th. This is about the time to plant corn in this locality. When the

ground is warm enough to germinate corn quickly, flax seed will germinate, and the young plants will make a rapid growth. Care must be taken in not sowing too late, and yet late enough to enable the farmer to thoroughly prepare the ground. It is better to wait a little later than to sow the seed on poorly prepared ground. By properly preparing the ground more moisture will be saved for the use of the plant, than if the ground is left in a cloddy condition. Seed sown in this climate on well prepared ground will reach maturity, making a good growth, without any rain-fall. This has been demonstrated by actual experiments. The moisture in the air will furnish a large supply to the growing plant, if the soil is in a condition so that it can be penetrated by the air. Under average climatic conditions we do not believe that it is safe to sow flax seed, throughout the Willamette valley, before the first of May.

HARVESTING THE CROP.

Flax should be pulled when the lower leaves turn yellow and the lower part of the stem begins to turn. Much valuable flax is ruined by letting it get too ripe. The yield of seed will not be quite so large, but the increase in value of fiber product, will more than make up for this loss.

There are machines for pulling flax, but the writer is not familiar with the results thus far attained. Some good authorities claim that the machines are a success. This is an important consideration where labor is dear.

The following extract is taken from Farmers' Bulletin No. 27, Department of Agriculture :

"As to the special mode of harvesting the crop, nearly every experimenter states that the straw was pulled. This is not the usual practice of the Western flax grower, who cultivates for seed, however, and it has been urged that it is absolutely essential, where the object is to produce both fiber and seed, or, to state it more precisely, when the object is to produce a common grade of fiber and at the same time save the seed. If the land surface is made very smooth so that the knives of the reaper may be set low, cutting by machine (rather than pulling) may answer. Several inches of the best portion of the stem will be lost and the square ends of the fiber will not work into the "sliver" as smoothly as pulled flax when the fiber is being manipulated in the first stages of manufacture. A flax-pulling machine is a desideratum, and for the past two or three years inventors have

attempted to work out the problem. The Department has knowledge of four inventions in this direction, one of which, the Lamar device, controlled by the Minnesota Flax Company, has already shown good results."

"After all has been said, pulling is essential to the production of fine fiber. If pulled by manual labor, the course is to draw the handful of straw out of the ground, and by striking the roots against the boot the earth is dislodged. The straw is then laid in handfuls, crossing each other, so as to be readily made into bundles. In Belgium the flax is pulled with great care, the ends being kept very even, and the straw laid in handfuls upon the ground, a line of straw being first laid down, which serves to bind these handfuls when a sufficient quantity has been pulled to tie. When put into stooks to dry, the seed ends being tied together, the bottom ends are opened out, giving to the stook the appearance of an A tent. After drying in the stook the handfuls of straw are then tied into small bunches, or "beets," and piled something as cord wood is piled in this country, two poles being first laid upon the ground to prevent injury to the bottom layer by dampness, and two poles driven at each end of the pile to keep the "hedges" in form."

The matter of handling the crop after it is grown is very important. A mistake in this work will change the outcome, very materially as far as quality of fiber is concerned. The following extracts are taken from a report made by Mr. Henry Wallace to the Department of Agriculture covering the flax industry of Ireland and Belgium. While these suggestions may not apply to the industry here, and undoubtedly many of them will not, they will serve as "guide posts" to those who start out in the work in an experimental way.

"A flax crop in Ireland is grown mostly at an elevation of from 250 feet above down to sea level, and the best flax is grown at an elevation but little above the level of the sea. The climate is moist, but a few days at most intervening between showers. The soil is by no means rich; in fact, is much inferior to most soil of the Northern and Western States. Few of the soils on which flax is grown so successfully will grow red clover, except as a rotation crop, and only at intervals of six or seven years. It is, besides, polluted with weeds to an extent that an American can scarcely comprehend, the weeds being mostly deep-rooted, and growing from detached pieces, which the moistness of the climate prevents being killed by cultivation by any kind of machine. The only known method of destroying these weeds is by careful hand pulling. Given a soil somewhat clayey and retentive of moisture, the absence of winter freezing and a moist climate, with frequent showers during the growing season, and we have the conditions which the flax grower must meet by the method of culture described below.

"In Ireland the seed of flax is rarely or never saved, and hence all the seed sown is imported from Riga, Russia, or from Holland, generally from Rotterdam. We find many farmers sowing Riga seed, while preference is generally given to the product of Riga seed sown one or two years in Hol-

land. This is called Dutch seed. By personal inquiry in Holland we find that the seed sown there is constantly renewed from Riga, few farmers venturing to sow their own seed longer than one year, so that Riga may be regarded as the source of all the seed sown in the linen-producing countries.

"As the object in Ireland is to produce fiber and not seed, flax is sown very thickly, averaging about 2 bushels per statute acre. By this thick sowing, the plant is pushed upward in a straight stem, with but one or two top branches, and attains a height of from 3 feet to 3 feet 9 inches. As the branch scutches off into tow and the universal practice of pulling the fraying off of the root end, this gives a length and staple of from 27 to 36 inches, an exceedingly important consideration in producing valuable fiber. To what extent the practice of sowing flax thinly to produce a seed crop tends to develop and transmit by the law of heredity the habit of low branching we have been unable to determine, as no flax is grown for seed in Ireland. In Holland it is grown for both seed and fiber, while it is grown mostly for seed in Russia, and it would therefore seem that the tendency to branch is governed by the same law that prevails among trees, thin planting developing a tendency to branch while thick planting compels an upright growth. Our observation among the flax growers of Belgium and Holland shows that when the climate and conditions are favorable it is possible to secure a moderate crop of fairly good seed, and at the same time a crop of good fiber. The finest fiber in the world is grown in Belgium, where the seed is also saved, although it must be stated that the seed grown in Belgium is quite inferior in quality, everything being sacrificed to the production of the choicest fiber.

"From observations continued over two months during the growing period, we are inclined to the belief that the most important of all the operations connected with flax growing is that of seeding. Weeds are especially pernicious to flax; they not only occupy space that should be occupied by the plant, but they interfere very seriously with pulling, causing more or less loss of staple in separating the flax from the weeds, and, we have reason to believe, not merely exhausting the fertility of the soil, but absolutely poison it.

* * * * We did not see in either Ireland, Holland or Belgium a single good flax crop where weeding had been neglected, nor did we see a poor one where the flax had been kept scrupulously clean and free from weeds. In growing flax, America will for many years have a great advantage over these countries in this, that the weeds that trouble the Western farmer are mostly annuals, which can be destroyed for the most part in a dry, hot climate by cultivation of the ground previous to sowing, while the soils of the Old World are polluted with many varieties of weeds which cannot be killed by a brief exposure to the low temperature of these climates."

Mr. Wallace's report contains the following remarks on flax growing in Belgium:

"The soil and the general principles of this district bear a striking resemblance to the prairie States of the West. The whole region is under the most complete and thorough system of cultivation, fences being used only to inclose permanent pastures and the tillable land being under a most complete system of rotation. Belgian soil gives an opportunity for a more varied rotation than in Ireland, growing, as it does, wheat, rye, oats, barley, sugar beets, clover, chickory, turnips, rape, and smaller crops. The principles followed in adopting a rotation for any particular farm are the same as those adopted by the Irish farmer, few farmers caring to sow flax on the same land oftener than once in eight years, and the greatest success being obtained when the crop is not more frequent than once in from fifteen to twenty years. The following is one of the favorite rotations: wheat, barley,

INTERNATIONAL EXHIBITION.

PHILADELPHIA, 1876.

(No. 222.)

The United States Centennial Commission has examined the report of the Judges, and accepted the following reasons, and decreed an award in conformity therewith.

Philadelphia, Dec 19th 1876.

REPORT ON AWARDS.

Product, *Flax in Straw & Lint*

Name and address of Exhibitor, *Parrish & Miller*

Jefferson Marion Co Oregon

The undersigned, having examined the product herein described, respectfully recommends the same to the United States Centennial Commission for Award, for the following reasons, viz:

*Extraordinary length, good in strength, Superior
gloss and silky softness*

M. Dickins

Signature of the Judge.

APPROVAL OF GROUP JUDGES.

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REPORT OF JUDGES.

potatoes (with manure), wheat, clover, sugar beets, chickory, flax, in which rotation the flax comes but once in eight years. Others bring in flax after mangolds or sugar beets. Belgian farmers adopt practically the same policy adopted by the Irish farmer in regard to manure. They avoid the application of coarse rank manures, which would produce an uneven fiber, preferring land that has been kept in a higher state of fertility and not exhausted by previous crops, and when manure is applied it is done a month or more previous to sowing, in the shape of colza cake or liquid manure, which can be applied evenly and with due regard to each portion of the field.

"No pains are spared in the preparation of the soil. The Belgian farmer is practically a gardener, who wastes nothing and leaves no spot with its resources undeveloped; and to this end he uses whatever kind and amount of labor is necessary to attain the desired end. The greatest care is used in the selection of the seed, adopting practically the same methods as the Irish farmer.

* * * The rate of seed sown is about 7 bushels per hectare or $2\frac{1}{2}$ bushels per acre. This is heavier than the Irish practice, but the Belgian farmer corrects any excess by removing the surplus plants at the first weeding.

"The weeding is regarded as one of the most important operations of the flax grower. When the flax is about 2 inches high it is gone over by the weeders, mostly women, often from ten to thirty in a field, their elbows touching each other, who remove with the greatest care every weed, however small. Two or three weeks afterwards the operation is repeated and at the end of this weeding the fields are absolutely clean. The wages paid weeders are from 14 to 25 cents per day.

"In this district flax is grown for both seed and fiber, and hence the plant is allowed to maintain greater maturity than in Ireland (where the pulling commences when the leaves begin to fall from the lower part of the stem), but is not allowed to attain that degree of maturity that fits the seed for sowing. Belgian seed is always a synonym for poor seed.

"The pulling is done with extreme care, the root ends being kept even, and the straw is cured by stooking the handfals. After this it is tied up in "beets" or small bundles and then placed in what are called "hedges" or ricks of bundles with plenty of air spaces between, and finally stacked preparatory to retting in the river Lys, the sacred river of the Belgian flax grower. * * * *

"The yield of fiber in Belgium seldom exceeds 500 pounds per statute acre. This is not greatly different from the yield in Ireland when allowance is made for the wasting of fiber by the practice of retting in running water. In Holland, where both systems are followed, we found that retting in water with the slightest possible current led to a decrease in the quantity of fiber of about 15 per cent, while increasing the quality in about the same ratio."

While it will be impracticable to follow the methods practiced in Belgium in all the details, the general principles of careful, pains-taking work will apply here as elsewhere. In the matter of applying machinery, to many of the operations now performed by hand in the flax districts of Europe, the American will make long strides. The American laborer is loath to use his hands in any occupation where mechanical appliances can be made to perform the same kind of work, and many times in a more satisfactory manner. The machine for pulling flax referred to in another place in this Bulletin is an American invention, and

from the latest reports promises to become a complete success. Our implements for cultivating the soil and destroying weeds are far superior to those used in the Old World. On this account there will be less danger of the product being injured by weeds. We have not the cheap labor, which it is to be hoped we never will have, but the loss may be made good by other conditions equally remunerative.

YIELD PER ACRE.

From experiments in this state and elsewhere it is safe to place the yield of straw at 3 to $3\frac{1}{2}$ tons per acre.

RETTING.

Retting is the process by which the woody portion of the stalk is separated from the fiber. This is done by inducing a certain stage of decomposition or fermentation. By this means the gum, which holds the fiber closely bound together with the woody portion of the stalk, is dissolved away and the fiber will separate freely from the worthless portion of the stem.

Dew retting is followed most generally in this country and and in Canada; but pond or river retting is the most common practice in the European flax districts. While the dew retting is slow and in it there is little danger of over retting, the majority of evidence is in favor of pond retting or a still more modern method, tank retting. By this latter method the operator may have a more complete control of temperature and other conditions of water, used in the retting process. Mr. Dodge in his reports on flax for fiber states that "rain, dew, sun and wind influence the rind in a high degree, and cause a loss of weight, fineness, and strength, and the result is a reduced quality and quantity of flax and an increased quantity of loss. The loss of weight from dew retting amounts to 30 or 40 per cent, while water retting causes a loss of 20 to 30 per cent."

Soft water is desirable for retting purposes. It should not contain any considerable amount of lime or iron and should be free from vegetable matter. From observations made in Oregon, west of the Cascade mountains, we are led to think that many of the mountain streams, which flow into the Willamette river, would furnish an excellent supply of water for retting purposes. The water taken from the Willamette river at this place is comparatively free from lime, and would not be called hard water.

The matter of double retting is becoming a very important consideration in flax countries. In a recent publication received from Mr. William M'Causland, Belfast, Ireland, this process is spoken of as follows :

"Having been informed by several gentlemen, conversant with Continental methods, that flax straw was often steeped two or three times in order to procure finer quality, in the year 1892, along with the new flax of that year, I resteeped a few beets of flax that had been watered in the customary way in 1891. Having had this small lot dried and scutched separately, I showed it to several competent judges, and they were astonished at its quality and fineness, no Irish flax equal to it having been seen for many years. This experiment confirmed my opinion that Irish flax, by rewatering could be improved in quality, and the extra trouble made to pay."

Undoubtedly the practice is based on sound principles. One thought suggested to the writer by Dr. Thornton is, that the flax fiber, when the straw remains in the water until completely retted, is injured and discolored by decomposition or fermentation, and by sunning and drying, the fiber is relieved from this danger. When again placed in the retting pools, the woody portion of the stem is attacked first by the fermentation, and is completely broken up before the fiber can be injured; and in this way the fiber comes out of the steep without any discoloration or injury whatever. It is not our purpose to go into the details of retting flax or any of the operations which follow the harvesting of the straw. We believe it is the intention of those who contemplate entering into the industry to buy the straw direct from the farmer as per contract. The preparation of the straw for fiber will be carried on by the company that purchases the straw. We agree fully with Mr. Dodge in this particular and herewith give his views as published in *Farmers' Bulletin* No. 27 :

"While I have given above full instructions for retting the crop, this operation is not strictly the work of the farmer, for in this country the industry must be developed on the lines of a practice that will be essentially American. In this age everything is reduced to specialties so far as possible, cost of production being reduced by coöperation.

"This brings us to an important consideration which may be called one of the most urgent needs of the flax fiber industry in the United States. Something more is required to set the industry on its feet than for a body to undertake to grow the plant for fiber. There is a necessity for a class of skilled workers who will come between the farmer and manufacturer in carrying on the operations of retting and scutching. It is futile to expect the farmer to ret and scutch his flax. It is not done on the farm in foreign countries, nor in Canada, save, to a very limited extent, and it cannot be done here. It is done largely in Russia, and low-grade fiber requiring most careful sorting by the buyers is the result.

"As the case stands, the farmer is hardly in position to grow flax, save in an experimental way, until he is sure of a market, and the manufacturer, that is, the spinner, is not in a position to make offers of purchase or to

name a price, because he is not sure that the farmer can grow flax of the proper standard, or that he can afford to purchase at any price, for his particular manufacture, such flax as the farmer may produce.

"Does this mean a deadlock between grower and manufacturer, an insurmountable obstacle that will doom forever the American flax fiber industry? Not at all. It simply means that what isolated farmers can not accomplish alone must be accomplished by the establishment of little local industries. To borrow a foreign term, the future flax industry of the United States must be communal; that is to say, capital must establish scutch mills in localities where flax may be profitably grown, farmers of the neighborhood agreeing to produce 5, 10, or 20 acres of straw each, under the direction, if need be, of the managers of the mills, the growth of a quality of straw that will give the proper standard of fiber. This relieves the farmers from any responsibility in the matter further than to produce a proper crop of straw. The scutch mills or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner.

* * * * The scutcher has a money interest in the matter of the production of properly grown straw by the farmer, and is in position to aid him by many hints and suggestions. In Canada and in Northern Michigan (in the neighborhood of Yale, where there are scutch mills) the practice is to sell the seed to the farmers, at the mills, at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw of which the managers of the scutch mills agree to take at a fixed price per ton, in some cases \$10 being named. And in no other way can an American flax fiber industry be established."

As a matter of information to those who are not familiar with the terms applied to the various processes through which the straw passes before it reaches the fiber stage the following explanations are given :

The seed is first removed by a process called "rippling." The seed bolls are combed off or the seed is thrashed out of the straw by passing it between rollers. This is now done by machinery.

"Breaking" and "scutching" refer to the process by which the fiber is separated from the woody portion of the stalk or "shive."

The plan as outlined by those who are interested in the development of the flax industry in this state is to establish a company whose object will be to contract with the farmers to grow the flax, and sell the straw direct to the company. This company will furnish capital sufficient to establish the scutching mills, and to supply seed to farmers who will not be required to pay for the same until the straw is delivered at the mill.

It is the plan of the Experiment Station to assist as far as possible in determining the possibilities of the industry by experiments in testing varieties of seed and various methods of culture.

I wish to acknowledge my appreciation of assistance rendered in furnishing information on this subject from the various sources mentioned in the text. Great credit is also due Prof. E. F. Pernot in the skill displayed in making the cuts which appear in the Bulletin considering the difficult objects from which the cuts were made.

BULLETIN NO. 44:

MARCH, 1897.

OREGON AGRICULTURAL EXPERIMENT STATION.

CHEMICAL DEPARTMENT.

A REVIEW OF

OREGON

SUGAR

BEETS.

By G. W. SHAW.

"Respect me, for I enrich the soil; I fertilize the land, which without me would remain uncultivated; I employ the hands, which without me would be idle. Finally, I solve one of the greatest problems of modern society, I organize and increase labor." *PRINCE NAPOLEON in Analyse de la Question des Sucre.*

The Bulletins of this Station are sent free to all residents of Oregon who request them.

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Corvallis, Oregon, 1897.

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PLATE 1, A TYPICAL SUGAR BEET.

INTRODUCTION.

In February, 1893, this Station published in Bulletin No. 23 under the title, "The Sugar Beet in Oregon," the results of a series of experiments in sugar beet culture which covered a period of three years. The edition of that bulletin was very soon exhausted. Since the publication of these results, we have been much gratified to note the interest they aroused in the state, and also the attention which has been directed toward our state as one adapted to sugar production. Several attempts have been made in different localities to secure the location of a sugar factory, but through unfortunate combinations of circumstances, and the extreme caution with which any investments have been made in manufacturing enterprises during the last few years, these attempts have achieved no success.

The present publication is intended to review fully the work there presented, and to add such results as have been obtained since the former bulletin. With these results is included information thought to be of value to those interested in this possible new industry in Oregon. We are indebted to a number of publications for the general information, among which are the "Sugar Beet," "The American Agriculturist," and the bulletins of various Experiment Stations.

March 1, 1897.

PRODUCTION OF SUGAR IN OREGON, FROM AN ECONOMIC STANDPOINT.

H. B. MILLER, Director.

One of the most important industrial questions in the United States, to-day, is how to produce our sugar supply. This is as important to the people of Oregon as to any part of this country. In consideration of this matter, it is of primary importance to examine the economics of it before much effort is wasted.

We must be able, with our soil and climatic conditions, fuel, lime, and other elements employed in the production of sugar, to produce it as cheaply as other sections of the country, or the industry will be short-lived and wasteful. It is well settled that we cannot produce the sugar from cane in competition with the Southern States and the Islands. If other states can produce higher grade beets in unlimited quantities for less money; if fuel, lime, transportation and other factors are greatly in their favor, so that the cost of production and distribution would be less for them, it would not be wise or economical for Oregon to undertake the production of sugar from beets.

The economic theory of supply and demand (a product of a purely commercial era), has given place, under pressure of the present age of science and industrial production, to the law of cost of production, as the regulator of values

The values of things are no longer fixed by the merchant who merely buys and sells; but are regulated by the scientific skill, the ability and judgment of the producer and manufacturer, combined with natural forces. The natural advantages of soil, climate, power, transportation, etc. combined with capital, regulate the price.

The general who directs industrial forces, if he wins in the contest, must be wise in the selection of these elements and a master in directing them. There is a growing fever of excitement throughout this country in the matter of sugar production from beets. Nearly every state has the subject under discussion and rumors are multiplying regarding the erection of factories.

California has achieved the greatest success thus far in the production of sugar from beets, and from reliable reports, it is fair to expect that California will soon have a dozen factories in operation.

At the present time there are three factories in operation in California, two in Nebraska, one in Utah, one in New Mexico, one in Wisconsin, and one in Canada.

The total consumption of sugar in the United States is about 5,000,000,000 lbs. per annum, and not over one-fifth of it is produced in this country. We have passed the experimental stage in the production of sugar from beets, and it has been clearly proven that the United States can and should produce all of the sugar we consume.

During the last five years it has taken three-fourths of the money received in this country from exported wheat and flour, to pay for imported sugar.

For the past five years over one hundred millions of dollars per annum have been sent to foreign countries for sugar. It seems to be a certainty that this country will very soon stop that outgo of money by producing all of this at home and that mostly from sugar beets. Oregon pays out about one million of dollars per annum for sugar, and her part in this general problem is to determine whether or not she can keep this amount within her boundaries. The question is one to be settled by a scientific and economic examination of the facts involved in production.

The world's consumption of sugar has increased fifty-five per cent in ten years, hence there is no danger of short consumption. The consumption per capita is seventy-nine pounds in England, and sixty pounds in the United States. The cheaper cost will without question, increase consumption; therefore the important question for us to determine is this,—can Oregon produce the sugar from beets and carry it to the people as cheaply as California or other states? We must carefully analyze the elements that enter into the production of sugar from beets, and compare them with the cost of the same elements in other sections.

First:—Can we produce good beets?

Second:—Comparative cost of production,

Third:—Cost of power and fuel,

Fourth:—Cost of lime rock,

Fifth:—Cost of other materials,

Sixth:—Economy of sugar beet industry in its relation to our other agricultural industries.

The answer to the first question will be found in our favor

after a careful examination of the extended reports herein made by Prof. Shaw. The sugar contents and purity are the factors to be examined to determine the quality of the beets.

The following, taken from a Wisconsin bulletin on beet sugar, by W. A. Henry, is a clear explanation of the relation of sugar contents and purity to the value of the beet :

"In the pages which follow we speak of the per cent of sugar in the juice and the coefficient of purity. Let us understand the meaning of these terms. A hundred pounds of sugar beets contain about 95 pounds of juice. This juice not only contains sugar but various other substances, largely mineral matter, which are a great hinderance, causing serious losses of sugar during the manufacture. A hundred pounds of average beet juice will carry about fifteen pounds of solid matter, of which twelve pounds may be sugar, and three pounds matter not sugar. If we divide the number of pounds of sugar, (12), by the total pounds of solid matter, (15), we get .80 which sum is called the coefficient of purity; that is, beet juice with 15 parts solids, 12 of which are sugar, is said to have a coefficient of purity 80. If the sample of juice contains 16 parts solid matter and 12 parts sugar, as before, then the coefficient of purity is only 75.

When reducing the beet juice to make sugar, each pound of foreign matter, not sugar, keeps at least one pound of sugar from crystallizing. This true, we see at once that the manufacturer desires beet roots not only carrying much sugar, but also with a high coefficient of purity. Immature beets, those grown on soils rich in vegetable matter or fertilized with fresh barnyard manure, those grown on land recently cleared from the forest, or on drained swamp lands, are all liable to carry a great deal of solid matter not sugar in the juice and consequently are quite unsatisfactory to the sugar manufacturer. Large beets are likewise always poor in sugar. The leaf stems of the beet, as well as the crown of the beet root itself also carry much foreign matter. In practice, the manufacturer recovers about seven out of every ten pounds of sugar contained in the beet root."

The following table gives some interesting figures relative to the sugar contents and the coefficient of purity of the sugar beet juice, from several states where sugar is produced together with Oregon and Washington.

	Sugar in juice,	Purity.
Wisconsin, averages,.....	12.44	76
Nebraska, 5 years,.....	13.5	80
Utah, in 1891 averaged,.....	11.0	80
" " 1894 " 	12.7	80.2
" " 1895 " 	13.5	81.5
Chino, Calif., 1891, averaged...	13.0	80
" " 1894-5 " 	15.	.....
California, average 5 yrs.....	14.9	83
Washington, 1st result,.....	14.2	82.6
" " 1895 2d " 	13.2	83.8
Oregon, 1891.....	14.13	78.08
" " 1892.....	15.7	78.08
" " 1892 to 1897.....	14.9	83.

The examination in Washington covers twenty-seven counties, and that of Oregon has covered the eastern, southern, and western sections.

One important thing will be observed in this table, viz: that the sugar contents and purity have all been below Oregon and Washington to begin with, and have improved under cultivation.

The quantity of sugar per acre has increased in Utah from 1452 lbs. in 1891, to 3116 lbs. in 1895; and in California at Chino, it has increased from 1888 lbs. in 1891 to 3309 lbs. in 1892. It is only reasonable to suppose that the same would occur in both Oregon and Washington, and in that case, this country would certainly equal, if not excel any part of the United States in the production of the sugar beet.

The second element, the cost of production, is more difficult to determine because of the imperfect data at hand.

In Utah, the average yield per acre in 1891 was 6.6 tons; in 1895 it had increased to 11.5 tons. In Wisconsin the yield in 1896 was about 12 tons per acre; while the estimates from 400 experiments was 15 tons per acre. In Nebraska the yield per acre for 1895 was about 13 tons. The average production of beets per acre in Germany for 1894 was 12.8 tons. In Oregon the average yield, estimated from 40 experiments in different parts of the state was 20.5 tons in 1892, and 23.2 tons in 1893. When we note the fact that the quantity per acre has gradually increased at other places, and when we observe that beets in general are very prolific and thrifty growers all over the state, and when we note the further fact that our climatic conditions give us a good position in the sugar beet belt, we are safe in saying that no other section will excel us in the quantity per acre that we can produce.

We have no definite data from which we can give accurate statements of labor required to produce a ton of good beets. From the reports received at this Station, we feel safe in saying that this state can produce an average of from twelve to fifteen tons per acre at a cost of from \$2.50 to \$4.00 per ton. The reports from Washington experiments confirm this statement and indicate that this territory, comprising Oregon and Washington, can produce superior beets with a large yield at a low cost, as compared with other sections of the country.

For the third problem,—cost of power and fuel:—the aver-

age cost of fuel at the various factories now in operation in the United States is \$3.50 per ton of coal. The use of wood, coal and water power in Oregon will give us at least equal if not superior advantages of power and fuel.

The cost of lime rock at the various factories ranges from \$2.00 to \$3.00 per ton. In Southern and Eastern Oregon, the price of lime rock would not exceed this and in some places it would be less. In the Willamette Valley the lime rock would no doubt cost from \$3.00 to \$4.00 per ton.

The amount of lime rock required per ton of sugar is about one ton, hence its cost is an important item in producing sugar.

The fifth item,—cost of other materials, such as coke, soda, sulphur, tallow, general laboratory supplies, wages, etc., should be about the same here as elsewhere.

The sixth point of examination,—the relation of the sugar beet industry to other agricultural pursuits, is a matter of economy largely in our favor. The residuum has been used both for beef and milk purposes and it is claimed that it has no equal as a milk producer. Oregon is sure to be a great dairy state and there is no better combination than sugar beets and dairying. Every combination for rotation of crops, especially fitting to Oregon, provides for root crops and clover. Nothing would be more certain to develop intensified farming and diversity of crops than the sugar beet industry.

The residuum of lime is of great value, especially in Western Oregon as a fertilizer for our fruit orchards. The product contains 67 per cent of lime carbonate. It is well known that the soils of the Willamette Valley are not overcharged with lime, and this material would be valuable especially in our prune orchards.

From this general examination of the subject, it seems clear that there are no serious obstacles in the way of producing sugar from beets in Oregon. The indications all point in the direction of as low a cost of production as can be had at any point in the country. The opportunities of distribution are such that the industry cannot fail to thrive if the cost of production is low. We shall carry on experiments at the Station and at various other places during the coming season with a view to determine more definitely the elements of quality and value of sugar beets in Oregon.

A REVIEW OF OREGON SUGAR BEETS.

By G. W. SHAW, A. M., Chemist.

The reasons for undertaking these investigations may be stated as follows: The consumption of sugar in the United States is greater than in any other nation. At present this country does not produce one-fifth of the sugar she uses. To show the sources of this foreign sugar for the last five years the following table is inserted :

TABLE I

*Showing sugar supply of the world from 1890-1895 inclusive.**

SOURCE.	1890-1891 Tons.	1891-1892 Tons.	1892-1893 Tons.	1893-1894 Tons.	1894-1895 Tons.
Germany.....	1,331,965	1,280,000	1,224,000	1,375,000	1,800,000
Austria	778,873	850,000	793,000	834,000	1,050,000
France.....	694,537	750,000	580,000	570,000	814,000
Russia.....	524,000	530,000	450,000	647,000	600,000
Belgium	200,000	295,000	166,000	220,000	230,000
Holland	61,307	50,000	65,000	72,000	90,000
Other Countries.....	80,000	61,900	97,000	119,000	.....
Miscellaneous†.....	2,525,649	2,630,000	2,782,000	3,197,000	4,792,000
Total.....	6,196,331	6,346,900	6,157,000	7,034,000	7,859,000

We can hardly understand why the foreign countries have been allowed to outstrip us to so great an extent, we continuing to import and consume, while there are portions of the United States equally, if not better, adapted to sugar production than France, Germany, or Austria.

Few people realize what the establishing of sugar factories in the United States, in sufficient number to supply the home demand for sugar, would mean. To give some idea of the benefits to be derived and to show the channels which the money would reach, the attention of the reader is invited to the following figures, which are based upon data from the Lehi, Utah, factory :

*Compiled from data in "The Sugar Beet."

†Cane sugar.

Cost of 21,574,000 tons raw material.....	\$115,313,337.00
Cost of fuel.....	10,867,500.00
Cost of coke.....	2,753,100.00
Cost of limestone.....	3,238,112.00
Cost of sal soda.....	170,750.00
Cost of bags and ducking.....	5,505,737.00
Cost of tallow.....	217,350.00
Cost of sulfur.....	483,000.00
Cost of muriatic acid.....	281,550.00
Cost of laboratory and other supplies.....	4,023,000.00
Wages.....	42,603,562.00

Total that would be expended at home.....\$185,545,998.00

The cost of machinery and transportation of raw and manufactured material is not included in these estimates : probably they would add a third to the total. But even on this basis we have an expenditure on home industries and labor far exceeding—nearly doubling—that of the value of all the wheat exported from the United States.

Certainly no one will attempt to deny the incalculable benefit to be derived from keeping at home the whole, or even the larger part, of this financial drain upon our country, by supplying the American market with American sugar.

The experiment stations of many states have been investigating this subject for the past few years, and many thousand analyses of American raised beets have been made. In addition, factories have for some years been in successful operation in several states. The nine factories in six states will probably turn out this season not far from 75,000,000 lbs. of granulated sugar. Thus, there is no longer any doubt but there are portions of the United States well adapted to the production of sugar from beets. The initiatory twist has certainly been given to the industry in this country, and we may expect to see a great impetus imparted to it in the near future.

Can Oregon stand in the line of sugar producing states and thus reap the rewards that are bound to follow in the wake of such an industry? Can she not gain the advantages to be derived from the building up of prosperous communities around the factory, furnishing better markets for other home products, and

encouraging the farmer to adopt more scientific methods of cultivation, which would certainly extend to other farm crops than beets, until its influence would be felt all along the line of agricultural pursuits? If the soil and climate of Oregon is favorable to the production of beets rich in sugar, and economic conditions are inviting, then there is a new and profitable industry possible for our state, one which Mr. Paddock, in a speech before the U. S. Senate, claims is more important than any twenty others in this country. That there is an abundant *home market* is evidenced from the fact that the people of this state alone, according to an estimate on the basis of 60 lbs. per capita and a population of 350,000, consume 21,000,000 lbs. of sugar per annum. It was to seek an answer to these questions that these experiments were conducted.

In the back of this bulletin will be found a table showing analyses of all beets which have been received at the Station in a suitable condition. Analyses numbered from 1 to 96 were made during the season of 1891-1892, and those from 96 to 161 during the season of 1892-1893; the remainder have been made since that time. Following this table will be found another showing analyses of Oregon grown beets sent to the U. S. Department of Agriculture, at Washington, D. C.

The Beet as a Sugar Plant.

The beet is a hardy, biennial plant, indigenous to Southern Europe, and more recently introduced into Canada and the United States. Internally the beet root is built up of a large number of concentric rings formed of a much larger number of small cells, each of which is filled with a watery solution of small bodies other than sugar.

A cross section of the beet is shown in the accompanying illustration. These contain a number of crystalloid salts, as the phosphates, malates, oxalates

of calcium, and potassium, the salts of the latter being by far the most prominent. The juice also contains a large number of colloid substances, as the albuminous and pectinous compounds. The sugar present in fairly ripe beets is crystallizable and identical with cane sugar.

Crystallizable sugar was obtained from beets in 1847, but it was about a half century later before any success was achieved in its extraction. At first only about three per cent of crystallized sugar could be obtained, although the beet contained from six to seven per cent. The demands of the Napoleonic wars on the one hand, and human needs on the other, continued to concentrate attention upon the beet as a sugar producing plant, until in 1813 a report of the French minister of the Interior stated that during the year past 7,700,00 pounds of sugar had been made, which was the output of 334 factories. In other European countries the industry had assumed a commanding position. From that time to the present there has been a steady growth of the industry till now more than one-half the sugar of the world is made from beets, and instead of receiving a bounty in Europe, as at first, it is now subject to an internal tax. In the meantime, by selection and cultivation, the sugar in the beet has been increased to 15 per cent, a large portion of which, by the improved methods of extracting and purifying, can be obtained as crystallized sugar. The industry has constantly grown in Europe until she now has about 1450 factories in operation.

History in the United States.

Notwithstanding the continuous growth of sugar beet culture in the foreign countries, as indicated above, its early career in this country was marked by a succession of failures, on account of poor business management and unsuitable locations. As early as 1830 attention was directed to the subject in America by two gentlemen in Philadelphia, without success. David L. Childs, eight years later manufactured sugar from beets, in a limited way, for a short time. There was then an interim of active interest till 1863, when an enterprise was started at Chatworth, Ill., by the Gennet Brothers, from Germany, but the undertaking proved disastrous. The company in order to counteract unfavorable local conditions moved to Freeport in the same state. The

PLATE II. SHOWING BEETS OF GOOD FORM.

unfavorable climate of this locality, however, finally caused the factory to succumb. In the meantime the industry had made a start at Black Hawk, and Fon du Lac, Wis., both of which proved unsuccessful. The machinery from each of these places was soon moved to Alvarado, California, where the enterprise led a struggling existence till 1876. In 1879 the company re-organized, and since that date, under the efficient management of Mr. E. H. Dyer, has been in successful operation. From this beginning the industry has grown to the proportions before indicated.

What is a Good Sugar Beet ?

At the outset of our discussion, I desire to say that many people have a wrong idea as to what constitutes a good beet for sugar purposes. Contrary to a popular idea which is quite extant in the state, the beet should be small, with a large leafy top. Brien says : "The size of the beet is in the inverse ratio of its sugars and salts ; the content of water increases with the size and weight of the beet."* In general, the standard adopted seems to be a beet weighing from $1\frac{1}{2}$ to $1\frac{3}{4}$ lbs., carrying 14 per cent sugar, and having a purity of 80 per cent, although factories will accept beets weighing as high as 3 lbs., and having as low as 12 per cent sugar. In addition good sugar beets should be long tapering roots, without branching rootlets. A typical sugar beet is shown in the *frontispiece*.

The average sugar content and purity for the states where sugar is now being manufactured from beets is as follows :

	SUGAR.	PURITY.
California.....	14.9	83
Nebraska.....	13.5	80
Utah.....	14.5	80
Wisconsin	12.4	76

From a report by Commercial Agent Hawes, of Reichenberg, Austria-Hungary :

"The conditions required of a good sugar beet are :

(1) Regular shape (cone, pear or olive shape). Many side roots or prongs are disadvantageous, because they make cleaning more difficult and increase the waste. The leaves should be thick and should be of the characteristic shape and color, and those which lie flat are to be preferred as protecting the beet against frost.

(2) A medium size, say, 1 to 2 pounds. Small beets make a small crop,

*Journal des Fabricants de Sucre, Oct. 23, 1878.

while large beets contain comparatively little sugar. The length should not be more than 35 centimeters (14 inches).

(3) Rich in sugar—from 9 to 25 per cent

(4) A white, compact, brittle substance. Such beets are more resistant to destruction by storage. A small head not protruding from the ground, as this head must be cut off, containing, as it does, very little sugar.

"It is very important to select the proper variety for a given district, because the different economical conditions of climate and soil require different varieties, if the largest possible crop is to be harvested. It is, therefore, quite necessary for every farmer to experiment with different varieties."

Climate and Soil Conditions.

CLIMATE.—The sugar beet does not differ from other plants in requiring certain conditions of climate and soil to yield favorable results. In foreign countries both of these questions have been pretty satisfactorily settled, but in some parts of the United States, notably California, the conditions that seem favorable, so far as rainfall is concerned, differ very materially from the foreign, hence the latter cannot be taken as an absolute guide.

The season for the growth of beets may be divided into three periods—that of germinating; that of plant formation; and that of sugar storing. The following is a comparative table showing the temperature averages for Germany and certain parts of Oregon during these periods:

TABLE II
Showing Temperature for Periods of Growth.

Periods of Growth.	Average Temp. Foreign.	Average Temp. E. Oregon.	Average Temp. Willamette Val.	Average Temp. South, Oreg.
First	49.1	56.0	52.5	53.3
Second	63.3	65.0	64.4	64.5
Third.....	56.3	64.5	63.3	54.8

On the opposite page are given comparative temperature charts, which show the normal curve for the leading foreign sugar beet areas, and also for the Willamette valley and Eastern Oregon. That for Southern Oregon is not given since it so nearly covers that of Eastern Oregon as to be essentially a duplicate. Thus it is seen that *in the matter of temperature Oregon seems well suited to the conditions demanded by the sugar beet.*

The subject of temperature with reference to the sugar beet has been very carefully studied by Dr. McMurtie, who has constructed his mean isotherm for beet culture at 70° F. for June, July and August. Taking this as a basis, Mr. H. W. Wiley, in his

Comparative Temperature Charts.

April May June July Aug Sept Oct Nov Dec

France

Germany - - - - -

Willamette Valley ———

April May June July Aug Sept Oct Nov Dec

France

Germany - - - - -

Eastern Oregon ———

report on beet culture* gives a map of the United States showing 100 miles on each side of this isotherm, within which area favorable results may be looked for. The inserted map shows this area, shaded, as given for Oregon. On the same map are given the average sugar content for each county, as well as the lime

areas, indicated + +. It is not by any means certain that good sugar beets cannot be raised in other portions of the state than within the 100 mile limit. Concerning this, Bulletin No. 27, of the Department of Agriculture, says: "There are many localities lying outside the indicated belt, both north and south, where doubtless the sugar beet will be found to thrive. The map, therefore, must be taken to indicate only in a general way those localities at or near which we should expect success to attend the growth of sugar beets in the most favorable conditions other than temperature alone." This has already proven true in some instances, and the data here given certainly show that fully as rich beets can be produced outside of this area—in Southern Oregon—as within it.

*U. S. Department of Agriculture, Bulletin No. 27.

It is in the rainfall of the state that we find the greatest seeming deviation from those portions of the world which are taken as typical beet producing regions. This seeming difference should not be considered as a too serious drawback, nor would it appear so to those acquainted with all the conditions. The average amount of rainfall does not differ much from that of the beet-growing regions of other countries, yet it is not as evenly distributed. It must be borne in mind, however, that the soils of Oregon are much different with respect to their retentiveness of moisture, and that for all our crops, the necessary moisture nearly all falls during the "wet season," and for this reason we do not usually consider the *monthly* rainfall as bearing so close relation to the crops as it does in most other states, but rather are wont to consider the *seasonal* precipitation as the more important factor. Consequently tables for seasonal precipitation are given rather than for the monthly. The places chosen are such as *fairly* represent the different portions of the state.

TABLE III
*Showing Seasonal Precipitation.**

LOCALITY.	SPRING.	SUMMER.	AUTUMN.	WINTER.	Years Obsvd
	Mch-May	Jun-Aug	Sep-Nov	Dec-Feb	
LaGrande, Eastern Oregon	4.10	2.26	2.38	15.81	2
The Dalles, Central Oregon	2.93	.88	3.98	8.50	13
Albany, Willamette Valley	10.07	2.43	9.75	22.76	8
Roseburg, Southern Oregon	8.22	1.79	8.00	17.60	10
Newport, Coast Region.....	11.60	8.16†	10.72	34.50	2
Ashland, Southern Oregon	4.79	1.61	4.90	11.63	4
Lakeview, Lake Region.....	4.32	3.09	3.18	6.79	3

SOIL.—Beets seem to have little preference in soils, yet they are the most grateful for a sandy loam of considerable depth. Speaking concerning this matter Commercial Agent Hawes says:

"The best soil for quality, as well as quantity of production, according to the experiments of Orth, are those that consist of mild, moist loam about 50 centimeters (20 inches) deep, then loam or marl 1 to 2 metres (3 to 6 ft.), and, under this, sand. Such soils, which are easy to cultivate, have a high degree of absorption, can combine nourishments, and give the plant physically a good start. Such soils are called "natural sugar-beet soils."

Bassett‡ quotes Chaptel as follows :

"Soils which are dry, calcareous, light, etc., are not well suited to the beet. Strong clay soils have little aptitude for the culture of this root. In

*Compiled from State Weather Service data.

†For two months only.

‡Guide Pratique du Fabricant de Sucre.

order that the root may prosper, it needs, in general, a mellow fertile soil, the arable stratum of which should be 12 to 15 inches thick. The root succeeds more or less well in all arable soils, but the products vary wonderfully according to the nature of the soil."

"Vilmorin considers that any good soil that will grow wheat and has an arable statum of 12 to 15 inches, will be well suited to this culture."

So far as the chemical constituents of the soil are concerned, phosphoric acid seems to bear the closest relation to the amount of sugar, or, if this be wanting, sugar will not be provided, while a lack of lime would be replaced by potash, soda, or magnesia.

Champion and Pellet consider phosphoric acid as an indispensable base for the formation of sugar in the beet. They classify the order in which the plant food is indispensable as follows: (1) phosphoric acid, (2) lime, (3) nitrogen, (4) potash.

It is foreign to our purpose to discuss, at this time, the soils of Oregon to any length, but in connection with the last statement I desire to direct attention to the fact that the soils of Oregon are well—yes, abundantly—supplied with phosphoric acid, that they surpass those of France in lime, and equal them in potash. Below are contrasted analyses of some of the French sugar beet soils with those of the natural divisions of this state, and those of California. These results, I think, speak for themselves, and need no further comment.

TABLE IV
Showing Average Comparative Composition of Soils.

ANALYSIS OF FINE EARTH	France.		Oregon.			California.
	Somme	Nord.	Eastern	Willam Valley.	South'n	
Insoluble matter.....	81.80	82.50	66.59	65.18	62.45	67.88
Soluble Silica.....			13.12	5.02	8.74	8.96
Potash (K_2O).....	.06	.14	.43	.23	.34	.64
Soda (Na_2O).....	.09		.22	.18	.21	.28
Lime (CaO).....	.51	.42	1.22	.83	2.22	1.08
Magnesia (MgO).....	.....	.....	.75	.79	.80	1.49
Manganese (Mn_2O_4).....	.....	.....	.10	.08	.25	.06
Iron (Fe_2O_3).....	2.88	2.18	10.69	16.45	15.35	15.02
Alumina (Al_2O_3).....	7.24	8.62				
Sulfuric Acid (SO_3).....	.....	.....	.04	.03	.01	.05
Phosphoric Acid (P_2O_5)...	.09	.08	.14	.21	.13	.08
Carbonic Acid (CO_2).....	.40	.70	.....	.....	.....	.....
Nitric Acid.....	.....	.....	.....	.....	.....	.....
Hydrochloric Acid.....	.....	.....	.....	.....	.....	.....
Water and organic matter	5.60	4.84	6.21	10.77	9.52	4.40
Other matter.....	1.85	1.52	.....	.....	.....	.....
Humus.....	.....	.....	1.44	1.63	2.25	.75

PART II.

THE EXPERIMENTS.

Having now compared the climatic and soil conditions of the state with those of the natural habitat of the beet, and found them apparently favorable to its culture, the questions arise as to whether beets rich in sugar will actually be produced under these conditions ; whether such beets can be produced at a price a factory can afford to pay, and still leave a fair profit for the farmer. I shall submit in evidence, first, the conditions under which the beets were grown : second, the particular results obtained : third, the yield : fourth, the cost.

When these results are considered and compared with those obtained in other states, and particularly with those obtained in states in which the manufacture of sugar is now being successfully conducted, I believe it will be admitted that none offer greater inducements than are offered in some parts of Oregon.

Seed and Cultivation of the Beets.

Each year arrangements were made with farmers in different parts of the state to cultivate a small plat of beets, the seed being furnished by the Station. Although there was a hearty and ready response to the Station's offer to furnish seed to those who would agree to forward samples for analysis, accompanied by a report—blanks for which were furnished—there were many who never responded to a single inquiry after they had received the seed, notwithstanding the fact that they had expressly agreed to report results.

The seed used for the experiment was obtained from the Department of Agriculture, at Washington, and of E. H. Dyer, Alvarado, Cal., all of it being imported and the very best that could be obtained. From the former place two varieties were obtained, the Klein Wanzlebener and the Vilmorin Improved ; from the latter the Dippe Klein Wanzlebener. In addition to these, a small quantity of Lane's Imperial sugar beet seed from Thorburn, of New York, was planted at the College. The State Board of Commerce distributed some seed throughout the

state, and a number of beets from parties who received seed from that source were sent to the Station for analysis.

To secure a uniform method of cultivation the following directions, taken from competent authorities in this country and Europe, were sent out with each package of seeds :

*Method of growing Sugar Beets to be followed by those taking
part in the Co-operative Experiments with
Sugar Beets in Oregon.*

SOIL.—This should, where possible, be a light loam, preferably containing some lime. The land should be well drained. The beet gets the greater part of its food from the ground at a depth of 8 to 12 inches. Hence freedom from excess of water is necessary.

PREPARATION OF LAND.—The land selected should have been plowed the fall before planting of seed. As soon as it can be properly worked in the spring the land should be plowed again, this time to the depth of 12 inches. Allow to lie until about one week before the time of seeding. Then plow once more to the depth of 4 to 5 inches, and work the soil into a fine and *light* condition (i. e., do not pack it down with a drag). After allowing land to lie 5 to 7 days plant the seed. The object of allowing the land to lie is that sufficient moisture may be drawn from below for the germination of the plant, and that the land may be warmed by the sun, after pulverization. No manure should be applied unless in the shape of well-rotted compost put on in the fall. The land on which the beets are to be grown should be measured approximately, and enough ground planted so that it will be possible to take the eightieth of an acre from the plot without including any *outside* rows. In ordinary soil the rows should be eighteen inches apart; in very rich, less; and in poor soil more than that distance apart. The conditions should be such that the beets cannot attain a greater weight than two pounds each. The seed should be planted one-half to three-quarters of an inch deep, and about 20 pounds of seed to the acre. Plant, when possible, in April.

CULTIVATION.—This should be thorough, and should begin as soon as the plants show in the row. When the beets have put out four leaves, thin them out so as to leave the plants standing about 4 to 6 inches (not farther) apart in the row. The weeds should be kept down and the ground well stirred.

It should be remembered that a beet which grows up out of the ground is worthless for sugar, also that the beets must not attain to a weight greater than two pounds each, and must be smooth and tapering in shape.

EXPERIMENTS OF 1891.—That the results of this season's work may be better interpreted, tables are given below for precipitation and temperature in 1891, and the departure from the normal is also indicated for various parts of the state, the same general regions being taken as are indicated above. These tables are also compiled from the reports of the State Weather Service.

PLATE III, POORLY CULTIVATED SUGAR BEETS.

TABLE V
Showing Precipitation for 1891.

LOCALITY.	March		April		May		June		July		Aug.		Sept.		Oct.	
	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Coast.....	5.83	-2.01	8.20	+3.67	3.37	+.13	4.33	+2.04	.66	-.52	1.21	+4.40	4.18	+1.82	6.46	+0.69
Willam'te Valley	2.39	-2.54	3.46	+.71	1.99	-.26	3.08	+1.30	.30	-.41	.86	+4.49	2.36	+.84	5.00	+1.57
South'rn Oregon	2.81	-.03	1.39	-.22	3.22	+1.51	1.92	+1.08	.74	+.49	.33	+0.07	1.04	+.29	1.70	-0.17
Eastern Oregon	1.99	-.20	.50	-.41	1.52	-.47	2.68	+1.13	1.45	+1.05	.32	+0.07	.61	+.16	0.61	-0.54

TABLE VI
Showing Temperature for 1891.

LOCALITY-	March		April		May		June		July		Aug.		Sept.		Oct.	
	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Coast.....	44.6	-1.1	50.2	+1.6	55.	+1.1	57.8	-.7	61.0	+1.4	64.5	+4.8	58.3	+.5	55.7	+2.7
Willamette Valley.....	42.9	-3.0	50.4	-.3	57.7	+1.2	58.3	-3.2	66.3	+.6	68.0	+2.8	58.7	+.6	55.2	+3.8
Southern Oregon.....	46.2	-1.2	51.7	-.9	57.9	-1.1	59.2	-5.0	68.3	-.6	71.0	+3.8	60.9	+1.4	55.2	+2.9
Eastern Oregon.....	35.6	-5.8	49.7	-.6	58.3	-1.5	58.2	-2.0	69.2	+.3	69.5	+1.2	59.0	+.2	51.5	+3.2

In the tables given above the average temperature and precipitation are given by months in the column marked "A," in the column marked "D" is noted the Departure (plus or minus) from the normal of the respective localities.

It will be noticed that in general the spring rains lasted until quite late thereby causing delay in the time of planting, nearly all of which was done in May, whereas under ordinary circumstances the seed could doubtless be in the ground by the middle of April at the latest.

A great many letters written by the growers to the Station show that the cultivation was not in all cases what could be desired, and the same thing was also indicated by some of the beets received. This seems to be particularly true concerning the preparation of the ground, for many beets were of an irregular shape as shown in *Plate III*, which is made from photographs of beets received at the Station. It will be noticed that these beets are all "scraggly," showing that the ground was not worked to a sufficient depth. The beets shown in this plate are poor, and would not be easily disposed of for sugar purposes. It should always be borne in mind that beets which are profitable for the manufacturer are also profitable for the farmer.

In addition to being irregular in shape, which is of itself bad, branching beets are usually sun-burned, as they have usually been lifted partially out of the ground by their own growth. In some instances beets were received at the Station from which it would be necessary to reject fully one-half the beets as unsuitable for sugar manufacture, because allowed to grow above the ground.

One of the worst things to befall a beet crop is growth above ground.

The best beets for sugar purposes are the long, tapering roots, without branching rootlets, and if the soil has been properly prepared, and the cultivation has been of the proper kind, beets will always take the tapering form shown in *Plate II*.

RESULTS.—The analyses made at the Station during the season of 1891–1892 may be summarized as follows :

TABLE II
Showing County Averages for 1891.

County.	No.	Sugar.	Purity.
Benton.....	39	12.30	74.12
Clackamas.....	7	14.55	77.30
Columbia.....	1	13.74	79.42
Douglas.....	9	12.99	73.45
Jackson.....	3	18.93	80.99
Lane.....	16	14.32	79.95
Linn.....	5	13.54	79.91
Marion.....	1	15.99	78.38
Polk.....	1	14.72	78.08
Union.....	3	15.84	79.89
Washington.....	11	13.96	78.79
Yamhill.....	1	10.73	76.64
Average.....		14.13	78.08

An examination of the results reveals that the analyses had a wide range, viz : from 6.77 per cent to 22.44 per cent sugar in the juice. Of the 95 analyses made 8 fell below 10 per cent ; 76 showed over 12 per cent, and 37 over 14 per cent sugar. An average of 81 analyses for the Willamette Valley shows 13.76 per cent sugar and a purity coefficient of 77.89 ; the average beet weighing a little over $1\frac{1}{4}$ pounds, while an average of 10 analyses of beets from Southern Oregon showed 13.38 per cent sugar with a little larger beet. For the entire state the average weight was 608.5* grams ; sugar in juice, 14.13 percent ; purity, 78.08 per cent.

The results obtained from the different kinds of seed were as follows :

Klein Wanzebener	14.3	Sugar in Juice.	79.0	Purity.
Dippe Klein Wanzebener	13.2	" " "	77.1	"
Vilmorin Improved	13.4	" " "	76.2	"

YIELD AND COST.—An attempt was made to collect reliable

*One pound = 453.5 grams.

data as to these items, but the reports received were very meagre. The average of all reports concerning yield was 20.5 tons per acre, the extremes being 5.1 and 44.2 tons. The yield as reported is given below.

TABLE VIII
Showing Estimated and Theoretical Yield.

GROWER.	Post Office.	County.	Reported Yield in Tns.	Theoretical Yield in Tons.*	Probable Yield of Su- gar per acre.
Edward Albright.....	Ashland	Jackson	12.0	10.18	3584.0
A. W. Lucas.....	Monmouth	Polk	30.0	27.50	8832.0
D. S. K. Buick.....	Roseburg	Douglas	25.0	†	2385.8
H. C. Perkins.....	Llewelllyn	Lane	18.0	32.50	4386.4
J. Voorhees.....	Woodburn	Marion	21.5	40.50	6184.2
J. S. Powell.....	Philomath	Benton	32.7	15.80	9364.6
W. E. Smith.....	Vale	Malheur	20.0	15.40	7076.0
J. H. Rinck.....	Buxton	Washington	17.4	9.90	5056.4
John Henry.....	Beaverton	Washington	5.1	21.10	1287.2
R. Scott.....	Milwaukee	Clackamas	44.2	53.40	9025.6
J. H. Crow.....	Lorane	Lane	11.0	9.50	3130.6
C. D. Thompson.....	Corvallis	Benton	5.1	21.10	1287.2
Average.....			20.5	23.34	5133.3

So far as reports were received, the cost of production ranged from \$11.25 to \$24.18 per acre, some including harvesting and some not, which represented all hand work. This subject is treated more definitely later in the bulletin.

Considerable disappointment is felt that farmers to whom seed was sent in the majority of cases did not take the trouble to report more carefully the two items of yield and cost. These are two vital items to the farmer—the very ones which affect him most. It matters little how high a per cent of sugar Oregon beets contain, if they cannot be produced at a price a factory can afford to pay, we may just as well stop all talk about the industry. Right here I desire to urge upon any who may undertake future work the *absolute necessity* of reporting these two items estimated as closely as possible.

EXPERIMENTS OF 1892.—For the investigations of 1892 the following varieties were used, Desprez' Early Rose, Vilmorin Improved, Klein Wanzlebener, and White Imperial, all of which

*The so-called theoretical yield assumes there are 40,000 beets to the acre, which in general holds true for beets weighing less than 800 grams.

†Weight of beet over 800 grams. See previous note.

are favorite kinds, the first being much used in California. Unfortunately the seed was delayed in reaching us, so it could not be distributed to the farmers as early as it should have been to secure the best results. Had the seed reached us in due time, it could have been put into the ground in April for at that time there was favorable weather for seeding, but by the time the seed had been distributed cold weather set in and continued till May, after which the weather became very dry rendering the conditions for a fair trial very unfavorable. The temperature conditions for the season are indicated on the charts given on the following page, which also give the normal temperature for this and the previous season. The rainfall for the season was below the normal and reports all read "very dry," "extraordinary dry," "weather very unfavorable." In fact nearly all the beets in the eastern portion of the state failed to mature, and in many instances the seed failed to germinate. So far as the season's climate is concerned, then, the experiments were greatly handicapped and we were "in pursuit of knowledge under difficulties."

The cultivation for this season was the same as for the previous year except that the rows were placed 20 inches apart.

Owing to the disturbed condition of the experiment the results are doubtless poorer than would have been the case had the season been one of more nearly normal condition. Still the results confirm the conclusions of the previous year, that Oregon possesses the conditions necessary for the production of excellent beets for the purpose of beet sugar manufacture.

RESULTS.—Seed was sent to 140 farmers, twenty of whom reported absolute failure of crop on account of unfavorable weather, and two on account of insect pests and squirrels.

The average of all analyses for the state was 15.7 per cent sugar in the juice, with a purity of 78.08, against 13.75 per cent and a purity of 77.57 for previous season. Out of the 65 analyses made only 11 indicated less than 12 per cent sugar in the juice, and 41 samples indicated over 14 per cent, the extremes being 9.4 per cent and 23.8 per cent. The average for the different natural divisions of the state were as follows:

Willamette Valley, 44 samples.....	14.7	per cent.
Eastern Oregon, 11 samples.....	19.2	" "
Southern Oregon, 10 samples	15.1	" "

Comparative Temperature Charts.

Normal for Eastern Oregon —————
 Mean for Eastern Oregon 1891 - - - - -
 Mean for Eastern Oregon 1892
 g

Normal for Willamette Valley —————
 Mean for Willamette Valley, 1891 - - - - -
 Mean for Willamette Valley, 1892
 5

Expressed by counties the averages are as follows :

TABLE. IX

Showing Averages for 1892 by Counties.

County.	No. Analyses.	Average for 1892.	Purity.
Benton.....	17	12.80	86.50
Clackamas.....	1	15.10	87.83
Douglas.....	9	15.20	81.15
Jackson.....	1	15.00	84.74
Lane.....	2	15.20	84.05
Lincoln.....	3	16.20	83.00
Linn.....	1	17.10	73.74
Marion.....	2	13.80	74.60
Polk.....	5	14.50	73.30
Union.....	7	19.80	87.33
Washington.....	10	15.50	78.79
Yamhill.....	5	13.70	82.83
Josephine.....	2	15.70	88.00
Wasco.....	1	21.10	90.50
Malheur.....	1	20.20	84.90

The results of the different varieties of seed have been calculated only for the Willamette valley since in the other portions of the state there was not enough of any one kind used to give any valuable indications.

Vilmorin Improved.....	13.4	per cent sugar.....	76.2	purity.
Imperial Rose.....	14.0	" " "	84.7	"
Klein Wanzlebener.....	15.0	" " "	81.9	"
White Imperial.....	15.9	" " "	82.3	"

Experiments from 1893-1897.

While no definitely outlined experiments have been conducted since 1892, yet the Station has furnished more or less seed to various parties, who have sent the beets to be analyzed. In other cases beet seed has been furnished by other parties, and analyses have been made in all cases when beets were forwarded to the Station. The average of the results of 23 analyses made since 1892 shows 15.05 per cent sugar in the juice, and a purity of 89.8 per cent. In addition to these analyses, the following were also made, but the beets having received several rains before being sent, which had induced a second growth, and a number of the beets having been grown on alkali soil, the results were not taken into account in making up the averages.

TABLE X.

Lab. No.	Grower.	Av. Weight Grams	Sugar in Juice.	Sugar in Beet.	Purity.	Solids.	Solids not Sugar.
780	W. G. Hunter	1997	13.6	12.93	70.5	19.3	5.7
779	L. Oldenburg..	1517	12.0	11.40	64.2	18.7	6.7
781	S. F. Newhard	717	5.0	4.75	57.7	8.8	3.8
782	C. A. Dunn.....	419	18.4	17.48	80.0	23.0	4.6
783	A. W. Gillis...	796	14.0	13.30	76.2	18.5	4.5
784	M. Reynolds...	225	10.0	9.50	66.7	16.5	6.5
785	W. A. Messner	474	20.9	19.85	82.5	25.2	4.3
786	A. Goodin.....	290	20.2	19.19	83.7	24.1	3.9
Average.....		804	14.3	13.55	72.7	19.3	5.0

Average of all Results.

Let us now collect the results which have been thus separately set forth. In the same table I beg to include the averages from analyses made at Washington, D. C., by the U. S. Department of Agriculture. These last mentioned results really indicate a little too high, probably about 10 per cent, on account of the time that necessarily elapsed between harvesting and analyzing, which would result in a loss of water.

Expressed by counties the averages are as follows :

TABLE XI
Showing Average of all Analyses for each County.

County.	No. Analyses	Av. of Analyses made at Station.	Purity.	No. Analyses	Average for U. S. Dept. Agriculture.	Purity.
Benton.....	42	12.57	79.63	5	14.34	82.8
Clackamas.....	8	15.62	78.76	3	15.36	84.2
Columbia.....	1	13.74	79.42	3	15.30	81.7
Coos.....	0	.....	.....	5	14.56	82.6
Douglas.....	18	14.10	77.98	1	17.74	84.3
Jackson.....	4	17.93	81.00	1	18.94	83.9
Lane.....	18	14.42	80.19	6	14.24	85.4
Lincoln*	.....	.....	.....	..	.....	.....
Linn.....	6	14.13	73.43	1	14.15	79.4
Marion.....	4	15.17	74.60	2	14.15	81.1
Polk.....	16	14.54	74.10	1	12.10	79.8
Union.....	30	18.61	85.10	2	14.35	81.8
Washington.....	2	15.29	80.98	3	12.49	80.7
Yamhill.....	7	12.87	82.76	0	.....	.....
Josephine.....	2	15.70	81.21	0	.....	.....
Wasco.....	1	21.10	90.50	0	.....	.....
Malheur.....	1	20.20	83.44	0	.....	.....
Sherman.....	0	.....	.....	1	13.55	72.2
Umatilla.....	0	.....	.....	1	15.12	80.9
Multnomah.....	1	16.90	76.80	..	.....	.....

*Averaged with Benton County.

If we omit, in making up the average for the state, those samples which indicate less than 10 per cent sugar in the juice (which were very few, as will be observed on examination of the table in the back part of the bulletin) as being beets which had not received proper cultivation, the averages for the state will be

	SUGAR.	PURITY.
For the season of 1891.....	14.3.....	78.2
For the season of 1892.....	15.9.....	81.4
Since 1892.....	15.0.....	84.8
Mean.....	15.0.....	81.5

TABLE XII

Showing Results of Varieties in Willamette Valley.

	Sugar.		Purity.	
	1891	1892	1891	1892
Klein Wanzlebener.	14.3	15.0	79.0	81.9
Dippe Klein Wanzlebener.....	13.2	.....	77.1	.....
Vilmorin Improved.....	13.4	13.4	76.2	76.2
White Imperial.....	.....	15.9	.....	82.3
Desprez' Early Rose.....	.....	14.0	.....	84.7

Yield.

Attempts were made in these experiments to secure reliable data as to both the yield and cost as has been indicated above.

Altogether the reports for 1892 were quite complete. The results given are calculated from a measured plot according to the following instructions which were sent with each package of seed.

"When the beets seem to be mature select an average row and gather every plant along a distance which should vary as follows, according to width between rows:

From	rows	16	inches	apart	gather	75	feet.
"	"	18	"	"	"	66 $\frac{2}{3}$	"
"	"	20	"	"	"	59.8	"
"	"	22	"	"	"	54 $\frac{3}{4}$	"
"	"	24	"	"	"	50	"

"The number of beets growing in the row, of the length mentioned above, must be counted. The tops are then to be removed, the beets carefully washed free from dirt, wiped and weighed. When the row is not long enough to meet the conditions, take enough from the adjacent row to make up the required length. The number of beets harvested multiplied by 435.6 will give the total number per acre. The total weight of beets harvested multiplied by 435.6 will give the yield per acre.""

Upon the above basis the reports on the following page were made.

*Circular of U. S. Department of Agriculture.

J. S. Powell.....	Benton.....	15.8	M. Snyder.....	Linn.....	11.7
College Farm.....	".....	5.8	W. E. Smith... ..	Malheur.....	20.2
G. R. Woodruff.....	".....	18.0	J. Voorhees.....	Marion.....	21.5
".....	".....	38.0	J. W. Beatty.....	".....	45.0
C. J. Bishop.....	".....	23.8	Average.....		33.2
William Bogue.....	".....	15.1	A. W. Lucas.....	Polk.....	30.0
Average.....		19.1	J. D. Stewart... ..	".....	21.7
A. J. Thompson	Clackamas... ..	9.3	C. D. Nain.....	".....	44.4
D. S. K. Buick.....	Douglas.....	25.0	Average.....		32.0
W. L. Tower.....	".....	8.2	M. J. Duffy.....	Union.....	5.0
B. D. Dyer.....	".....	6.7	J. E. Reynolds.....	".....	22.0
M. Lemmer.....	".....	17.4	Average.....		13.5
J. H. Bard.....	".....	40.4	J. H. Rinck.....	Washington	17.0
".....	".....	36.1	".....	".....	10.0
W. H. Norcross.....	".....	17.4	John Henry.....	".....	5.0
Average.....		21.6	S. P. Reeder.....	".....	14.0
Edward Albright.	Jackson.....	12.0	J. D. Rowell.....	".....	21.0
T. E. Hills.....	".....	27.4	O. P. Pointer.....	".....	8.
Average.....		14.7	Average.....		12.6
H. C. Perkins.....	Lane.....	18.0	M. O. Lownsdale...Yamhill....		47.0
J. H. Crow.....	".....	9.5	J. H. Sample.....	".....	6.8
R. S. Reed.....	".....	22.8	Average.....		26.8
R. E. Cartwright.....	".....	30.2	E. F. Meissner.....	Josephine.....	15.2
Average.....		20.2			

Segregating the results of 1892 from those of 1891, it is found that notwithstanding the unfavorable season the average yield for the state was 23.18 tons per acre against 20.5 tons for 1891.

The average yield reported in California in 1896 was 14 tons per acre. The following averages have been obtained in other states :

Minnesota.....	15.0 tons per acre.
Wyoming.....	7.5 " " "
South Dakota.....	8.1 " " "
Nevada.....	20.0 " " "
Colorado.....	26.0 " " "
Iowa.....	20.0 " " "
Indiana.....	30.0 " " "
New York.....	19.5 " " "

With the exception of California, the yields above given were obtained in experimental culture as in Oregon. That from California was based upon actual results obtained by farmers in producing beets for the factory. Other results obtained in the same manner are as follows :

TABLE XIII.

	1891	1892	1893	1894	1895
Lehi, Utah.....	6.60	6.50	9.70	11.47	11.54
Chino, California.....	7.26	7.50	11.70	9.16	11.03

One striking feature in the above table is the increase in yield after the first two years—after farmers had become

acquainted with methods of cultivation. To produce the highest yield, both in tons and in the per cent of sugar, requires a certain amount of skill, which has to be learned by careful observation and study, which fact is illustrated in the above table.

Mr. John Henry, of Beaverton, and Mr. R. Kuhne, of Tigardsville, Oregon, both undertook quite carefully conducted experiments during the past year. The former reports a yield of 10.5 tons per acre, which cost \$42.89, not including delivery to the factory. Concerning the cost Mr. Henry writes:

"In this experiment the cost per acre of beets is far too high. I put the seed in with a hand instead of a horse drill, and dug with a spade instead of a horse puller.

"The fact which I sought was the cost between the time the seed was in the ground till the crop was ready to dig, with labor costing 10 and 12½ cts. per hour, and it was just \$12.14. In the total is included

Preparing the acre.....	\$5.00
Seed, 8¾ pounds.....	2.62
Interest on land.....	8.00

"The ground had an ordinary plowing in March, and was plowed ten (10) inches deep, and seeded May 21st. Previous crop was corn, manured."

It should be stated that Mr. Henry's beets were excellent samples, analyzing 18.3 per cent sugar in the juice, with a purity of 86 7. For such beets as these a factory would pay about \$5 per ton.

Mr. Kuhne's report showed a yield of 13 tons per acre, which cost \$35. These beets would have commanded from \$4 50 to \$5.00, according to their sugar content which in all cases was high, and the purity exceptionally good, thus giving a return of about \$60 per acre, or a profit of \$25.

I consider these results quite trustworthy, and fairly indicative of what may be expected from careful, intelligent work. Mr. Henry is a very careful worker, and has had much experience in vegetable growing. Mr. Kuhne has had many years experience both in Germany and this country in growing beets for sugar purposes.

It is evident that, as with every other crop, the yield and cost of beets must necessarily depend upon many things, as variety, distance between rows, soil, cultivation, and season, hence this will always be a more or less varying factor. I think, however, that for the Willamette Valley and Southern Oregon in general, when farmers have become accustomed to the business, an average of 15 tons per acre is a very conservative estimate.

In Eastern Oregon the uncertainty of the season renders the ability to irrigate almost an essential condition, and if this is met, there can be little doubt but that the yield would even exceed that for the Willamette Valley.

Turning elsewhere for additional information I offer the following from the Watsonville *Pajaronian* which gives a review of the cost and returns from sugar beet crops in the Pajaro valley during 1891. In explaining the results the writer says the results are taken from the cultivator's own figures. In each instance the land belonged to the beet grower, and his estimated value of the rent given. In the article mentioned there are given statements of ten growers of which we select the lowest, and the highest.

L. E. PEARCE—15 ACRES.

"Plowing and preparing land, \$5 per acre—31 cents per ton—total \$75. Seed, \$1.02 cents per acre—6 cents per ton—total, \$15.30. Hoeing, thinning, topping and loading into wagon, \$24.23 per acre—\$1.50 per, ton—total, \$362.45. Plowing out and hauling, \$8.08 per acre—50 cents per ton—total, \$121.20. 241,147 tons yielded \$1205.73; profit per acre, \$42.05; per ton, \$2.63; estimated rent of land, \$15 per acre—93 cents per ton."

J. PEDERSEN—15 ACRES.

Plowing and preparing land, \$7 per acre—30 cents per ton—total \$105. Seed, \$1.09 per acre—5 cents per ton—total, \$16.35. Thinning, hoeing, topping and loading into wagon, \$28.43 per acre—\$1.20 per ton—total, \$426.45. Plowing out and hauling, \$9.48 per acre—40 cents per ton—total, \$142.20. 350.17 tons yielded \$1,750.86; profit per acre, \$70.72; per ton, \$3.05; estimated rent of land, \$20 per acre—84 cents per ton.

I also present the statement of four growers near the Chino factory, which shows the cost to the time of harvesting.

STATEMENT OF F. MOORE.

Preparing soil, 20 acres.....	\$58.75
Seed, 302 lbs. at 12 cents.....	36.24
Planting.....	13.00
Thinning.....	75.00
Hoeing.....	24.00
Cultivating.....	27.50

Total expense.....\$234.49
Expense per acre..... 11.72

STATEMENT OF W. C. RIGHTMIER.

Preparing soil, 17 acres.....	\$68.90
Seed.....	20.40
Planting.....	6.80
Thinning.....	88.40
Hoeing.....	34.00
Cultivating.....	34.00

Total expense.....\$251.60
Expense per acre..... 14.80

STATEMENT OF BRENTINGER
& TIFFANY.

Preparing soil, 50 acres.....	\$150.00
Seed, 15 lbs. per acre, at 12 cts.	90.00
Planting.....	20.00
Thinning.....	308.00
Cultivating.....	25.00
Hoeing.....	60.00

Total expense.....\$653.00
Expense per acre..... 13.06

STATEMENT OF MR. PRIMS.

Preparing soil, 10 acres.....	\$25.00
Seed 108 pounds.....	12.96
Planting.....	4.50
Thinning.....	45.25
Hoeing.....	54.00
Cultivating.....	11.50

Total.....\$153.21
Expense per acre..... 15.32

PART III. Cultivation.

Too much cannot be said upon this subject, for *in the cultivation lies the secret of success in sugar beet culture*. It has been said, "The sugar is hoed into the beet," and this is literally true. The foregoing results were all obtained while the farmers were entirely unfamiliar with the careful culture so essential to success in this industry. The sugar beet is a thoroughbred, and needs close attention. When neglected it will show a double resentment by giving (1) a small sugar content and low purity, (2) a small yield. Small size, regular tapering roots, growing entirely below the ground are three essential points to be secured in beet culture. Whatever method of cultivation be followed, these three points should ever be the object. In many cases all three had been neglected in the cultivation of the beets above described, the directions to the contrary notwithstanding. This has undoubtedly had the effect of lowering the average for the state by at least one per cent.

I consider the beets produced by Mr. Henry and by Mr. Kuhne, before mentioned, as being the most indicative of what may be expected in Oregon, when growers understand the cultivation of beets for sugar purposes. Particularly do I think this is true of Mr. Kuhne's beets, for the gentleman for many years was connected with the Oxard factory in Nebraska as an expert grower of beet seed. These beets were received Oct. 1, and gave the following results:

TABLE XIV
Showing Analyses of Oregon Beets Produced by an Experienced Grower.

Lab. No.	Av. Wt. in grams.	Sugar in Juice.	Purity.	Variety.
748	275	17.0	91.4	Klein Wanzlebener (German Seed.)
749	337	16.6	89.2	Vilmorin, Blanche amelioré (Fr. ")
750	268	17.8	88.2	Kuhne's Improved (Nebraska ")
Av.	290	17.1	89.7	

The above samples had received the first rains. On Dec. 8, after the second heavy rain, beets from the same plats were again subjected to analysis.

PLATE III A. SUGAR BEET FIELD.

TABLE XV.

Lab. No.	Av. Wt. in Grams.	Sugar in Juice.	Purity.	Variety.
761	222	16.5	81.1	Klein Wanzlebener (German seed.)
762	198	14.0	77.7	" (Nebraska ")
759	329	15.4	93.0	Vilmorin Blanche amelioré (Fr. ")
760	.....	12.4	90.7	" " (Nebraska ")
758	158	13.6	85.0	Kuhne's Improved (Nebraska ")
	236	15.2	86.3	Av. of same varieties as in table XIV.

Mr. Henry's beets gave the following results:

TABLE XVI

Showing Analyses of Well Cultivated Beets.

Lab. No.	Av. Wt. in Grams.	Sugar in Juice.	Purity.	Date Received	Variety.
732	281	18.3	86.7	Sept 22 96	White Imperial, German
756	279	18.8	92.1	Nov. 2, 96	" " "
757	279	16.1	71.2	Nov. 2, 96	Klein Wanzlebener
		17.1	83.3		Average.

When these results are compared with those of other states in which the cultivation has become reasonably good, I think it will be admitted that Oregon need stand second to no state in producing beets suitable for sugar purposes. Prof. Wiley in his notes on the analyses made at the U. S. Department of Agriculture, says: "The samples from Oregon are uniformly rich in quality, and if they truly represent the capabilities of the state, there is certainly a bright future for the sugar beet industry on that portion of the Pacific coast."

If we turn to either California or Utah, we will find evidence that in neither place did the farmers at first reap the greatest rewards, and this could not be expected in Oregon. In these two states there has been a progressing richness of the beet as better methods of cultivation were adopted, as instance:

TABLE XVII

Showing Effect of Improved Culture.

STATE.	1891	1892	1893	1894	1895
California, Chino.....	13.0	14.0	14.0	15.0	15.0
Utah, Lehi.....	11.0	11.8	11.6	12.1	13.5

Not only has the sugar per cent increased, but also the yield per acre:

YEAR.....	1891	1892	1893	1894	1895
Utah, tons.....	6.60	6.50	9.70	11.47	11.57

A small beet is desirable, for the sugar content and purity varies inversely as the size of the beet. The size of the beet can be largely governed by close planting, which not only gives a richer beet but also a greater yield. Pagnoul has conducted experiments extending over 8 years intending to show this.

DISTANCES APART IN INCHES.	PER CENT SUGAR.	YIELD PER ACRE.
Wide distance, 20 × 20	10.2	28.40
Narrow distance, 17 × 8	12.2	36.05

The same may be shown by the following Oregon produced beets, selected at random from the tables:

TABLE XVIII
Showing Quality of Small and of Large Beets.

SIZE.	VARIETY.	Weight in Grams.	Per cent Sugar in Juice.	Purity.
Small.	White Imperial.....	192	20.60	84.32
"	Klein Wanzlebener.....	341	19.00	67.80
"	White Imperial.....	250	16.70	88.30
"	Early Rose.....	165	17.70	76.60
"	Klein Wanzlebener.....	236	16.20	76.04
"	Vilmorin.....	350	18.00	82.13
Average..		256	18.00	76.19
Medium.	White Imperial.....	538	14.70	71.80
"	Klein Wanzlebener.....	865	14.15	81.79
"	White Imperial.....	803	10.90	83.20
"	Desprez Early Rose.....	980	14.00	82.90
"	Klein Wanzlebener.....	920	15.99	78.38
"	Vilmorin.....	1021	13.40	54.10
Average..		856	13.86	75.36
Large.	White Imperial.....	1623	14.00	74.20
"	Klein Wanzlebener.....	1880	14.41	80.55
"	White Imperial.....	1416	19.30	77.20
"	Desprez Early Rose.....	1970	11.90	85.00
"	Klein Wanzlebener.....	1700	12.88	80.00
"	Vilmorin.....	1700	9.81	68.12
Average..		1715	13.71	77.51

Thus it is seen that the method of planting conducive to the production of beets rich in sugar, also gives the largest yield.

Good cultivation demands that the beet root be entirely below the ground. If above ground the sugar content decreases rapidly in the upper portion, which under any circumstances is the poorest in sugar which fact is well shown in the following tables:

TABLE XIX
*Showing Effect of Good Cultivation.**

		Amt. of sugar	Purity.
Well grown, average of	top.....	15.5	82.7
	bottom.....	16.6	83.0
Poorly grown, average of	top.....	11.4	69.9
	bottom.....	13.6	77.2

Also from beets analyzed at the Station :

TABLE XX
Showing Relative Quality of Top and Bottom of Root.

	Sugar in Juice.	Purity.
Top of No. 782.....	17.0	76.6
Middle of No. 782.....	18.6	83.4
Bottom of No. 782.....	20.4	86.8

The matter of securing good beets rich in sugar, as well as a good yield, is almost entirely dependent upon careful cultivation. They cannot be produced on a large scale by any one person, nor in as careless a manner as most crops. The industry offers no inducement for the naturally tired farmer. The sugar beet requires much work, but when well cared for will give larger returns. There is no royal road to wealth even through the sweetness of the sugar beet.

The soil requires special preparation. The first plowing, which should be in the fall, should be followed by a spring plowing to a depth of not less than 10 inches, and almost without exception in Eastern Oregon and the Willamette Valley the ground should be sub-soiled to a depth of 15 inches. This I deem essential in portions of Oregon to prevent the beet from growing out of the ground. If the beet comes in contact with a hardpan, it is pushed directly upward by its own growth, and in most cases the root splits into several branching prongs, as illustrated in *Plate III.*

Allow to lie until about one week before the time for seeding. Then plow once more to a depth of 4 to 5 inches, and work the soil into a fine and *light* condition (i. e., do not pack it down with a drag.) After allowing land to lie 5 to 7 days plant the seed. The object of allowing the interim is that sufficient mois-

*Bulletin 67, Ontario Experiment Station, Guelph.

ture may be drawn from below for the germination of the plant, and that the land may be warmed by the sun, after pulverization. No manure should be applied unless in the shape of well-rotted compost put on in the fall. In ordinary soil the rows should be eighteen inches apart: in very rich less; and in poor soil more than that distance apart. The conditions should be such that the beets can not attain a greater weight than two pounds each. The seed should be planted one-half to three-quarters of an inch deep, and about 20 pounds of seed used to the acre. The seed may be soaked before planting, which should be done as early in April as the conditions will allow.

The cultivation must be thorough, and should begin as soon as the plants show in the row. When the beets have put out four leaves thin them out so as to leave the plants standing about six inches (not farther) apart in the row. The weeds should be kept down and the ground well stirred.

Several special tools have been devised for the cultivation of the crop, a description of which can be found in the publications of the U. S. Department of Agriculture. These, however, will only be needed in case the industry should attain a footing which demands a large supply of beets. As soon as the beets begin to show any tendency to grow out of the ground, earth should be well ridged up along the rows to cover the upper part of the beets.

The beets should not be harvested till perfectly ripe, which will be indicated by a yellowish green color of the outer leaves, which fall and form a wreath around the plant.

Just what will be found the *best* method of keeping beets after they are ripe, till they can be used at the factory, cannot be answered at present with any degree of certainty. It may be found possible in Eastern and Southern Oregon to leave the beets in the ground till needed at the factory. This would be possible if it is found that the slight second growth which might be induced would not cause a greater loss of sugar than would be occasioned by siloing. If this method can be practiced it means a material saving in handling the crop. If the loss by such a method is too great, then either the silo, consisting of a pit lined with straw, or sheds, as used at Norfolk, Neb., shown in the accompanying illustration, which also well illustrates the magnitude of the industry as there operated, may be used. Either of these

PLATE III B. EXTERIOR OF BEET SUGAR FACTORY, NORFOLK, NEBRASKA.

methods, I am satisfied can be used successfully in the eastern or southern part of the state, but in the Willamette Valley probably the shed will be the only feasible means. Experiments are to be made this season to determine the rate of decrease in sugar content and purity by allowing the beets to remain in the ground till used.

The producing of beets rich in sugar is an important matter from a financial standpoint, for it costs nearly as much to produce beets containing the minimum of 12 per cent sugar, as to produce those carrying 18 per cent. The former would bring but \$3.50 per ton, or, assuming a yield of 12 tons per acre, an income of \$42 per acre, while the latter would bring \$4.50 per ton, or \$54 per acre, which is a very material difference.

The growing of beets is particularly adapted to small farms, and offers remunerative employment to nearly the whole family. Much of the work can be done by the children, thus giving fair returns for their labor, as well as the profit on the crop.

Further the industry is bound to show results in a better system of general farming, for it will induce careful attention to the best practice in order to obtain the optimum results. He who produces the best quality of beets will obtain the best price for his product. Hence the industry will be an educational one in the truest sense.

Beets instead of Bare Fallow.

If farmers undertake sugar beet growing the crop should be one of rotation. This could well be substituted for the bare fallow, to which wasteful practice so many farmers in this state are wedded.

It has been found both in Europe and in this country that it is much more profitable, as well as better for the land, to raise a crop of beets than to allow the ground to lie fallow. Instead of substituting beets for some other crop they should be made supplemental to those at present available. No farmer should think of giving up cereals or potatoes for beets; but he can, by proper cultivation, devote one-fifth of his land to beet culture and raise as much from the remainder as though none of the land was occupied by beets. There is no crop which could better fall into a rotation suitable to Oregon than sugar beets. In California it has been found a most excellent crop to precede barley, giving both a better yield of grain and a better quality.

In this connection let us use the words of Mr. E. H. Dyer, taken from a circular sent in 1885 to the members of congress. In relation to establishing the industry in California, he says :

"One of the greatest obstacles we had to contend with, was to induce the farmers of California to cultivate beets in a manner to be profitable to manufacture into sugar. We had to convince them that beets properly raised for sugar were not exhaustive to the soil. We have, at this time, overcome most of the farmers' prejudices, and now have no difficulty in obtaining an abundant supply of beets, cultivated properly for sugar. Our farmers have ascertained by actual experience, that beets are very desirable to rotate with other crops ; cereals raised on land planted to beets the preceding year give large returns."

This is the more true since the beet is not exhaustive to the soil, and the richer the beet in sugar the truer is the above statement. The sugar is produced by a combination of carbon dioxide from the air with water, and investigation shows that the salts of the beet are inversely proportional to the sugar. The part of the beet which removes the largest amount of mineral matter, i. e., the leaves and crown, is either returned to the soil directly, or indirectly by being fed to stock.

Enemies.

It is not proposed to discuss this subject at length in this Bulletin. There were but few pests reported as troubling the sugar beet. The most to be feared is perhaps, *Monoxia guttulata*, (Lec.) as reported by Prof. F. L. Washburn, and described in Bulletin No. 14, of this Station.

There was also sent to this Station, and referred to the Entomologist, another insect which was said to be troubling the beets raised in Clackamas county. This pest, known as the "flea beetle"--*Phyllotreta decipiens* (Horn), belonging to the family *Chrysomelidae*, is about $\frac{1}{8}$ inch long, and of a black color. With other members of the same family, it has the femurs of the hind pair of legs strongly developed, and when alarmed jumps with so much alacrity that it is difficult to catch, hence the popular name of the family. They are found on radishes, turnips, potato vines, etc. It is not likely that they are a serious enemy of the sugar beet.

The "cut worms" were also reported to have caused considerable damage to the beet in Central Oregon. In fact, they were reported as having in some instances destroyed the entire crop.

Gophers also caused some trouble in Benton county, and are said to have shown a decided preference for the sugar beets.

PLATE IV, *MONOXIA GUTTULATÆ* AND ITS WORK.

PART IV.

The Factory.

One of the most frequent questions asked is concerning the location and cost of a sugar factory, hence I deem it advisable to present here such information as can be given briefly.

Before considering the cost it is well to determine whether or not all the requisites can be furnished, for the cost will be governed by these considerations.

The first requisite is *an abundant supply of pure cool water*, which is absolutely indispensable. A factory of 300 tons capacity uses daily no less than 1,000,000 gallons of water.

Second, there must be *an adequate supply of fuel*, which can be had at a reasonable cost. The cost of fuel at other places is given elsewhere in this Bulletin. A factory of the above named capacity would use about 100 tons of coal, or its equivalent per day.

Third, *good transportation facilities* are essential, hence, other things being equal, it is best to locate where both river and railroad transportation can be secured, and usually near some center of population, although the latter is not absolutely essential.

Fourth, *there must be an available supply of suitable limestone*, of which about 3 car loads per day are used. It ordinarily requires a ton of lime to each ton of purified sugar.

Fifth, *the enterprise requires a large capital* to erect buildings, purchase expensive machinery and secure skilled labor. It is often asked if a factory could not be started on a small scale by the coöperation of a few farmers. Suffice it to say that experience has amply demonstrated this to be entirely impracticable. The average capital invested in a factory using 350 tons of beets per day is about \$500,000. Such a factory would expect to run 125 to 150 days which period is called the campaign. To carry on the work of such a factory about 200 men would be required, of which the following must necessarily be skilled labor, a superintendent, and an assistant, ten employes skilled in diffusion, etc., a chemist, and a machinist. These would be sufficient for train-

ing others in the business.

Dr. Wiley, chief of the Division of Chemistry, Department of Agriculture, in Bulletin 27, says :

"The cost of a beet sugar factory depends on so many conditions that it will be impracticable to give anything more than a rough estimate of it. Much depends on the character of the building itself, and this, for various reasons, should be made fire-proof, thus entailing the construction of a building of considerable cost. In regard to both the building and the machinery, the total cost will depend largely on the capacity of the house; the cost, however, does not increase in the same ratio as the capacity. In other words it may be stated that the cost of a beet sugar factory capable of working 400 tons of beets per day would not be double the cost of one working 200 tons. A beet sugar house based on an estimate of 300 tons per day would probably be more in keeping with the character of the houses that which are to be built in this country for sometime to come than any other. With a proper fire-proof building, and the best and latest machinery, such a factory would cost, ready for work, from \$150,000 to \$200,000. Factories, of course, can be built at much less cost than this, but doubtless at the sacrifice of efficiency in some of its parts, so that true economy would advocate the construction of a high priced factory of the best workmanship and of the most approved style."

Mr. M. Swenson, of the Walburn-Swenson Company, of Chicago, manufacturers of sugar machinery, writes to the Wisconsin station as follows :

"The cost of the machinery complete in every particular for a beet sugar factory having a capacity of from 300 to 350 tons of beets per day, including all pumps for water supply, boilers, engines, etc., the whole to be of the very best design and workmanship, and capable of making white sugar direct from the beets, without any refining would be in the neighborhood of \$170,000 on cars in Chicago. The machinery for a factory having double this capacity would cost about \$260,000.

"These prices you will of course understand are somewhat approximate as prices vary very much.

"The cost of a first-class brick building, including boiler house for the smaller sized factory, would be from forty to fifty thousand dollars. This would also include foundations, lime kilns, etc. Just what the cost of the sheds for holding the beets would be I cannot say, but I am of the opinion that four or five thousand dollars would be sufficient to cover this item. All the castings, etc., for the lime kilns are included in the price of the machinery, and the brick work would be easily within the above cost of buildings.

"A building for the larger plant would probably cost \$75,000 if put up in every way first-class.

"There is no doubt but there is much misconception as to the cost of a factory of this kind, and many people write us thinking that with an old building and a second-hand boiler and engine that has been used for some other purpose, they have a good nucleus for a beet sugar factory, and that for twenty or thirty thousand dollars it can be all fitted up. Any attempt of this kind is simply throwing money away, and it would be a great misfortune to the beet sugar business to have it gone into without sufficient capital to erect a factory of proper size, as well as of the most modern construction."

A sixth requisite for a factory is *an unfailing supply of beets*. To supply the demands of a factory of 300 tons of beets per day

PLATE V. INTERIOR OF BEET SUGAR FACTORY, NORFOLK, NEBRASKA.

would require about 3000 acres of land each year. Since beets should not be produced two consecutive years upon the same soil 6000 acres of beet land must be available.

THE MANUFACTURE OF SUGAR.—The campaign in countries where early frosts interfere is of about 100 days duration, but in Oregon it could be extended to 150 days, or even longer, by storing the beets as before described. A detailed description of the process of sugar manufacture would not be in place in this publication, hence only a short resume is inserted.

The beets, after leaving the storage bins or pits, are thrown into canals, and by machinery washed free from dirt. By revolving knives they are cut into thin slices or "cosettes," which are macerated in water, in this process passing through a battery of several cells, known as juice stations, which remove all the sugar. The juice is now passed to a cooling reservoir, after which it is purified by means of lime, carbonic acid and filter process. The purified juice is now evaporated in vacuum pans to a kind of sugar containing about 6 per cent of water. This is known as "masse cuite." This is passed to a centrifugal machine, or granulator, where it is dried and sifted into a hopper, from which it is drawn into barrels or sacks ready for the market as granulated white sugar. The syrup is reboiled and again passed through the granulator. The chips are used for cattle food, the press cakes and other refuse are used for fertilizing purposes, and the waste syrup used for the manufacture of alcohol. When beets are sound it takes about 15 hours to convert them into granulated sugar. If they are frozen it takes a little longer.

The manufacturer has practically all the risk to run, unless he can actually be assured of a sufficient supply of beets. If he cannot be thus assured, of course we will have no factory, for no man or combination of men would invest much capital in an enterprise which would be entirely at the caprice of the farmers. The question as to whether or not farmers should grow beets depends upon whether or not factories are established to use the beets, and *vice versa*, hence it is a question of double issue and can only be solved by coöperation. It is a lamentable fact—yet no less a fact—that the farmer looks upon the manufacturer as one who is, at all times and under all circumstances, trying to get the better of him, and this serves as a great barrier to success in

the production of beet sugar. In this industry, as in no other, are the producer and the manufacturer linked hand in hand, and what is money in the pocket of one is also money in the pocket of the other. It matters not how well equipped and manned a factory is unless it is amply supplied with beets it is doomed to failure. In Nebraska two factories existed several years before farmers supplied beets sufficient for a profitable campaign.

If Oregon enters the arena, it must be with the most modern appliances. If this cannot be done we would best not undertake the enterprise. It is best to go slow but sure in a matter of so great moment, for a failure from lack of beet supply would be a serious blow to future work. Let farmers coöperate in thoroughly investigating and satisfying themselves as to the cost of producing good beets. The Station stands ready to determine the quality of the beets free of cost, and to publish the results, provided the experiments are conducted in accordance with our directions. Let meetings be called and definite work be planned. For determining the cost of cultivation ordinary seed may be used, and the crop can be utilized as feed for cattle. Each farmer who enters upon the experiment should plant several rows of genuine sugar beet seed in order to determine the quality of the beets he is able to produce. This seed cannot be had of the regular seed dealers, but must be obtained from some of the factories. The Station will furnish directions for cultivation free of cost, or they will be found in this bulletin.

It is of little use for a few farmers in each county to plant a few rods of beets. The work should be done on a larger scale, and undertaken as a business proposition, in order that very tangible results may be secured as a basis for future work. It is already demonstrated that Oregon can produce beets rich enough in sugar, but it is not yet proven that she can produce them in sufficient quantities to supply the needs of a sugar factory. Co-operation of farmers is needed for this work from now on, and it is hoped that various farmers' organizations will take hold of the matter in a determined and systematic manner. It is a matter of supreme importance to the farmers of the state, particularly in Southern and Eastern Oregon. Will the farmers organize for the work? We shall be glad to advise with any organization having the above object in view.

Resume.

The development of the beet as a sugar producing plant dates from 1847. It now yields from 15 to 20 per cent sugar and furnishes about one-half of the world's sugar supply. The early history of beet sugar manufacture in this country was marked by several failures, but for several years past factories have been operated successfully in California, Nebraska and Utah. Factories have also been erected in Wisconsin, New Mexico, and New York.

A good sugar beet should weigh about $1\frac{3}{4}$ lbs., should contain about 14 per cent sugar, and should have a purity of 80 per cent.

Systematic experiments in sugar beet culture were conducted during the years 1890—1892 to ascertain if Oregon could produce such beets.

Oregon is in the sugar beet belt. In the matter of climate the state is well suited to the conditions demanded by the sugar beet. (See map on page 14, and temperature charts pages 13 and 23.)

The apparent difference in rainfall from that of foreign areas should not be considered a too serious drawback, for the *seasonal precipitation in the Northwest, as in California*, is the influencing factor in crop production. When thus considered the precipitation compares well with areas now successfully producing beets for sugar purposes.

Any good wheat soil is a good beet soil, but beets are most grateful for a deep sandy loam. Oregon soils are abundantly supplied with phosphoric acid, the indispensable element for successful beet production, which fact is likely to bring the beets to an early maturity.

In the experiments the standard varieties of seed were used. In the experiment of 1891 it was impossible to plant seed till May, while ordinarily it can be done early in April. The beets did not receive as good cultivation as was desired.

In 1891, of the 95 analyses made, only 8 fell below 10 per

cent, 76 showed over 12 per cent and 37 over 14 per cent sugar in the juice. For the entire state the average sugar content was 14.13 with a purity of 78.08. The average reported yield was 20.5 tons per acre.

Of the three varieties, original Klein Wanzlebener, Dippe Klein Wanzlebener, and Vilmorin, the first gave the best results.

The experiments of 1892 were handicapped by a "very dry" and unfavorable season. The average of all analyses for the state was 15.7 per cent sugar in the juice and a purity of 78.08.

Of 65 analyses made 41 showed over 14 per cent, and 11 showed less than 12 per cent. The range was from 9.4 to 23.8, but most of those running below 12 per cent were immature beets. Forty-four samples from the Willamette Valley showed 14.7 per cent sugar in juice; 10 samples from Southern Oregon showed 15.1, and 11 samples from Eastern Oregon, 19.2. White Imperial variety gave the best results, being above Klein Wanzlebener, Imperial Rose, and Vilmorin in the order named. The average reported yield was 23.18 tons per acre.

The average of the results of 20 analyses made since 1892 is 14.9 per cent sugar in juice with a purity of 89.8. Discarding poorly cultivated beets the mean of all analyses for the above three periods is 15 per cent sugar in the juice and 83.1 per cent purity.

Of the varieties previously mentioned White Imperial and original Klein Wanzlebener have given the best results in the order named.

Experience elsewhere shows that the highest results are not obtained by farmers at first, but that both the sugar content of the beet and the yield increase as farmers become more careful in the culture.

The cost of cultivation in Oregon will not be far from \$35 per acre. Twelve tons per acre is a very conservatively estimated yield.

The sugar beet is a thoroughbred, and demands very careful cultivation. The sugar is hoed into it.

The sugar and purity are both lowered by a second growth. Three samples of beets grown by an experienced grower gave 17.1 per cent sugar, and 89.7 per cent purity on Oct. 1. On Dec. 8, after the second heavy rain beets from the same plats analyzed

15.2 per cent sugar, and 86.3 purity.

A small beet, with the root grown entirely beneath the soil, is demanded. This can be had by close planting and proper cultivation. The method conducive to the production of the most sugar also gives the largest yield in tons. The matter of securing good beets rich in sugar is almost entirely dependent upon careful cultivation.

Soil for beets should be thoroughly pulverized and sub-soiled to a depth of 15 inches. Seed should be soaked in urine and water before planting, which should be done in April. Keep absolutely free from weeds, and the soil well ridged up along the rows of beets.

The growing of beets is particularly adapted to small farms, offering employment for the whole family.

The beet crop should be one of rotation, and should replace the bare fallow as it is better for the land.

A factory would cost about \$200,000. The requisites are an abundant supply of water, fuel, and limestone, good transportation facilities, and an unfailing supply of beets.

If Oregon engages in the business, and hopes to succeed, it must be with the most modern appliances.

It is already demonstrated that Oregon can produce beets sufficiently rich in sugar, and with an exceptional purity. The question now before the farmer is, can he produce them in sufficient quantity and at a sufficiently low price. Coöperation of farmers is urged to settle this question.

The Station offers to direct the work, analyze all beets and publish results free of cost.

Table XXI
Showing Analyses of Sugar Beets, 1891-1896.

	GROWER.	LOCALITY.	POST OFFICE AND COUNTY.	Weight in Grams.	SUGAR.		Solids not Sugar.	Brix.	Purity.	Pounds Sugar Per Ton.	VARIETY OF BEETS.
					Sugar in Juice.	Sugar in Beet.					
1	Ewd. Albright.		Ashland, Jackson.	244	14.00	13.1	5.3	19.3	72.53	280.0	Klein Wanzlebener.
2	A. W. J. Icas.		Monmouth, Polk.	624	14.72	13.3	4.2	18.8	78.08	294.4	"
3	D. S. K. Buick.		Roseburg, Douglas.	1700	9.81	9.3	4.6	14.4	68.12	196.2	Vilmorin Improved.
4	J. Voorhes.		Woodburn, Marion.	1140	16.07	9.1	3.9	14.0	71.21	201.4	Klein Wanzlebener.
5	H. C. Perkins.		Llewellyn, Lane.	920	15.99	14.6	4.4	20.4	78.38	319.8	"
6				739	17.66	16.0	4.3	21.3	80.09	341.2	"
7				600	14.96	12.7	5.3	20.3	69.26	299.2	Unknown.
8	L. E. Wilson.		Corvallis, Benton.	379	13.46	10.9	6.3	19.8	66.36	269.2	Vilmorin.
9	College Farm.		Llewellyn, Lane.	375	13.28	12.0	4.4	16.4	80.97	265.6	Klein Wanzlebener.
10	H. C. Perkins.		Corvallis, Benton.	1200	17.70	16.1	4.3	22.0	80.45	354.0	Lane's Imperial.
11	College Farm.			335	12.03	11.4	3.1	15.2	79.91	247.8	"
12	"			280	12.39	11.6	2.5	14.9	83.15	297.6	Klein Wanzlebener.
13	"			530	14.63	12.7	2.7	17.3	84.57	297.6	"
14	"			216	14.02	12.6	2.8	16.8	83.45	280.4	"
15	"			208	16.35	14.0	3.5	19.8	82.56	327.0	Dippe Klein Wanzlebener.
16	"			312	13.50	11.9	4.5	17.0	79.41	270.0	Vilmorin Improved.
17	J. S. Powell.		Philomath.	384	13.38	12.4	3.8	16.9	76.80	261.6	"
18	"			388	11.36	10.8	5.2	16.6	78.48	227.2	"
19	"			465	11.97	10.8	5.0	17.9	70.45	239.4	"
20	"			594	13.07	11.8	5.1	18.2	65.66	284.4	"
21	C. J. Bishop.		Tidewater, Lincoln.	397	14.46	13.7	5.1	19.6	73.77	289.2	Dippe Klein Wanzlebener.
22	College Farm.		Corvallis, Benton.	397	14.86	11.5	3.0	15.9	80.88	257.2	Klein Wanzlebener.
23	"			185	12.86	11.5	3.3	15.9	78.61	250.2	Lane's Imperial.
24	"			285	12.51	11.3	3.3	12.3	79.10	194.6	Vilmorin Improved.
25	"			200	9.73	9.0	2.5	12.3	81.76	270.6	Klein Wanzlebener.
26	"			290	13.00	11.9	2.9	15.9	77.59	257.6	Vilmorin Improved.
27	"			780	12.88	11.5	3.7	16.6	71.78	241.0	"
28	J. D. Wilson.		Yoncalla, Douglas.	612	12.08	11.0	3.8	16.8	79.72	297.5	"
29	"			348	14.75	14.0	3.8	18.5	79.72	256.4	"
30	A. R. Shipley.		Oswego, Clackamas.	496	14.32	13.3	3.1	15.1	79.47	240.0	Dippe Klein Wanzlebener.
31	"			945	12.00	10.9	3.1	17.4	73.64	254.2	"
32	John Rickard.		Corvallis, Benton.	1170	9.81	8.4	5.1	15.0	65.40	167.0	Klein Wanzlebener.

33	John Rickard	Corvallis, Benton	700	6.76	6.0	4.7	11.5	58.78	135.2	Vilmorin
34	"	"	650	8.16	7.0	3.4	12.6	64.92	163.2	"
35	I. N. Saunders	Union Union	350	18.97	16.6	4.9	22.0	82.13	361.4	"
36	"	"	475	15.52	14.4	3.7	19.3	80.04	210.4	Klein Wanzlebener
37	C. L. Gowell	Toledo, Lincoln	295	17.29	16.1	4.0	21.3	80.37	345.8	Vilmorin Improved
38	P. Cooper	Roseburg, Douglas	1150	13.42	11.5	2.8	16.3	76.19	109.0	Klein Wanzlebener
39	B. F. Collins	Fir, Washington	375	9.95	9.4	2.6	12.6	78.96	214.6	"
40	G. W. Mitchell	Newberg, Yamhill	975	10.73	9.8	3.2	14.0	76.64	243.4	"
41	B. F. Collins	Fir, Washington	1145	12.17	11.38	3.2	15.4	78.90	232.8	Vilmorin
42	G. W. Mitchell	Newberg, Yamhill	1115	11.64	10.52	4.5	16.1	72.29	274.8	Klein Wanzlebener
43	J. C. Johnson	Seapose, Columbia	465	13.74	13.14	3.6	17.3	79.42	312.2	Unknown
44	J. H. Rink	Buxton, Washington	225	15.61	14.58	4.2	19.8	78.83	466.8	Vilmorin
45	W. H. Smith	Roseburg, Douglas	665	10.34	9.12	2.0	12.3	84.04	261.0	Vilmorin Improved
46	H. Marks	"	1230	10.80	10.26	4.2	15.0	72.99	258.6	Redtop
47	John Withers	Lebanon, Lin.	187	12.93	11.62	2.6	15.7	82.23	287.6	Klein Wanzlebener
48	John Henry	Beaverton, Washington	480	14.38	12.62	1.8	16.2	88.70	260.4	Vilmorin
49	"	"	340	13.02	12.14	5.1	18.2	71.78	267.2	Dippe Klein Wanzlebener
50	College Farm	Corvallis, Benton	475	13.36	12.06	3.4	16.8	79.61	250.2	Lane's Imperial
51	"	"	509	12.51	11.91	3.1	15.7	71.30	241.0	Vilmorin
52	"	"	283	12.05	11.52	4.8	16.9	75.75	256.4	Unknown
53	"	"	170	12.12	11.10	3.9	16.0	76.75	248.4	Klein Wanzlebener
54	"	"	155	12.82	11.68	3.8	16.7	78.11	260.0	"
55	"	"	225	12.42	11.18	3.4	15.9	76.47	226.0	Klein Wanzlebener
56	Samuel Howard	Eugene, Lane	1300	13.00	11.97	3.9	17.4	73.37	276.4	Unknown
57	"	"	10 lb	11.30	9.81	4.1	15.4	82.26	243.6	Klein Wanzlebener
58	R. Scott	Milv ankee, Lackamas	1213	12.82	12.91	2.98	16.8	85.82	224.6	"
59	"	"	200	12.18	11.66	4.2	16.4	81.79	183.0	Klein Wanzlebener
60	T. Pavey	Yaquina, Lincoln	856	16.23	14.43	2.6	18.9	86.55	288.2	"
61	E. Terpenning	Eugene, Lane	1880	14.15	13.76	3.1	17.3	89.29	303.6	"
62	"	"	550	15.18	13.74	1.9	17.0	86.00	757.6	"
63	"	"	1700	12.88	12.38	3.2	16.1	84.39	307.2	"
64	M. H. Harlow	"	930	15.36	14.20	2.8	18.2	80.84	352.2	"
65	"	"	340	17.61	15.74	2.0	19.6	84.20	296.4	"
66	"	"	575	14.52	13.09	2.7	17.6	79.62	313.8	Dippe Klein Wanzlebener
67	"	"	682	11.30	10.22	4.7	16.0	99.70	77.50	Klein Wanzlebener
68	W. W. Crow	Lorane, Lane	215	15.69	14.23	2.7	18.4	77.50	279.0	"
69	J. H. Crow	Tidewater, Lincoln	875	13.42	12.24	3.3	16.8	74.34	273.6	Dippe Klein Wanzlebener
70	C. J. Bishop	Newbridge, Union	1150	13.95	12.67	4.1	18.0	77.57	268.0	Vilmorin
71	W. R. Wise	Toledo, Lincoln	450	13.68	12.16	3.8	17.3	78.82	321.0	Klein Wanzlebener
72	J. H. Rosebrook	"	460	13.42	11.92	3.8	18.6	71.65	368.4	"
73	"	"	927	14.68	13.95	3.9	22.4	86.00	311.4	Bulleau Desprez
74	C. J. Bishop	Tidewater, Lackamas	720	16.05	15.07	5.3	22.4	86.00	251.0	Unknown
75	John Gage	Stafford, Clackamas	875	13.42	12.14	4.7	18.2	84.75	283.4	"
76	"	"	412	15.57	14.85	2.4	18.0	84.75	283.4	"
77	C. J. Bishop	Tidewater, Lincoln	405	14.17	13.12	2.3	17.3	72.54	240.6	"
78	James Wilkinson	Beaver Creek, Lincoln	1075	12.55	11.59	4.6	16.4	73.35		"
79	Albert Brown	Philomath, Benton	825	12.03	11.23	4.3				"

Table XXI (Continued)
Showing Analyses of Sugar Beets, 1891-1896.

	GROWER.	LOCALITY.	POST OFFICE AND COUNTY.	Weight in Grams.	SUGAR.		Solids not Sugar.	Britz.	Purity.	Pounds Sugar per Ton.	VARIETY OF BEET.
					Sugar in Juice.	Sugar in Beet.					
81	J. H. Rinck.....	Buxton, Washington.....		395	15.71	14.38	6.2	20.0	71.40	314.2	Klein Wanzlebener.
82	".....	".....		250	18.86	16.09	3.0	10.9	89.94	376.0	"
83	Edward Albright.....	Ashland, Jackson.....		325	20.56	16.30	3.1	24.7	87.21	411.2	"
84	".....	".....		255	22.24	20.99	3.2	25.5	79.88	287.6	"
85	G. H. Baber.....	Forest Grove, Washington.....		830	14.38	13.08	3.6	18.0	76.94	292.4	Unknown.
86	J. G. Stevenson.....	Eugene, Lane.....		495	14.62	13.25	4.3	19.0	77.30	151.4	Vilmorin Improved.
87	".....	".....		475	7.57	5.88	5.3	12.9	70.87	226.8	"
88	J. B. Riddle.....	Riddle, Douglas.....		865	11.34	10.48	4.6	16.0	68.04	241.0	Klein Wanzlebener.
89	".....	".....		1010	12.95	11.93	4.6	17.7	83.01	380.0	"
90	W. E. Smith.....	Vale, Malheur.....		350	19.00	17.69	2.8	22.9	81.98	272.2	"
91	O. F. Coshow.....	Brownsville, Linn.....		450	13.61	11.58	3.0	16.6	72.16	226.6	Unknown.
92	".....	".....		950	11.33	10.53	4.3	15.7	72.16	397.4	"
93	".....	".....		750	9.87	8.48	1.7	11.6	85.08	206.0	"
94	".....	".....		600	10.00	8.98	2.7	12.8	76.12	304.8	"
95	A. N. Ault.....	Forest Grove, Washington.....		375	15.24	15.00	6.0	21.3	71.54	266.0	Vilmorin Improved.
96	E. F. Meissner.....	Kerby, Josephine.....		393	16.00	15.20	5.5	21.5	74.41	320.0	Early Rose.
97	A. J. Thompson.....	Oswego, Clackamas.....		325	15.20	14.10	2.3	17.5	86.85	314.0	"
98	J. J. Odale.....	Union, Union.....		495	16.10	15.20	1.6	17.7	90.95	332.0	Klein Wanzlebener.
99	A. J. Goodbrod.....	".....		817	23.00	21.90	3.9	26.9	85.50	460.0	"
100	College Farm.....	Corvallis, Benton.....		2408	12.66	11.97	1.8	14.4	90.95	252.0	"
101	".....	".....		2900	11.20	10.60	2.0	12.6	88.80	224.0	Vilmorin.
102	".....	".....		3326	15.50	14.70	2.2	17.7	87.50	301.0	White Imperial.
103	".....	".....		4536	13.90	13.20	1.8	15.0	92.60	278.0	Early Rose.
104	S. P. Reeder.....	Greenville, Jackson.....		532	18.20	17.30	3.8	22.0	78.68	374.0	White Imperial.
105	College Farm.....	Corvallis, Benton.....		270	12.70	12.00	2.7	14.7	86.53	254.0	Klein Wanzlebener.
106	".....	".....		390	12.60	12.00	1.4	14.0	90.00	252.0	Vilmorin.
107	".....	".....		303	13.97	13.10	1.8	15.7	89.10	278.0	White Imperial.
108	".....	".....		305	10.00	9.50	1.7	11.7	85.88	200.0	Early Rose.
109	T. F. Hills.....	Ashland, Jackson.....		783	15.00	14.20	2.7	17.7	84.74	300.0	Desprez Early Rose.
110	J. M. Hirsch.....	Union, Union.....		605	17.60	16.20	1.5	18.5	93.40	340.0	Unknown.
111	College Farm.....	Corvallis, Benton.....		340	11.00	10.40	3.2	14.2	77.40	220.0	Klein Wanzlebener.
112	".....	".....		490	9.80	9.30	3.1	12.9	76.29	196.0	Vilmorin.
113	".....	".....		263	11.40	10.80	1.2	12.6	90.46	228.0	White Imperial.

114	College Farm.....	Corvallis, Benton.....	296	13.70	13.10	1.7	15.4	88.97	274.0	Early Rose.
115	H. Buxton.....	Forest Grove Washington.....	1970	11.90	11.30	2.1	14.0	85.00	238.0	"
116	"	"	525	13.10	12.40	3.0	16.1	81.42	262.0	"
117	"	"	1045	14.30	13.60	1.8	16.1	88.80	286.0	"
118	T. R. Cornelius.....	Cornelius, Washington.....	567	12.00	11.40	3.0	15.0	80.00	240.0	Desprez' Early Rose.
119	George R. Woodruff.....	Philomath, Benton.....	620	9.40	8.90	2.1	11.5	87.70	188.0	Early Rose.
120	"	"	640	12.90	12.30	2.8	15.7	82.17	258.0	Vilmorin.
121	"	"	776	11.90	11.20	2.6	14.5	82.17	238.0	Klein Wanzelebener.
122	M. P. Jones.....	Perrydale, Polk.....	1022	13.40	12.70	1.4	24.8	54.10	268.0	Vilmorin.
123	W. C. Tower.....	Oakland, Douglas.....	1938	20.60	19.60	3.7	24.3	84.32	412.0	White Imperial.
124	J. D. Rowell.....	Scholl's Ferry.....	341	19.00	18.00	3.0	28.0	67.80	380.0	Klein Wanzelebener.
125	College Farm.....	Corvallis, Benton.....	375	14.40	13.50	2.4	16.8	85.70	288.0	Early Rose.
126	"	"	367	16.70	15.80	2.2	18.9	88.30	334.0	Klein Wanzelebener
127	"	"	250	11.30	10.80	3.0	14.3	79.02	226.0	White Imperial
128	B. D. Dyer.....	Myrtle Creek, Douglas.....	291	15.10	14.30	2.9	18.0	83.09	302.0	Desprez' Early Rose.
129	B. F. Cartwright.....	Eugene, Lane.....	568	15.00	14.20	1.6	16.6	73.40	300.0	Klein Wanzelebener.
130	Michael Lemmer.....	Roseburg, Douglas.....	458	15.00	14.20	1.6	20.7	71.80	294.0	White Imperial.
131	O. P. Pointer.....	Hillsboro, Washington.....	535	14.70	14.00	6.0	23.3	73.40	342.0	Early Rose.
132	M. Snyder.....	Plainview, Linn.....	617	17.10	16.20	6.1	23.4	76.60	374.0	Klein Wanzelebener.
133	J. D. Leonard.....	Carlton, Yamhill.....	755	18.70	17.70	5.7	25.0	77.20	386.0	White Imperial.
134	Jas. Edson.....	Ballston, Polk.....	1416	19.30	18.20	5.7	21.3	63.50	292.0	Unknown.
135	S. W. Gaines.....	Hubbard, Marion.....	558	14.60	14.00	6.7	17.0	82.90	280.0	Early Rose.
136	M. O. Lowndale.....	Lafayette, Yamhill.....	980	12.50	12.00	3.4	15.9	78.60	250.0	Klein Wanzelebener.
137	"	"	1050	14.20	13.40	2.5	16.7	85.00	288.0	Early Rose.
138	"	"	800	21.50	20.40	2.9	24.4	88.10	430.0	Unknown.
139	C. J. Bishop.....	Tidewater, Lincoln.....	676	15.30	14.40	2.7	18.0	85.00	306.0	Vilmorin.
140	M. J. Duffy.....	Cove, Union.....	660	15.00	14.30	1.9	17.0	88.80	302.0	Klein Wanzelebener.
141	R. S. Reede.....	Creswell, Lane.....	352	15.10	14.30	1.9	17.0	87.00	296.0	Desprez' Early Rose.
142	B. C. Hawley.....	Logan Clackamas.....	351	14.80	14.10	2.2	17.0	90.58	308.0	Vilmorin.
143	J. K. Simpson.....	North Yamhill, Yamhill.....	770	15.40	14.40	1.6	17.0	84.90	404.0	Desprez' Early Rose.
144	B. F. Church.....	Monmouth, Polk.....	570	22.20	19.10	3.6	23.8	74.20	280.0	White Imperial.
145	W. E. Church.....	Vale, Malheur.....	1623	14.00	13.30	4.6	21.8	76.60	354.0	Klein Wanzelebener.
146	C. D. Nain.....	Ballston, Polk.....	165	17.70	16.80	4.1	18.6	80.60	300.0	Early Rose.
147	J. H. Rinck.....	Buxton, Washington.....	873	15.00	14.20	3.6	16.1	80.70	260.0	Vilmorin.
148	William Bogue.....	Toledo, Lincoln.....	840	13.00	12.30	3.1	22.9	83.40	388.0	White Imperial.
149	Z. W. Beatty.....	Chenawana, Marion.....	210	19.40	18.40	3.5	25.9	91.90	476.0	Desprez' Early Rose.
150	R. S. Barclay.....	Tidewater, Lincoln.....	310	23.80	22.60	2.1	23.3	90.50	422.0	Early Rose
151	C. C. Stanley.....	Timbler, Union.....	330	21.10	20.00	2.2	17.5	88.00	308.0	Desprez' Early Rose.
152	John End.....	Warmic, Wasco.....	400	15.40	14.60	2.1	18.0	77.90	290.0	White Imperial.
153	E. F. Meisser.....	Kebyville, Josephine.....	623	14.50	13.70	4.1	21.2	75.90	322.0	Unknown.
154	J. H. Bard.....	Oakland, Douglas.....	843	16.10	15.30	5.1	15.9	88.61	282.0	"
155	P. J. Bond.....	Peel, Douglas.....	225	14.10	13.40	1.8	15.9	85.77	430.0	Klein Wanzelebener.
156	"	"	246	21.50	20.40	2.4	23.9	85.42	418.0	Desprez' Early Rose.
157	J. E. Reynolds.....	La Grande, Union.....	635	20.90	19.80	2.4	23.3	76.04	324.0	Early Rose.
158	Robert Deal.....	"	236	16.20	15.30	6.1	16.4	82.30	270.0	Vilmorin.
159	F. Clairhorn.....	Oakland, Douglas.....	323	13.50	12.80	3.1	13.1	83.20	218.0	White Imperial.
160	W. H. Norcross.....	Central Point, Jackson.....	803	10.90	10.30	2.2	15.9	226.0	71.00	Vilmorin
161	A. H. Sampson.....	Lewisville, Polk.....	930	11.30	10.70	4.6				

Table XXI (Continued)
Showing Analyses of Sugar Beets, 1891-1896.

GROWER.	LOCALITY.	POST OFFICE AND COUNTY.	Weight in Grams.	SUGAR.		Purity.	Pounds Sugar per Ton.	VARIETY OF BEET.
				Sugar in Juice.	Sugar in Beet.	Brix.		
H. L. Heath.....	McMinville, Yamhill.....	.....	11.55	10.97	1.45	13.0	88.84	New Danish.
D. K. Bill.....	Hillsboro, Washington.....	.....	12.10	11.79	.90	13.0	93.04	French.
Max Steaples.....	" " "	.....	13.60	12.92	3.40	17.0	80.00	Unknown.
W. H. Bucher.....	" " "	.....	14.20	13.49	4.00	18.2	78.02	"
B. W. Thorne.....	" " "	.....	13.90	13.20	4.30	18.2	76.37	"
W. B. Kingley.....	McMinville, Yamhill.....	.....	14.90	14.16	4.00	18.9	79.36	"
College Farm.....	Corvallis, Benton.....	.....	13.00	12.35	.. ..	.. ..	.. ..	Kiehholz Klein Wanzelebener.
.....	" " "	.....	12.60	11.97	4.20	16.8	75.00	Lion Most Saccharine.
.....	" " "	.....	14.40	13.60	3.30	17.7	81.35	Improved Imperial.
.....	" " "	.....	4.56	14.70	2.30	16.8	86.31	White Imperial, German.
John Henry.....	Beaverton, Washington.....	.....	665	18.30	17.39	21.1	86.70	Klein Wanzelebener.
.....	Tigardville, " "	.....	275	17.00	16.15	18.6	91.40	Vilmorin, blanche amelioré.
R. Kuhne.....	" " "	.....	337	16.00	15.78	20.0	89.20	Kuhne's Improved.
.....	" " "	.....	268	17.80	16.91	25.0	88.60	Unknown.
.....	McKee, Marion.....	.....	199	17.30	16.44	20.3	85.20	"
H. E. Dosch.....	Hillsdale, Multnomah.....	.....	264	16.80	15.45	22.0	76.80	White Imperial, German.
John Henry.....	Beaverton, Washington.....	.....	279	18.80	17.86	20.4	92.10	Klein Wanzelebener.
.....	" " "	.....	305	16.10	15.22	22.6	71.10	Vilmorin.
R. Kuhne.....	Tigardville, " "	.....	326	15.40	14.63	16.4	93.00	"
.....	" " "	.....	12.40	11.78	2.40	14.8	90.70	Klein Wanzelebener.
.....	" " "	.....	223	16.50	15.70	3.70	81.10	"
.....	" " "	.....	198	14.00	13.20	4.00	77.70	"
.....	" " "	.....	662	14.00	13.20	4.00	83.00	"

Table XXII
Showing Analyses of Oregon grown Sugar Beets made by
the Department of Agriculture at Washington, D. C.*

GROWER.	COUNTY.	Weight in Grams.	Sugar in Juice.	Sugar in Beet.	Purity.	Solids.	VARIETY.
Herman Benke.....	Benton.....	370	13 88	14 18	79 3	17 49	German.
J. J. Nye.....	".....	355	13 30	12 65	78 4	16 97	"
C. J. Bishop.....	".....	335	15 40	14 63	87 5	17 61	Bulteau Desprez.
G. H. Rosebrook.....	".....	300	14 05	13 35	83 1	16 89	Klein Wanzleben.
Henry Delinger.....	".....	1589	15 05	14 30	85 4	17 64	"
Average.....	".....	628	14 34	13 71	82 8	17 32	"
Thomas Daniels.....	Clackamas.....	500	19 88	18 88	87 6	22 68	"
O. P. Yoder.....	".....	105	14 55	13 82	86 5	16 83	Klein Wanzleben.
Richard Scott.....	".....	1155	12 25	11 62	77 0	15 91	"
Average.....	".....	586	15 56	14 78	84 2	18 47	"
Clarence Reed.....	Columbia.....	275	16 50	15 67	83 9	19 67	"
".....	".....	830	15 60	14 82	79 8	19 67	"
J. C. Johnson.....	".....	535	13 90	13 21	86 0	16 17	"
Average.....	".....	546	15 30	14 56	81 7	18 50	"
J. M. Perkins.....	Coos.....	1030	13 00	12 35	80 8	16 31	Klein Wanzleben.
Mat Kerrigan.....	".....	600	14 50	13 77	83 8	17 31	Vilmorin.
".....	".....	530	14 65	13 92	80 5	17 71	Klein Wanzleben.
John Fox.....	".....	975	16 80	15 96	87 0	19 31	"
T. T. Smith.....	".....	865	13 85	13 16	79 1	17 51	Vilmorin Improved.
Average.....	".....	860	14 56	13 83	82 6	17 63	"
W. L. Tower.....	Douglas.....	340	17 74	16 85	84 3	21 03	German.
Edward Albright.....	Jackson.....	570	18 94	17 99	83 9	22 57	"
J. G. Stevenson.....	Lane.....	115	12 15	11 54	77 5	15 67	Vilmorin Improved.
W. N. Crow.....	".....	595	14 05	13 36	77 7	18 09	"
H. L. Perkins.....	".....	475	13 95	13 25	81 2	17 17	"
J. H. Crow.....	".....	230	17 50	16 63	84 6	20 68	"
C. J. Dodd.....	".....	815	15 10	14 35	83 9	17 99	French.
L. Martin.....	".....	1100	12 67	12 05	82 5	15 35	"
Average.....	".....	550	14 24	13 53	85 4	17 49	"
John Withers.....	Linn.....	180	14 15	13 42	79 5	17 81	"
Jacob Raber.....	Marion.....	1365	12 35	11 73	76 2	16 17	"
Jacob Voorhees.....	".....	560	14 45	13 73	85 7	16 87	"
Average.....	".....	962	13 40	12 73	81 1	16 52	"
James Douglas.....	Polk.....	880	12 10	11 50	79 8	15 17	German.
J. E. David.....	Sherman.....	435	13 55	12 86	72 2	18 77	"
J. H. Logan.....	Umatilla.....	395	15 12	14 36	80 9	18 69	French.
W. R. Wise.....	Union.....	980	14 10	13 40	81 0	17 39	"
".....	".....	1130	14 55	13 82	82 6	17 59	"
Average.....	".....	1055	14 32	13 61	81 8	17 49	"
J. H. Rinck.....	Washington.....	250	12 67	12 04	85 8	14 77	Klein Wanzleben.
A. N. Ault.....	".....	430	15 00	14 25	82 0	18 29	Vilmorin.
".....	".....	1365	9 80	9 31	68 3	14 38	"
Average.....	".....	681	12 49	11 86	80 7	15 48	"
Average for the state.....		644	14 57	13 84	82 2	17 72	

*Compiled from Bulletin No. 33, U. S. Department of Agriculture.

Oregon Agricultural EXPERIMENT STATION.

Bulletin No. 45. - - June, 1897.

Prunes in Oregon.

“Dried plums, which are commonly called Prunes, are wholsomer, and more pleasant to the stomacke, than the Greene plums: they yeeld much better nourishment, and such as cannot easily putrifie, by reason that their crude and superfluous moisture is dried up and consumed. The Damask and Spanish Prunes are the best, because they are the sweetest: being boyled in brothes, they loose the belley, and excrete out choler: being stewed and eaten betweene or before meales, they are most pleasant to the taste, excellently refresh a weake stomacke and doe also mollifie. They are most convenient for them that are of a cholericke or sanguine constitution. French Prunes, and all such as are somewhat sour in taste, are somewhat of a bin ling, and not of a soluble faculty.”

Published in London in 1628 by T. VANNER, “Doctor of Physicks.”

The Bulletins of this Station are sent free to all residents of Oregon who request them.

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Corvallis, Oregon, 1897.

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PLATE I. SHOWING WELL CULTIVATED ORCHARD

Oregon Agricultural College.

Corvallis, Oregon, January.— 1897.

The following bulletin on prunes is respectfully submitted to the fruit-growers of Oregon. The bulletin is the outgrowth of a demand among our fruit-growers, in the beginning of an almost new industry, for information dealing with the known facts and methods relative to the industry. The bulletin is, then, essentially only a preliminary report, facts being as yet too meagre and fragmentary to allow of a finished account being published. The writers only hope that it is up to date in the teachings and conclusions set forth and that they as fully as possible meet the demand for such information. Various problems touched upon in this bulletin are still matters of experimentation, to be more fully considered after conclusive results are obtained from experiments now planned or in progress ; this is especially true of all questions relating to the evaporation of fruits, to certain diseases and insects, and to some chemical problems. Some parts of Bulletin No. 40, "Prunes, Apples, and Pears in Oregon," are incorporated in this bulletin.

U. P. HEDRICK, Horticulturist and Botanist.

IS THERE PERMANENT PROSPERITY FOR THE OREGON PRUNE INDUSTRY ?

APPLICATION OF THE LAW OF VALUE TO THE PROBLEM.

H. B. MILLER, Director of Station.

Many persons are misled in their selection of crops by not having a clear conception of the law governing values. If a big price is realized this year for a given product, thousands of people rush into the business and soon the market is demoralized. The market price of a thing is only one side to the law of value, and before we engage in the permanent production of anything like prunes, we must examine the other and more important as well as the more difficult side of the question; and that is the cost of production. The cost of production in this sense includes growing, curing, preparing and sending to market. After becoming convinced of a permanent demand for a thing, the next step to consider is the natural advantages of production and transportation. This is a broad field and one requiring much careful thought and deliberation.

If the climatic and soil conditions in France, Austria-Hungary or any other foreign country, be better for the production of prunes than this country; if the cost of labor is also permanently less, and the cost of transportation to our market no greater than ours, then it would be folly for us to engage in the business unless the government provides a protection by tariff legislation.

If we have advantages of soil, climate, transportation and labor cost, over any foreign country, or not having these, the government provides for any or all of these deficiencies by a protective tariff; then the scope of our investigation is reduced to our own country, provided that the market is here.

The consumption of prunes in the United States is growing rapidly. In 1891, the importation of prunes to the United States was 34,000,000 lbs., and the production was 29,000,000 lbs.

The consumption could not have exceeded 63,000,000 lbs. of prunes in a dried state. In 1895, the importation was 14,000,000 lbs. and the production about 69,000,000 lbs., showing an increase in consumption of about 20,000,000 lbs. in four years. The consumers pay from ten to fifteen cents per pound for these. When the consumers can procure these prunes at from six to ten cents per pound, as they should and will no doubt ere long, the consumption of prunes will demand a larger production.

The prune grower can look for a much greater consumption of prunes and a more certain and steady market in the future, with a much greater degree of certainty than he can expect increased prices. A strong healthy and reliable market even at past prices, is much more to be desired than an uncertain and fluctuating market.

As to the production of prunes in this country, it seems to be settled, for various reasons, that no other section of the country can compete with the Pacific Coast.

The prospect of a market being assured, the next problem to consider is, — can we compete with California, the greatest prune producing section of the world? If their cost of production is from a half to one cent a pound less than ours, then they will eventually kill the industry in Oregon. California makes a claim of producing a better grade prune; one containing more sugar. While their claim is not altogether true, there is no reason for us to be discouraged if our cost of production is low, for the question of permanent success hinges upon the cost of producing good fruit for the masses. If after a careful examination of all the facts relating to competition with California, we become convinced that the industry can be made a success here, and we concluded to engage in prune growing in Oregon, then we have to consider the same question again, and determine which section of Oregon will produce prunes the best, for there is a great difference in the different parts of our own state. After having determined which section of the state is the best suited, we must still keep the cost of production in view. Will we get the largest and best continuous crops from sandy loam, river bottom land, the ordinary gray valley land, or the red hills? Look at the subject from any point you will, the economic law of cost of production must be the primary factor. If other sections with their natural

influences, can produce them at a less cost, it is folly to rely upon the expectation of an exorbitant price and engage in the industry on wild hopes of a great market. The lowest cost of production for the market will win the day in the production of fruits as in all else.

Law of Value.

The value will be governed by the cost of producing the most expensive part of the required amount. For example, if it should cost one cent a pound more to produce prunes in California than in Oregon and the market required the California product in addition to ours, there would be an assurance of profit to the Oregon producer. If one-third of the prunes raised are produced on hill lands at a cost of half a cent a pound more than on bottom lands, and the market would not take the prunes at the highest cost, then those engaged in prune growing on the hills would have to give up. It is a grievous mistake to engage in production simply on an examination of market rates. If the elements at command insure the lowest cost of production, then there need be no hesitancy whatever in entering the field with confidence and assurance of success if proper attention is given.

This law is so unerring that if the elements of it are followed there need be few failures. The cost of production of prunes in Oregon will vary from two to five cents per pound. Those who can produce at a cost close to this lower cost-line, are assured of a continuous and profitable industry, while those along the higher cost-line may depend upon a hard struggle with every prospect of failure.

In the production of prunes for market in the green state, the same law holds good, and must be the rule of action in determining the wisdom of any locality building up the business. This law is becoming clearer every year, in almost every line of industrial life as is shown by the specializing of manufactured as well as all kinds of agricultural products.

Any locality that can produce a certain line of marketable products the best with the least labor, is leading and producing profits in that line.

The question is constantly being asked—"Is there not great danger of overproduction of prunes?"—"Will it pay to engage in the industry?" Many who have already planted orchards are

wondering whether or not the supposed overproduction will make it unprofitable for them to continue.

A careful examination of the principles outlined above, seems to answer this question completely. The question for the prune grower to determine is not—"Will there be an overproduction," but, "Can I produce near the lowest cost?" If there is an overproduction, those laboring under the most expensive difficulties and whose cost of production is along the higher margin, will be the ones who must discontinue the business; while those whose production is the cheapest can continue with an assurance of profit. The whole question of prune producing in Oregon must be solved by those who undertake it, through the practical competition of cost of production.

There is too great a margin between the amount received by the producer and the amount paid by the consumer. This phase of the subject must eventually be solved by the producer. Prune growers' organizations, I believe to be the only practical method by which this margin of difference can be substantially and permanently reduced.

PRUNE GROWING IN OREGON.

U. P. HEDRICK, Botanist and Horticulturist.

I. General Culture.

INTRODUCTION.

he prune interests are greater than all other orchard interests in Oregon. Within the last half decade the industry has grown from insignificance to be one of the large commercial enterprises of the state. If the market for the product, dried and green, increases in the future as in the past the outlook is most promising for a great industry; for, the prune in Oregon has much in its favor. Climatic conditions are good; the soil is such that productiveness is insured; and there is a comparative immunity from pests. With these advantages Oregon can safely defy competition in the cost of production of prunes, and prune growers can rest assured that there is a good foundation for their industry.

There are about 26,000 acres devoted to prune growing in Oregon. Prunes are grown throughout the western part of the state and along the Columbia and its tributaries in Northern and Eastern Oregon, but the major part of the industry is comprised in the Willamette and Umpqua River valleys. In the Willamette Valley, there are about 15,000 acres of prune orchards. As yet most of these orchards are on the black alluvial soil near the river and have not to any appreciable extent encroached upon the red hill soil farther away, though that this soil will produce prunes is certain. The second largest prune district is in the Umpqua River Valley. Here there are about 6,500 acres of prune orchards. The valley of the Umpqua seems to be the most favored region for prunes, trees and fruit reaching their highest perfection there. The Petite or French prune especially seems to thrive; the Italian can be as well, and perhaps better, grown in the Willamette Valley. The Petite prune, and the Italian more or less, are grown very successfully in the Rogue River

Valley also, where there are approximately 1,500 acres. Attempts are being made to grow prunes in Hood River Valley and along the Columbia in Eastern Oregon, but experienced orchardists say that these sections cannot well compete with the more favored prune localities, and that their splendid fruit resources can be used to better advantage in growing other fruits. In these districts there are about 2,500 acres.

CLIMATE.

One of the resources of Oregon is its climate. An adequate estimate of its functions and value as a factor in producing prunes, and its influence upon prune growing, would lead us far beyond the limits of a brief bulletin.

The horticultural effects of the Willamette Valley climate are as follows. All fungous diseases are more prevalent than in the higher and drier valleys. The great prune pest of the state, shot hole fungus, finds a more congenial home and is far more rampant in the Willamette Valley than elsewhere. Brown rot newly introduced into the state, is as yet found only here and will soon be a grievous pest. In the humid atmosphere, moss and lichens quickly cover the trees. Strong winds, a feature of Willamette Valley climate, make it necessary to head low and prune so as to secure strong, stocky trees. Sunburn is not so common as in the warmer and drier valleys. Fruit ripens from one to three weeks later than in the other valleys. Deficiency in sunlight and summer heat makes the growth of some varieties of prunes unsatisfactory.

The chief horticultural effects of the Umpqua, Rogue, and Hood rivers valleys and Eastern Oregon climates, are, in comparison with the Willamette Valley, fewer fungous, but more insect pests:— San Jose scale, red, and yellow spider are more plentiful, except, perhaps, in Hood River. There is an earlier and more perfect ripening of fruits, especially those of summer and autumn, because of the continual sunshine and dry air. On the other hand, Italian prunes do not attain their full size and best characteristics because of being forced into early maturity. Injuries from hot winds and sun-scald are more frequent. Local influences governed by topography are much more marked in these valleys, making it important that fruit locations be selected with great care. More attention must be given to the special

conditions and natural agencies which contribute to the development of fruit in any location. The rainfall is much less and the atmosphere not nearly so humid so that in some places prune growers may have to resort to irrigation.

The same causes that make the differences in the various valleys make local variations also, and these need always to be taken into consideration by the fruit-grower. There are, for example, all through the state small valleys protected from cold winds and heavy fogs and open to sunshine which produce fruits earlier in the season, and of better quality, than locations not so favored. Elevation ministers to the same effect. Rivers moderate climatic influences somewhat. In general, then, the metes and bounds of latitude are set aside somewhat by local modifications, and the intelligent fruit-grower who chooses his location in accordance with climatic condition, will find in the climate a valuable ally.

SOILS.

Soils and stock are intimately related, but of the latter we shall speak hereafter. Prunes thrive best in a rich, loamy, river bottom soil, as is well demonstrated by the splendid orchards grown on that soil in Douglas county. The second best soil is the black loam of the valleys, always provided that it is well drained. At present, most of the Willamette Valley orchards are in this soil, and better ones can hardly be produced, when other conditions are proper. The red lands are third in the list of soils, but as to whether they are desirable is yet to be determined. Great care in selecting locations on red lands must be taken in regard to depth of soil. One of the grievous mistakes made by planters all through Western Oregon is that of planting on shallow soils. This is especially true on the red lands. The minimum depth of soils for prunes is four feet, and as much deeper than that as possible is desirable. Fine prunes are grown on granite soils, but these soils are not lasting and must be irrigated if best results are to be had. The above claims for the various soils are not arbitrary. In fact, location, drainage, and depth of soil have almost as much to do with prune growing as does the kind of soil. It must be remembered that there are infinite gradations between the various soils.

The prune tree is a gross feeder, its limbs growing often-

times several feet in one season, so whatever the soil, it must be rich. On the other hand a soil may be too rich, producing a weak, watery growth not at all desirable. Prunes contain a large amount of water so that it is necessary to have a soil somewhat retentive of moisture, and also one that can be thoroughly tilled, that being essential to proper conservation of moisture. But, as before stated, the land for prunes must be thoroughly drained. This is to be emphasized at all times since one of the great faults of the prune orchards of Oregon is that they are not on properly drained land. Briefly, the ideal soil for a prune orchard is: a rich, sandy loam, warm, mellow and deep, containing sufficient vegetable humus to give lightness and retain moisture without being damp and heavy, and having good natural or artificial drainage. The character of the soil is not to be determined by surface appearance but by thorough examination.

Procuring Trees.

Oregon is well supplied with good nurseries and a grower can get first-class trees, but many hardly know what they want. One of the chief complaints among the prune growers is in regard to young trees. Procuring trees is so largely a matter of business and good judgement, that anything which any one aside from the buyer could say would be of little value, but a word or two in a general way will be proper here. Patronize the nearest reputable nursery-men, endeavoring to get stock at a low price, but not purchasing simply because of cheapness. Buy only first-class trees, one or two years from the bud, having as an ideal, trees of medium size, with straight, stocky, hard growth; clean trunks; free from borers, insects and injuries; and a perfect union of stock and scion. Have your trees shipped as soon as they can be easily dug, and set them as soon as possible, having the ground in the best condition. Buy only varieties which show the greatest adaptability to your particular location, a point which seems trite, but which nevertheless is not always observed. Varieties in unsuitable locations and mixed orchards are such common faults that particular attention is called to the fact, that only those you know will do well should be planted.

Stocks.

Prunes can be and at one time were grown on their own roots, but their habit of sending up suckers condemned this

practice. Peach roots were next adopted as a stock upon which to grow them, but in nearly all prune and plum growing regions, excepting the Pacific Northwest, the peach was discarded for the myrobolan plum chiefly; but recently, because it is said to sucker, to dwarf the scion, and to be hard to propagate from cuttings in quantities, the myrobolan has fallen somewhat in disfavor, and the Marianna takes its place in popular favor. The writer is satisfied that peach stocks have been used too commonly in Oregon and that the poor orchards on the heavy, cold, damp soils are largely attributable to the fact that peach stocks were used.

In the prune bulletin issued last year, information concerning any orchards growing on myrobolan or Marianna stocks was asked for. Several letters came telling of experiences with these stocks. I have been able also to visit some orchards having trees growing on myrobolan and Marianna roots. After a careful study of the question in the orchard and from the experience of others I present the following in regard to the relative merits of peach, myrobolan, and Marianna stocks.

The peach is not desirable in Oregon because there are few soils in the state upon which peaches will thrive; peach roots require better drainage than can commonly be given in Oregon; peach stocks are grown from seeds and as each seed produces a tree different from every other one in habit of growth and vigor it follows that the stocks vary in their capacity to develop a good prune tree. Pits for stocks are obtained from fruits too poor for market and hence always have a tendency to degenerate; prunes do not always take well on peach roots and must often be double "worked;" peach stocks are quite susceptible to borers and to diseases so that a prune on peach stock has a precarious and often a short life. In general, then, peach stocks should be used only when a prune orchard is to be set on a strikingly good peach soil.

From the experience of some of our nurserymen and the descriptions given of their myrobolan and Marianna stocks, I fear that in our state the two varieties are sadly mixed, and so before discussing their relative merits as stocks it may be well to distinguish between them.

In his work upon native plums,* Prof. L. H. Bailey, who

*Bulletin 38, Cornell University Agricultural Experiment Station.

has probably given the subject more study than any other horticulturist or botanist, says that the myrobolan belongs to *Prunus cerasifera* and that "the Marianna is either the same species or a hybrid between it and some American plum, possibly the Wild Goose." The following are descriptions of the myrobolan and the Marianna plums,—of the myrobolan as typified by the variety, De Caradeuc,—taken from Bailey.*

"De Caradeuc.—(myrobolan.) Rather large (1 to 1¼ in. in diameter), globular, deep dull purple red when ripe with a prominently colored suture but yellowish green splashed with red when it first becomes edible: flesh thin, very juicy and sweet: cling, the stone rounded ovate, rather turgid, scarcely pointed and evenly pitted; leaves rather firm, ovate oblong. Early. In central New York it ripens from the first to the middle of August (a little later at the Oregon Experiment Station. U. P. H.) Tree, an erect grower.

Marianna.—Large, round, oblong; short stemmed as compared with the De Caradeuc, bright red and finely speckled and covered with a thin bloom; flesh soft and sweet, juicy; semi-cling, the stone like that of De Caradeuc; flowers small, sessile on short stalks in dense lateral clusters like the native varieties, the calyx lobes, narrow and erect; leaves much as in De Caradeuc; a little later than De Caradeuc, but ripens before the Wild Goose. Tree a very spreading grower. C "

It must be remembered that both myrobolan and Marianna as seedlings vary much. The relative merits of the two plums as stocks can only be determined by longer experience. In the past, myrobolan has been mostly used and is to my mind much superior to the peach. Just now, however, there seems to be a well founded opinion that the Marianna is better than the myrobolan for the reasons that it does not dwarf the tree, seedlings do not vary so much, it does not sucker as much as the myrobolan, unites with all varieties while the myrobolan does not, and lastly the cuttings of Marianna root much easier than those of the myrobolan, a point of much importance since properly all stocks should be propagated from cuttings. The indiscriminate use of variable seedlings is to be condemned, as much of the trouble with stocks can be laid to this cause. In this connection it is well to say that in setting stocks from cuttings if uniform results are to be obtained, particular strains should be used and not anything that may happen to be on hand. It is claimed by those favoring the seedlings that the roots formed from cuttings are weak and in the end make a poor root system and

*Bulletin 38, Cornell University Agricultural Experiment Station.

that oftentimes cuttings are diseased in the roots while seedlings are almost universally healthy. Theoretically there are no reasons why a tree from a cutting is not as good as one from a seed, and it is not at all hard to find good thrifty orchards that have been so grown. It is said that most of the myrobalan stocks in California are grown from cuttings.

Fruit-growers often want to grow their own stocks. For such as may want to grow them from cuttings the following method is advised. Nurserymen usually have their own ways of growing them. Cuttings should be taken before the sap begins running in the spring from well ripened wood of the previous year's growth. They should be from six to ten inches long, two-thirds of the length to go in the ground. The soil best adapted for growing them is a good rich loam, well drained and yet always moist as tender roots die quickly in dry ground. The cultivation should be that usually given to seedlings or tender plants just starting to grow.

We advise any one contemplating putting out a prune orchard to thoroughly look into the matter of stocks. Many grievous mistakes have already been made in selecting trees with peach roots. Longer experience will determine the relative value of myrobalan and Marianna stocks just as it has determined their superiority to the peach.

Draining and Subsoiling.

The notion seems to prevail in Oregon that land does not need to be drained for prunes. At least in the hundreds of orchards in the state there are hardly a score that have been drained. With drainage as with fertilization people have the erroneous opinion that a prune orchard can get along without it. To be sure we have a great deal of naturally well drained soil upon which it would be useless to spend money in laying drains, but in the major part of our prune orchards the character of the land is such that water is held in the soil until evaporated from the surface, keeping the soil in such condition that the roots of the trees are injured and proper spring cultivation is absolutely prohibited. The whole trend of the information obtained from prune men in regard to the ills of their orchards points to drainage as one of the first of the great fundamentals of a rational system of prune growing in Oregon. The need of it can hardly

be over-estimated and fruit-growers must come to look upon the lack of it as the direct and indirect cause of a multitude of the ills of their orchards. Let us glance at a few of the things to be gained by good drainage.

The essential mechanical features of good fruit land demand drainage. There must be an ability to get rid of surplus water if any orchard tree is to grow and thrive, even if the water is only over abundant when the tree is dormant. Proper drainage helps to retain moisture in the dry season, since, if soil has too much water it becomes puddled, then bakes, and sun and wind quickly evaporates all moisture from it. Well drained land is warmer in spring and fall because of not having the cooler water in it; it is cooler in the heat of summer, when proper root growth demands an amount of moisture, coolness, and circulation of air, that can not be had in a baked, parched, soil. A boggy, miry condition of the soil prohibits cultivation often times when it should be given, and so hinders good tillage. Good drainage makes available plant food that is otherwise lost. By allowing a free passage of currents of air, carrying with them rich substances, in the atmosphere, it helps to fertilize a soil. There are still other conditions, which added to these, make underdrainage, as a rule, absolutely necessary in our prune orchards.

We give the following brief directions in regard to the construction of underdrains. Information is easily available from other sources so we need not go very deep into the subject in this connection. Size of tile varies with the amount of water to be carried off, though in Oregon they should never be smaller than three inches because of the great amount of water to be carried off at certain seasons; a row of tile to every two rows of trees would be a good rule thus making the drains 36, 40, or 44 feet apart; the proper depth is, on most lands, about three feet; tile can be as well laid at one time as another provided the ground is soft from the rains; a surveyor should always be employed to run the levels, otherwise the system is almost be unevenly laid. Good burned drain tiles can be obtained in almost all parts of the state and should be used even though the planter lives at some distance from the factory, as open ditches, cobblestones, mole drains, or any cheap substitute is but a temporary makeshift.

In Eastern Oregon dynamite is being used to a limited extent as a means of breaking the hard-pan so that the water can drain through. I believe the method is not an unqualified success both because of expense and inefficiency. On alkali soils, to allow the alkali to be carried downward the same method has been used with a show of success.

Intimately connected with drainage is subsoiling. What has been said about the necessity of drainage largely applies to subsoiling. It is a peculiarity of Oregon soils that you cannot judge the subsoil with any certainty whatever from the surface, nor can you infer that the same subsoil extends for any great distance under the same surface soil. Conditions vary so that every fruit-grower should examine his soil in several places and judge for himself whether any part of his orchard needs subsoiling.

Any soil having an open porous subsoil cannot be benefitted by having the soil made more open. But any soil upon which water stands, or runs off, having a subsoil that is at all compact, and to any great degree impervious to water, ought to be subsoiled. Oftentimes deep plowing will help to accomplish this object. But generally an implement which can be pulled through this compact soil, breaking and loosening it up, must be used. The nature of the soil determines the depth of subsoiling.

Like drainage, subsoiling tends to dispose of surplus water, allowing it to filter through the hard-pan, and also helps to retain it in a dry season, since the water sinks lower in the ground and is not so easily evaporated, but rises gradually by capillary attraction. The act of subsoiling tends at first to dry out a soil, and unless a rain follows before crops are put in may in this way be for a time injurious. Therefore, subsoiling ought to be done sometime before a crop is planted that the soil may contain the proper amount of moisture. The after-cultivation of land that has been subsoiled should be as shallow as possible, thus by mulching the evaporation is checked and moisture is retained. Such cultivation should be frequent and long continued.

Setting Trees.

There are a few points about setting trees which need emphasizing. It is obvious, first of all, that the rows must be straight. Any man with ingenuity and a "good eye" can secure this result. So far as trimming trees before planting is concerned,

it is advisable to cut away all roots which are broken and injured, since a smooth wound will heal more quickly than a ragged one. Roots of inordinate length may of course be cut back to make a symmetrical root system. When a tree is dug, half of the fibrous roots are left in the ground; the top, therefore, ought to be cut back a corresponding amount, or more, since it will require some time for the roots to resume vital activities. Trees not so trimmed often fail to grow at all, or if they do start, are, in their weak condition, destroyed by drouths or pests.

The following rules for tree planting are always in order. The soil should be well firmed about the roots of trees; the roots straightened out in approximately their natural position; the hole should be large and roomy; the earth fine and dry enough to crumble; the tree to be set a little deeper in the soil than it stood in the nursery row; the roots of the tree must not be long uncovered; and every care must be taken to get the tree in its natural environment as quickly as possible. If the operation of tree planting is to be perfect these details must be observed.

Distance Apart.

It is almost a universal fault throughout the state for prune growers to plant their trees too close together. The shrewd growers are convinced of this and will tell you not to plant less than twenty-two feet apart. The Petite prune, perhaps, may be well grown at twenty feet. Trees are gross feeders and need plenty of room. Additional reasons for a greater distance apart are, that it allows of better cultivation, enables you to spray more easily, and it will give you a well formed, strong tree with an individuality of its own.

Cultivation.

The most widespread, and the most serious fault of Oregon prune orchards is *neglect*. Commonest among the many things neglected, is neglect in tillage. It must be said that prune orchards in general yield so abundantly without tillage that it is not to be much wondered at that the prune growers think they do not need tillage. Every orchard is so greatly influenced by special soils and conditions in which it grows that it is hard to attribute the behavior of an individual orchard to either tillage or the lack of tillage. But if a man thinks for a moment of the

obvious effects of tillage upon any crop in the soil he will admit that cultivation is essential to any rational system of horticulture. Corn, potatoes, vegetables, all annual crops demand cultivation. Berries and fruits do not differ from vegetables in any of their activities of life, and that which benefits them must be as useful to these. Cultivation must be judicious or grievous damage to an orchard may result. There are underlying principles of the operation which must be interpreted with considerable skill if cultivation is successfully done. Just what proper cultivation is, must be determined by every man, for every farm, and for every season. Only general principles can be given and a few of these are as follows. All young orchards should be given perfectly clean cultivation. All through the state there are young orchards smothered in weeds the owner thinking it not necessary to cultivate until the trees begin to bear. *It is necessary to cultivate the first year* so that the trees may be rightly started and the roots sent deep enough into the soil to escape the plow and cultivator in future years. As the orchard comes into bearing, the cultivation, perhaps, need not be so thorough, the orchard itself, in its wood and fruit, being the indicator of the treatment needed.

Figures 1 and 2 show very strikingly the difference at six years of age between an orchard that has been cultivated from the start and one in which the owner thought it unnecessary to cultivate until the trees came in bearing. The orchards are of the same variety; the soil is identical; the orchards are in neighboring fields, and were planted under the same conditions and at the same time. The orchard shown in Fig. 1 has been plowed each spring and cultivated fortnightly until August. The orchard in Fig. 2 has been plowed in the spring and cultivated once or twice, occasionally three times, during the season.

Usually, sowed crops should be avoided in an orchard, since they forbid all chance of cultivation and use up plant food and moisture that should go to the trees. Occasionally, on an extremely rich soil, an orchard may be brought in bearing by sowing a crop of grain in it. There are no objections to growing hoed crops or small fruits in a young orchard, but the land must be well tilled and well fed, and it must be stopped when the trees comes in bearing as there is but little land that can be

PLATE II, SHOWING NEGLECTED ORCHARD.

worked on the share system;—a good yield of fruit and of another crop at the same time.

Cultivation should begin as early in the season as possible and should be given *frequently* thereafter until the time to cease comes, which, in this climate, is the middle of July or the first of August, this always to be governed by the growth the tree is making. Early cultivation is important since it warms up the soil, puts it in good mechanical condition, kills the sprouting herbage, and enables the trees to get quickly at work. Cultivation should stop as soon as the orchard has completed the desired growth so that the trees can ripen and harden their wood for the winter.

We are not sure but at this time a *catch crop* of rye, crimson clover, or some other quick growing plant might not be grown to advantage, to be plowed under in the spring. The merit of such a course would be that the unsightly crop of weeds which springs up after the summer's cultivation is finished, scattering its seeds to the four winds, certainly poor husbandry, would be destroyed; more important than this the mechanical condition of the soil would be greatly improved since it would keep it from running into a puddled mass in the winter, would dry it out more quickly in the the spring, and add very greatly to the vegetable matter of the soil. It would also aid in ripening the wood of the trees. This matter is only a suggestion, however, to be thought over by the grower. The practice is becoming a favorite one with Eastern orchardists and is recommended by Eastern writers.

In a young orchard it is advisable to plow the land each spring for several years. The after-cultivation should be with an implement, which with the minimum expenditure of time and labor will destroy weeds and keep the surface soil loose and friable. There are so many good implements that there need be no trouble in finding one suitable for any purpose. Disk harrows, spring-tooth harrows, clod-crushers, smoothing harrows, weeders, and cultivators all have their places. The reversible disk harrow, we find, is a favorite implement with many Oregon fruit-growers. The frequency with which one should cultivate, depends upon the soil, season, and purpose. Cultivating once a week some seasons is not too often especially if its object is to conserve the moisture. A crust should never be allowed to form

or weeds to become established. The soil should always be left soft and fine if the fresh and grateful effects of a mulch are to be obtained; when left in this condition the roots are enabled to reach every portion of the soil, thus utilizing a maximum amount of plant food much of which otherwise might remain unavailable. An implement should be used which will allow of working close to trees so that high pruning need not be encouraged on account of close working.

Pruning.

Prune trees, generally, have been fairly well pruned in Oregon. It is an operation not at all difficult to learn since the advice given in horticultural books is plain and generally good. Opinions differ as to what the ideal tree after pruning should be. The consensus of opinion of the best growers, as we conceive it, would favor a tree about as follows: A medium, low, roundish, symmetrical top, upon which the fruit can be readily thinned and picked, the tree easily sprayed, and upon which there are strong branches, that will not break with a load of fruit, and that will shelter the stem from the sun. Such a tree will be vigorous, and long lived. While failures are not often caused by neglect in pruning yet they are aggravated by it, and the experience given from all sources presses home in the most convincing way the fact that careful and thorough pruning has much to do with the success of a prune orchard. A man of good judgment will not adopt arbitrary rules for pruning, but the following hints, may be of value to him.

In forming the head the branches should be distributed upon the different sides of the stock as much as possible. It should be formed by selecting several branches well distributed along the stem for a distance of one foot down from the top and pointing in such a way that the head becomes well balanced and symmetrical. The strongest upright branch should be left as the leading shoot and be so trained that other branches can be given off from it. Side branches should be well cut back.

After the head is formed an annual pruning should be given though branches or shoots out of place ought to be removed as soon as discovered. In Oregon, prune growers consider late winter the best time to prune, but the work can be done any time after the wood has thoroughly ripened and before the buds start

in the spring. It is an almost universal fault in a prune orchard to find too much wood. There ought to be just so much wood with so much fruit, to secure which, you may either head back or thin out branches. If headed back, the cut should be made above a bud growing on the upper side of a limb so that the new branch will take a natural upward and oblique position, making a broad, strong branch with great weight bearing power. Be prudent in thinning out the branches of a prune tree as a tree will support many branches, having a tendency to "open up" as the branches become loaded with fruit. Crotches should be avoided, as when two branches of equal size form a crotch it is almost certain that one of them will break.

A pair of pruning shears or a sharp pruning knife is sufficient to do all the pruning needed if the work is undertaken in time. The use of a saw is to be discouraged though it is frequently a necessary evil. In making a cut no projecting spur should be left and the wound should be as small as possible, care being taken not to tear or injure the bark. The cut should always have a good slant. Whenever a wound is made with so great a diameter that it will not grow over in one season, it should be painted with something to keep the wood from checking and rotting. Shellac dissolved in alcohol is good, or ordinary paint may be used. To prune intelligently the habit of growth of the tree, whether upright, spreading, or close growing, should be studied. In fact, in practice, it will be found necessary to give every variety of fruit a little different treatment.

Thinning the Fruit.

One of the striking facts in regard to profits in growing prunes, is the much greater net profit in growing prunes of a large size. Net profits are almost doubled by an increase in size. The question as to why prune growers do not *thin* their fruit and get large prunes is constantly suggesting itself. In looking over the records of the Survey taken last year I do not find a dozen men who practice thinning their prunes other than by reducing the wood of the tree by pruning. The best prunes cannot be grown on overloaded trees. The quantity of fruit in bushels will be the same on a tree whether the fruit is thinned or not, and you have for the trouble of thinning a hand-

somer and much more valuable product. Thinning requires considerable work, but if systematically done it resolves itself in a simple job, and, at any rate, the fruit must be picked sooner or later and the work done in June and July saves just so much work when the crop ripens. From this standpoint, then, it is an extremely shortsighted policy not to thin fruit, but there is another factor which makes the operation still more important.

On trees that have had their fruit thinned there are, of course, many less pits, the large fruits being mostly watery flesh. For the formation of the excessive number of pits in the fruits on unthinned trees it requires a much greater quantity of the mineral elements of the soil and since these are the elements most apt to be wanting and most difficult to obtain it is obvious that the growth of a tree, overloaded with fruit, is checked, its vitality weakened, and in the end productiveness lessened.

During most seasons, on overloaded trees, much of the fruit drops. Had this fruit been taken off at the proper time there would have been a much less strain upon the tree. If properly thinned, the danger from "brown rot" or "plum rot," which has shown itself in the state and which threatens to do considerable damage, will not be so great, since the disease is communicated from fruit to fruit, hence will be worst where the fruit is thickest.

The thinning can be best done when the prunes are about the size of the end of one's thumb, though no set rule can be given for the operation. The quantity removed must vary with the size, and vigor of the tree, the variety, and the way in which the tree has been pruned. When the work is done the fruit should be evenly distributed over the tree, making due allowance for the size and strength of the various branches. With a little experience a tree can be very easily thinned, the prunes being pulled off by handfuls. The work is much facilitated if the tree has been well pruned, since pruning reduces the necessity and makes it easier to get at the fruit on the tree.

Pollination of Prunes.

Within recent years the importance of cross-pollination for some fruits has been clearly demonstrated by several scientific workers. The matter was first brought prominently before horticulturists by Waite* of the Agricultural Department at

*M. B. Waite, U. S. Dept. Agrl., 5th Div. Path.

Washington in his bulletin on the pollination of pear flowers in which he proved that "many of the common varieties of pears require cross-pollination, being partially or wholly incapable of setting fruit when limited to their own pollen." He also noted that some varieties of apples were sterile to their own pollen. Beach† of the New York Experiment Station found that some of the varieties of grapes need cross-pollination. Of more interest to prune growers are the statements of Bailey‡ of Cornell and the work of Waugh§ of Vermont. The former says that some of our varieties of native plums are not fertile with themselves, and that the "infertility is due to comparative impotency of pollen upon flowers of the same variety rather than to any structural imperfection in the flowers themselves," and that "this infertility is avoided by mixed planting, by means of which foreign pollen is supplied to the impotent varieties." Waugh found that "cross-pollination in plums is provided for by several natural adaptations, especially by the defectiveness of flower parts and by the sterility of certain varieties toward their own pollen." All of this leads up to the question as to whether our prunes, especially the Italian which sets fruit so poorly, would not be benefitted by cross-pollination.

It is a matter of common observation that the Italian for some cause or other, is, in certain locations, or in certain seasons, or under peculiar climatic conditions, a shy bearer. There are reports among fruit-growers that solid blocks of Italians fail to set fruit while in the same locality those in mixed orchards set a full crop. Such reports are not well substantiated, but their being current lends color to the view that cross-pollination, secured by mixed planting, would benefit that variety. Plans were on foot at the Station this spring to determine as far as possible the cause of the variability of the Italian in setting its fruit, but the entire failure of the crop frustrated all plans. The matter is of considerable interest to large growers of prunes and any data or information bearing upon the subject should be given to the public.

†S. A. Beach, N. Y. State Station Rpt. 1892. Self Pollination of the Grape.

‡L. H. Bailey, Cornell Expt. Sta. Bul. 38, Cultivated Native Plums.

§F. A. Waugh, Vermont Expt Sta. Bul. 53, Pollination of Plums.

II. Varieties of Prunes*.

t present there are but three varieties of prunes largely grown in Oregon: the Italian or Fellenberg, the Petite or French or Robe de Sargent, and the Silver or Coe's Golden Drop. By far the major part of these are Italians the Petites being second. Most of the other varieties now grown are sold, when cured, as one or another of these three varieties. All black prunes are sold as Italians; amber ones as Petites; and light colored ones as the Silver. The Italian is the great commercial plum of the Northwest for the reason that it thrives best and because its flavor and large size, as grown in Oregon, enables it to command a slightly better price than the Petite, the commonly accepted standard prune. In good locations, as in the Umpqua and Rogue River valleys, the Petite is largely grown and proves to be a more regular and prolific bearer than the Italian. But in growing the Petite we must enter in direct competition with California which at present is a little to our disadvantage. The Silver when well cured and of

*The distinction between plums and prunes is, that prunes can be successfully cured without removing the pits, the product being firm, sweet and long keeping. There is much confusion in horticultural literature regarding the nomenclature of prunes; nearly all of our prunes are known, by different names, in the East as plums.

large size, sells for a larger price than either the Italian or the Petite, but it is difficult to grow, hard to cure, and must be bleached; these qualities forbid its being extensively grown.

It must not be inferred that our wants are sufficiently well supplied by the three varieties named above and that there is no need of new varieties. Prune growers are not at all satisfied with the standard prunes now grown, as all of them have bad qualities which are serious drawbacks to their being put upon the market with the highest degree of success. There is a broad field for the introduction of better varieties. This is not strange since the prune industry in Oregon is but a few years old, and since, as a rule, the best varieties of fruits for any locality originate in that locality. We may then look forward to the time when the Italian and Petite will have been relegated to old orchards, and new varieties, natives of the Northwest, will have taken their places. We already have one or two new varieties that promise to equal or surpass our favorite Italian, and if their good qualities do not prove to have been overestimated it is to be hoped their supremacy will soon be established.

In the following descriptions I have included most of the prunes that have been tried in the state, and some that have not, but which, because of their merits in California, we might well try. All prune growers are urged to establish an experimental plot upon which new varieties may be tried. We shall, then, in the course of a few years, be able to profit by our mutual experiences, and the general approval of certain varieties will simply mark the survival of the fittest.

Much valuable information regarding varieties has been obtained from files of the Rural Northwest*. In writing descriptions of some of the older varieties I have freely consulted Wickson† and Downing‡. Special attention has been given to seedlings that have originated in the Northwest, and it is hoped that the descriptions and historical sketches are in the highest degree accurate. The cuts are mostly of old varieties and are from life and photographs. They are inserted chiefly that better comparisons may be made.

*Published in Portland, Oregon, H. M. Williamson, Editor.

†Downing's Fruits and Fruit Trees of America, Edition of 1888.

‡Wickson's California Fruits, Dewey & Co., San Francisco, Calif.

Description of Varieties.

THE ITALIAN PRUNE.—*Fellenberg, German Prune, Swiss Prune:*—Medium size or large, roundish but tapering at both ends; suture small but distinct; color, dark purple with a heavy bluish bloom; stalk, 1 inch long; cavity, shallow; flesh, yellowish green, juicy, parting easily from the stone; flavor, sweetish, sub-acid, delicious; tree, hardy, vigorous, very productive; rather late. It is not known where the Italian prune originated, but it has been grown in Italy for a long time, where it finds great favor in the fresh state.

The Italian is at present the leading prune in the Northwest, probably more than four-fifths of the trees in this section being of this variety. Its merits are superiority in size and quality to any other prune grown and superiority in productiveness to all excepting the Petite. When cured it is much larger than the Petite and its sprightly acid flavor makes it more agreeable to the taste for most people. The quality of the Italian prune is such that it bids fair to create a special market for itself, and since it can be well grown only in the Northwest, possibly when better known to consumers it may command a premium in the markets over other standard prunes.

The dried prune is black or bluish black in color and much larger than the Petite or French prune produced in California. Properly cured it has a most agreeable sub-acid flavor. The flesh is so firm that the fruit cures well and after being cured keeps well. The largest sizes of the Italian prune make a most beautiful product and will always bring good prices from customers who buy from appearance as well as quality.

The Italian prune as a plum has been known in the United States for many years. We are indebted to the Rural Northwest for the following regarding its history in Oregon. "The Italian

prune was first propagated in Oregon about 1857. Mr. Seth Lewelling and the late Henry Miller, both of whom were then engaged in the nursery business at Milwaukie, Oregon, imported Italian stock about that date from Ellwanger and Barry, Rochester, N. Y. So there is a difference of opinion as to which of these gentlemen has the honor of being the first to introduce the Italian."

The Italian prune in the East, or Fellenberg plum as it is known there, has long been considered difficult to grow well. To the contrary, in the Northwest it has been considered quite easy to grow the tree well. But since the Italian prune orchards planted so abundantly a few years ago have come in bearing it is found that it is a comparatively hard matter to grow a good orchard of them. They seem quite susceptible to changes in climatic conditions, are particular about soil, and are preyed upon by diseases and insects to a greater extent than most varieties. This year nearly every Italian prune tree in Oregon has suffered from the curling and withering of the leaves due to causes to be discussed hereafter. All other varieties were in the main exempt from this trouble. This curl-leaf has been present but not prevalent in past years. If in the future it should prove as injurious, and no means be found to stop it, the reputation of the variety as a standard prune for the Northwest, will be greatly endangered.

PETITE PRUNE.—*Prune d' Agen, French prune, Prune d' Ente, Lot d' Ente and Robe de Sergent.*—The fruit as grown in Oregon may be described as follows: Medium sized or small, oval or egg shaped, not uniformly pyriform; suture, small, distinct; color, violet purple with bright colored bloom; stem, short, slender; cavity, small, and shallow; flesh, greenish yellow, sweet, full of sugar, rich and delicious, clinging slightly to the stone. Tree, hardy, strong grower, very productive.

This is the prune most widely grown in the great prune

growing countries, the favorite in the markets, and is mostly known as Prune d' Agen, excepting in the Northwest where it is always called the Petite. There are several sub-varieties which differ from the Petite chiefly in size and shape; few, if any, of these sub-varieties are known in Oregon, the differences in the Petite as found here being due to differences in conditions. It is probably true that the Petite as we know it is superior to any of its congeners. Prune nomenclature is further confused through the giving of the name Robe de Sergent as a synonym for the Petite. The two are much alike and the writer is not sure but what they are the same, at least there is not more difference than there is between the Petite and some of its sub-varieties. The Petite came to California from France about 1856.

We take the following from a prune number of the Rural Northwest regarding its history. "The origin of the prune is unknown. Tradition in France is to the effect that it was introduced into that country by the monks of the Abbey of Clairac near Tonneins. From their gardens it spread into the valleys of the Garonne and Lot. Owing to the recognized value of this variety it was largely propagated by grafting and thus acquired the name "Prune d' ente," which signifies the grafted prune. By far the greater part of the prunes cured in France are of this variety." The Petite was introduced into California by Louis Pellier from Agen, hence is often called the Prune of Agen, Prune d' Agen. It derives its name, Petite, from the fact that Pond's Seedling was introduced into California about the same time and was thought to come from Agen. To distinguish them one was called the Petite, or small prune, and the other the Grosse or large prune. The name Petite still clings to the former, but the latter is commonly known, on the Pacific Coast, as the Hungarian prune. Since it came from France the Petite is often called the French prune. Robe de Sergent is one of its French names.

The Petite is smaller than most other varieties of prunes, but has a larger proportion of solids and so shrinks less in curing, thus partly making up for deficiency in size. Its special good qualities are, its wonderful productiveness, vigor of the tree, ease with which the fruit can be cured, small shrinkage in curing and the surety with which it yields a crop. One of its chief

defects is its lack of acid which gives it an insipid flavor, though its insipid sweetness recommends it to many. It is of but little value in the fresh state,—in fact is not marketable except as a cured product.

The Petite needs for its best development a warm, rather dry climate, and a rather light, rich, loamy, soil. In Oregon these conditions only prevail in Josephine, Jackson, and part of Douglas county, and in Eastern Oregon along the Snake river and some of its tributaries. Unless grown to a large size the Petite in its cured state is in demand only as a cheap product. The largest sizes, if well cured, will always be in demand as a somewhat fancy product.

SILVER PRUNE.—*Coe's Golden Drop*.—Size, large, oval or roundish; suture, distinct, one side abnormally large oftentimes, necked; color, light yellow in the sun, dotted with small red spots; stalk, stout, nearly one inch long; flesh, yellow, juicy, firm, adhering slightly to a very pointed stone; flavor, rich, sugary, good quality; tree, a precarious grower, but very productive when all conditions are favorable; season, late.

The variety originated with a Mr. Coe in England in the early part of this century and received the name of Coe's Golden Drop. A few years ago it was introduced in the Northwest as a new variety, the Silver, a supposed seedling. Much discussion was engendered because of the close resemblance to Coe's Golden Drop, and finally led to the appointment of a committee from the State Horticultural Society to investigate the matter. The investigating committee reported that the seedling Silver prune tree was a grafted Coe's Golden Drop plum.

The fruit in the fresh state is large and beautiful and of delicious flavor. The cured product is larger than that of any other variety, ranging in size from 15 to 30 to the pound.

The prune has a very agreeable sub-acid flavor and is much esteemed where ever known. Notwithstanding the size of the fresh fruit the proportion of sugars and solids is fairly large. Unfortunately public taste demands that a white prune be sulphured, which proves injurious to the flavor so that the quality of the Silver prune as commonly found in the market is generally not so good as the unsulphured product.

The tree in Oregon requires the very best attention and in fact cannot be grown except under most favorable conditions. Good prune soil, good drainage, attention in pruning, cultivation, and pests, are requisites that must be well looked after in order to succeed with the Silver prune. When the fruit sets well on the trees, the crop must be thinned in order to get prunes sufficiently large to make them of value, and to avoid the danger of broken limbs because of too great a load.

The Silver prune cannot be produced cheaply enough to compete successfully with the low priced prunes, but as a fancy product it will always be in demand. It will, therefore, be found a very profitable variety to grow if one has a location highly favorable to the growth of the trees, and will give them the extra care needed to produce a crop of large prunes, and lastly will give them special attention in curing.

The following taken from a letter written by Mr. W. H. Prettyman, of Mount Tabor, Oregon, tells of the introduction of the variety in the Northwest. It is possible that the so-called Silver is a seedling from Coe's Golden Drop, but if true, the resemblance is so very close to the parent that it serves no purpose, and only multiplies names to distinguish between the two.

"The Silver prune was first discovered in the orchard of Mr. A. L. Alderman, of Dayton, Yamhill, Co., Oregon, by Messrs. Plummer and Spaulding of the Plummer Fruit Evaporator Company. These gentlemen called my attention to it afterwards, got control of the stock, named it the Silver, and engaged me to propagate it. I propagated as many of them as I could for a number of years, but the supply never equaled the demand, the variety being very popular in California. The Silver has proved to be one of the best prunes in quality and leads all others in market value by from one to two cents per pound. The tree is a rapid grower and a very heavy bearer, the latter quality making it short lived unless good care is given and the fruit well thinned."

In Wickson's "California Fruits," Mr. Prettyman is quoted as saying, "The Silver is a seedling from Coe's Golden Drop, which it much resembles,

but it is much more productive ; one tree of Silver prune produces more fruit than five of Coe's Golden Drop."

REINE CLAUDE—*Green Gage*.—Fruit, small and round ; suture, not well marked, but showing from stalk to apex ; color, yellowish green, sometimes, or in the sun or at maturity, slightly marbled with red ; stalk, short and slender and inserted in a shallow cavity ; flesh, yellowish green, free, juicy, melting ; flavor, delicious, mildly acid, sweetish, unsurpassed. Tree of low, slow growing spreading habit ; very productive.

The nomenclature of this variety is somewhat mixed from the fact that the trees come fairly

true from the seeds, and that there have thus been propagated several varieties very closely resembling the Reine Claude. There is much discussion as to whether our Reine Claude is the Green Gage plum of the East. The writer feels sure that those he has seen in Oregon are the same. For a prune in the fresh

state we have no superior, in flavor, to the Reine Claude. In fact wherever it is known it is universally admitted that it has no equal in quality. The Reine Claude should rank equally high as a prune if properly cured. As yet there are but few who have tried to evaporate them in Oregon, but those who have done so pronounce them the most delicious of any of our prunes, claiming that they are equal to choice figs and raisins. The prune if bleached is bright golden, but if not is a dark amber in color.

YELLOW EGG.—*White Egg*, *Magnum Bonum*.—Large, oval, tapering at both ends ; suture, very prominent ; stalk about an inch long and inserted in a very shallow cavity having a fluted border ; flesh, when ripe, of deep

golden color, dotted with white dots and covered with a thin white bloom; flesh, yellow, clingstone, juicy, quality rather poor, sub-acid or sweetish, coarse grained. Tree fairly vigorous and fairly productive. Chiefly desirable on account of the splendid appearance of the fruit.

GERMAN PRUNE.—A name applied to several varieties of plums and prunes, the name representing a class rather than a variety since the tree comes fairly true from seed. The German prune is a great favorite in Central Europe because of its being easy to propagate and grow. It is an abundant bearer and of fair quality and easy to cure. When prune orchards were first started in Oregon a good many trees of this variety were planted, but because of their being so similar to the Italian, but not equal to it in quality or size, they are not largely planted now.

Fruit, medium size, long, oval, tapering at the ends, swollen on one side; suture very distinct, color, dark purple with a thick blue bloom; stalk, an inch long, slender, inserted in a shallow cavity; flesh, firm and of a greenish color, freestone; flavor good, sub-acid, sweetish. Tree, vigorous and productive. Two weeks earlier than the Italian.

HUNGARIAN. — *Pond's Seedling Grosse Prune d' Agen.*—Fruit, large, oval or ovate, tapering at the stem end, and oftentimes having a divided elevated neck; skin, thick and rich in color, sprinkled with brown dots and covered with a thin white bloom; stalk, stout and of medium length, set in a mamelon neck; flesh, yellow, coarse, juicy; quality, rather poor, sweet, but not rich. Tree, a strong grower and prolific bearer. Season,

two weeks earlier than Italian or about the middle of September.

Introduced into California at an early day and supposed to have come from Agen in France, being contrasted with the Petite Prune d' Agen it was called the Grosse Prune d' Agen. How the name, Hungarian, originated is not known though the variety is best known on the Coast by that name, and so sells in Eastern markets. The plum or prune is of English origin and its true name is Pond's Seedling.

For shipment in the green state the Hungarian is our best prune and is being very largely planted for that purpose, no other prune being as fit as this one for Eastern shipping. Its quality after reaching a distant market is good and its great beauty makes it very desirable in the markets. The trees are vigorous and very productive.

DOSCH.—Hon. Henry E. Dosch, Horticultural commissioner for the 1st district, writes me as follows concerning the prune which bears his name and which originated with him :

"Replying to your favor regarding the Dosch prune ; I beg to say : When I bought my present place, there was an acre of Washington plums grafted on plum roots on the place. On one of these trees grew a sprout which started below the union. The former owner called my attention to it and said that he judged from the dark foliage, large leaves, and immense bud shoulders, that it was a promising seedling, and begged me to leave it. I did so and was agreeably surprised at the beautiful, large, dark purple prunes it yielded.

"Its characteristics are : tree a vigorous, hearty grower, leaves, extra large ; dark purple fruit, covered with a fine light blue plush, and hanging on the tree with great tenacity, shriveling before it will fall off; The prune keeps in good condition three weeks after being picked. When ripe the flesh is a golden green and is very aromatic, semi-freestone. It evaporates 45 lbs. of cured product to 100 lbs. fresh fruit. In flavor it is sweeter than the Italian, but not so sweet as the French. It bears every year and is about ten days earlier than the Italian."

CHAMPION.—Large size, roundish, tapering somewhat at both ends ; suture, well marked ; color, dark purple with reddish bloom ; stalk of medium length rather stout and placed in cavity of medium depth ; flesh, firm, very juicy, parting from the stone easily ; flavor much like the Italian. Trees, very vigorous, healthy, and strong growers. Fruit a month earlier than the Italian. Very productive.

The Champion is one of the most promising of our new prunes for shipping in the fresh state. The vigor of the trees, their productiveness, the size, beauty, quality and earliness of the fruit all recommend it. It is a little too juicy to be very valuable for evaporating. A letter from Mr. C. E. Hoskins following the description of the next variety tells of the origin of the Champion.

WILLAMETTE PRUNE.—A dark ruddy brown prune of the Italian type. Said to be some larger than the Italian, a little sweeter, a little earlier, and to dry heavier. The dried prune is dark much like the Italian. It requires considerable skill in curing. In the fresh state it is hardly surpassed in quality.

One of the most promising of our new varieties. Mr. C. E. Hoskins, of the Springbrook Fruit Farm, Springbrook, Oregon, the introducer of the Willamette and Champion, writes as follows concerning these two varieties:

"Soon after I came to this state eighteen years ago, I visited Mr. Seth Lewelling, of Milwaukee, Or., Mr. S. A. Clark, of Salem, and Mr. Jesse Bullock, of Oswego, to learn all I could about prune growing. While at Mr. Bullock's, I was given scions of seven new seedlings to test. After fruiting them I reported that in my judgment only No. 1 and No. 6. were worth introducing.

"Mr. Bullock named No. 1 Champion and No. 6 Willamette. The Willamette has since been renamed "Pacific." But I know that they are one and the same fruit, and I have now growing as old a grafted tree of this variety as there is in the state.

"As regards the merits of the Champion and Willamette, especially as compared with the Italian, will say, that I would not recommend the Champion for general planting for evaporating. It will bring as good a price, but is hard to evaporate and will not evaporate so heavy by two pounds in one hundred pounds of green fruit. Its great value is its earliness. It ripens from two to three weeks before the Petite or French. The tree is healthy and a good bearer but does best on valley land, the fruit being small on hill or red land.

"In regard to the Willamette will say that I think it is the best new prune that I have fruited. It is from seven to ten days earlier than the French and is as large or larger than the Silver. The tree is very healthy and bears grandly.

"I find that it gives a larger percentage of cured fruit to fresh fruit than the Italian and it is also a good shipper in the green state. It does well on either hill or valley land."

PACIFIC.—Said to have originated at Mt. Tabor, Oregon. It has the general characteristics of the Willamette and is probably, as Mr. Hoskins says, the same. Those who call it a distinct variety, say that it is larger and more juicy than the Willamette, qualities that would recommend it for shipping in the green state, but not for evaporation,

STEPTOE.—Many good reports come from a new prune called the Steptoe. It has not fruited on the Station grounds nor have we seen the fruit. The following is the substance of a letter written by Mr. Geo. Purdy, of Colfax, Wash, a well known nurseryman in Eastern Washington, the introducer of the variety, telling how the variety originated and giving some of its characteristics:

"The Steptoe prune originated with Mr. Calvin Throop, now dead, many

years ago on a farm near Steptoe Butte in the Palouse country. Mr. Throop was one of the old settlers in that country and finding that the trees which he imported from the East did not prove hardy he planted pits and seeds of the various fruits. Among the plums of note thus originated was the Throop and the Steptoe prune. My attention was first called to the Steptoe in 1891 when the trees were probably six or seven years old and had been bearing two or three years. The Steptoe tree is an upright, thrifty, grower, bearing every year. The fruit resembles the Italian very much, but is nearly, if not quite, one-third larger. The Steptoe ripens fully two weeks earlier than the Italian which does not always reach maturity in Eastern Washington. Fruit cured in a steam evaporator was said to be a much finer product than that from the Italian. I am confident that in a climate and soil suited for growing prunes the Steptoe will outrank the Italian in every way. But few of the trees have been distributed as yet.

TENNANT.—A prune of the Italian type, which originated with Rev John Tennant, of Ferndale, Washington. Its most commendable quality is that it ripens much earlier than the Italian, its season being as early as any of our earliest prunes. In Washington it is being planted quite extensively and there are a number of plantations of the Tennant in Oregon. As yet not enough trees have come in bearing in this state so that the variety can be assigned a place.

The following varieties are grown in California, but have not yet been generally introduced into Oregon. Some of them might prove profitable in this state. Descriptions of the first three varieties are taken from Wickson's "California Fruits."

BULGARIAN.—"Fruit, above medium size, almost round, dark purple; sweet and rich with pleasant acid flavor; tree a vigorous grower and an early, regular, and profuse bearer."—*John Rock*. "As prolific a bearer as the Petite prune, but holds its size with a heavy load of fruit much better. The tree is a little more vigorous grower and forms a larger tree and bears its fruit more in the center. Closely resembles the Fellenberg or Italian prune in form and size, but it is not so large. It is rich and sweet when cured. It is not a freestone, but on some soils and in some seasons it has a tendency to loosen from the pit."—*W. H. Jessup*.

ST. MARTIN'S QUETCHE.—"Size, medium, ovate, broadest at base; surface pale yellow often spotted with brown; bloom, white; flesh, yellowish, very juicy, rich, excellent; ripens late and keeps long; tree, hardy and a good bearer; shoots smooth. Approved in Santa Cruz County."

TRAGEDY PRUNE.—"Originated with Mr. Rumyon, near Courtland, Sacramento Co., California. Introduced by W. R. Strong & Co.; appears to be a cross between German prune and Purple Duane; medium size, nearly as large as Duane, and looks much like it, except that it is more elongated; skin, dark purple; flesh, yellowish green, very rich and sweet parts readily from the pit; ripens in June. The first large plum to ripen very fine, and valuable for Eastern shipment."—*L. W. Buck*.

GIANT.—One of Burbank's seedlings. A cross between the Petite and Pond's Seedling or the Hungarian. Fruit large size, larger than Pond's Seedling; in color, dark crimson upon yellow background; flesh, rich yellow; texture, fine; freestone; quality, good, sweet and rich; season about

that of the Petite. Said to be easy to cure and to make a beautiful product. Well worth trying in Oregon.

BRIGNOLE.—The variety used in making the famous Brignole prunes of France. Introduced from Brignole. Medium size, oblong; color pale yellow with a reddish cheek in the sun; flesh, yellowish and of good texture; rich and sweet; cures well. Trees vigorous and productive in California.

DATTE DE HUNGRIE.—The date prune of Hungary. Size, large; skin dark purple, covered with a whitish bloom; flesh, greenish yellow, firm, with a very rich flavor; cures well and makes a good product.

ST. CATHERINE.—Medium size; obovate growing small toward the stem; suture, well marked; stalk, long and slender, inserted in a shallow cavity; color, greenish yellow with thin white bloom, occasionally with a blush on the sunny side; flesh, yellow, moderately firm, juicy, semi-cling; flavor, sub-acid, rich, aromatic, good; season, about that of the Petite—middle of September. Tree, upright, vigorous, prolific.

One of the oldest of our cultivated prunes, not much grown in Oregon, locally popular in

California. In France it is much esteemed and it is greatly used in making a superior product of prunes.

WANGENHEIM.—A variety very popular in Germany now grown to some extent in California. Fruit of medium size, oval; color, dark purple, covered with heavy blue bloom; suture well marked, but shallow; stalk, short and stout; cavity small and shallow; flesh, firm, greenish yellow, juicy, freestone; flavor, good, sugary, rich; season, early, two weeks before

the Petite, or the latter part of August.

III. Curing Prunes.

TO SERVE the present age, adequately expresses the purpose which prompts the writing of this chapter. Curing prunes in Oregon is yet in a state of evolution and anything said about it must be considered tentative and not conclusive. It is only hoped then that the best methods now known are presented in this chapter. Most of the information given has been obtained from successful prune growers of the state and therefore has the merit of being practical.

Our method of curing prunes is peculiar to the Pacific Northwest. In Europe the prunes are cooked in the process of curing; in California they are cured by exposing to the sun and wind; in Oregon and Washington we cure them by evaporating the surplus water from them in evaporators. We have only our own experience to guide us and our own inventions to work with. There is therefore a broad field for the origination of better methods and the invention of better apparatus, so that the process of curing may be cheapened and a better and more uniform product produced.

Definitions.

It takes an intelligent person some time to learn the meaning of the somewhat technical phrases commonly used in the prune industry. We therefore give the definition of those most current. Some of the words defined are colloquialisms, but most of them are common to the trade.

Bleaching.—The process of changing the dark color of prunes to a lighter hue; generally accomplished by sulphuring.

Bloaters. Prunes which in drying swell up to an abnormal size. The swelling is supposed to be caused by fermentation which produces a gas. Bloaters are generally produced from large, soft, overripe prunes.

Dipping.—A process of cleansing and cutting the skin of fresh prunes preparatory to putting in the evaporator, in which the fruit is submerged in boiling lye, made by using one can of concentrated lye to fifteen gallons of water. Cured prunes are also sometimes dipped in glycerin and water,—one pound of glycerin to 20 gallons of water, which improves their appearance and adds

to their weight and keeping qualities.

Drip.—The syrupy liquid which oozes from prunes in the process of curing; it generally characterizes a poor prune or a poor evaporator. As a verb, the falling of the drip.

Extras.—A superior quality of prunes; generally referring to size.

Frogs.—Small, poorly developed prunes having an abnormal shape. Not a synonym of bloaters. Supposed to be caused by unripe fruit, poor soil, or any unhealthy conditions of the tree.

Grading.—Separation of prunes either before or after curing in uniform sizes.

Pricking.—The process of puncturing the cuticle of the fresh prune preparatory to putting in the evaporator. Pricking is done by means of a machine the essential part of which is a board covered with projecting needles over which the prunes must pass. A substitute for lye dipping.

Sizes.—The number of cured prunes it takes to make one pound. Those requiring from 40–50 prunes to weigh a pound are called 40s–50s; those requiring 50–60, 50s–60s, etc. The “Four Sizes,” are the 60s–70s, 70s–80s, 80s–90s, and 90s–100s; commercially, it means equal quantities of these sizes. Sizes and grades are used as synonyms.

Sugaring.—The formation of globules of sugar upon the cuticle of cured prunes rendering them syrupy and sticky and destroying the lustre of the prune.

Sulphuring.—A process cured prunes are put through to give them a lighter color. The prunes are put in a tight room, generally just as they are put on trays before being placed in the evaporator, and subjected to the fumes of burning sulphur for a half hour. Or they may be sulphured after being taken from the evaporator.

Sweating.—A process prunes are subjected to, immediately after being taken from the evaporator, in which they are put in piles or bins with the temperature at from 70° or 80°, turned several times, and allowed to sweat.

Picking and Grading.

There are all sorts of prunes put upon the market. The differences are largely attributable to the care and attention given to the details of curing. Simple as it may seem the picking of the

fruit is one of the very most important matters in the process of curing prunes. Half the "bad luck" attending evaporation, in which frogs, bloaters, sugared fruit, and drip, are produced, is caused by carelessness in picking. We put the greatest emphasis upon this as neglect in picking is one of the commonest faults in prune making, and its betterment must be recognized as a fundamental requisite of success. I have seen men knocking the fruit from the trees with clubs, handling it with shovels, and pouring it roughly from boxes in a wagon bed. "There is nothing in prunes," was the cry when the product was put on the market.

Shortly before the picking season begins the ground under the trees should be cleared of rubbish and worthless fruit and the soil mellowed with a steel rake. The Petite prune, and to a large extent the Italian and other varieties, when ripe enough to dry will drop to the ground, at least no further assistance is given it in falling, than a gentle shake of the tree. If the fruit shrivels a little before dropping, all the better. The object in thus letting the fruit get *thoroughly ripe*, is: that not until then, is there a maximum amount of solids and saccharine matter so desirable in a good, cured prune; much drip is prevented since there is less juice; and the essential rich flavor is not present until the fruit is ripe.

In picking properly, the orchard must be gone over several times, the number depending upon the rapidity with which the fruit ripens. If shaking must be resorted to, labor can be saved by placing a sheet on the ground under the tree and the ripe fruit shaken into it after which it can be turned into boxes. At all times the prunes ought to be carefully handled to avoid breaking the skin thus causing the prune to drip or sugar in the evaporator, and allowing germs to enter to cause fermentation and consequent bloaters and frogs.

Prunes ought to be graded both before and after drying. Before drying in order to remove twigs, leaves, and rubbish, and to attain equality in drying, since the smaller fruit will of course dry more rapidly than the larger. As it comes from the orchard the fruit should be graded in three sizes to insure perfect uniformity in evaporation.

A number of machines and contrivances are used to do the

work. Without doubt it is best and cheapest in the long run to get one of the many excellent graders now on the market. These work on various principles, one of the commonest of which is an inclined plane with adjustable slats or screens allowing the large fruits to roll into receptacles at the bottom, while the small fruits fall through into other receptacles before reaching the bottom. One is made with wire screens of different size of mesh arranged as in a fanning-mill, each screen with a spout on the side where each grade drops into a box. All graders should have a screen so small that only dirt and stems can drop through. A good grader ought to be available for grading prunes both before and after drying.

The accompanying cuts show typical graders. The first one is a steam power machine with a capacity of seventy-five tons per day. There is much saving in having in connection with a large plant, all machinery run by steam power. The second cut shows a hand grader with a capacity of forty tons per day. Either of the two graders may be used before or after evaporating. Both are Hamilton graders.

Cured fruit is generally graded just after it has finished sweating. There are usually several sizes in each variety. The price varies from about one-sixth to one-tenth cent per size. The Silver will grade highest by two or three sizes, the Italian second, by three or four sizes higher than the Petite. Commission men

often prefer to do their own grading; the fruit in this case being taken directly from the evaporator to the warehouse. Proper

grading is a very important step in the industry, the way in which it is done having much to do with profit or loss.

Dipping Versus Pricking.

Prunes are dipped in boiling lye, or pricked by needles in a pricking machine, to check and make tender the tough skin so that the moisture can escape easily and drying be thus facilitated. Incidentally the fruit is cleansed. Both processes are in vogue and a discussion of their relative merits is in order.

Lye-dipping, as practiced in Oregon, is about as follows: One pound of concentrated lye is dissolved in from 10 to 50 gallons of water, the proportion of lye and water differing greatly with the various prune growers. The primitive way, is to keep the solution boiling in a large kettle, into which the prunes, placed in a wire basket or a much perforated metal vessel, are immersed and there kept in motion, by twirling or swinging, for from 30 to 60 seconds, depending upon the condition of the fruit. A more modern way is to have the fruit run from the grader to a set of endless chains with carrying aprons and by them carried through a pan containing the boiling lye solution, heated with submerged steam pipes; from the lye the prunes are carried on through fresh water, preferably running water, and then spread on trays.

If the operation is well done the prunes on coming to the trays should have their skins bright and shining and present upon close

examination a finely checked condition. Over or under immersion causes the fruits to dry unevenly; when too much scalded the skin tears and becomes ragged and the fruit becomes soft and mushy, making a sticky, nasty mess on the trays.

The accompanying line cut shows a Cunningham steam power dipping machine. The machine may be attached to a

grader and spreader, thereby enabling the grading, dipping and spreading to be done in one operation. There are a number of these machines in use in Oregon.

Pricking machines mechanically cut or perforate the skins of prunes. The fruit is fed over a shaking table that has needle points projecting above the surface, these cut and perforate the skins of the prunes. The needle table can be regulated so that by having different slants the skins may be cut more or less, as the condition of the fruit requires. The dirt and leaves are separated by a screen and the fruit is washed either by having it pass through hot or cold water, or by having a stream of water play on the fruit as it comes on the pricking table. The pricking machine may have grading and spreading attachments so that the fruit, from the time it is poured from boxes need not be handled until on the drying trays.

Each of the two methods are championed by experienced and practical men, some of whom have tried both, and seemingly have obtained directly opposite results. We must then come to the conclusion that a choice between the two methods rests either upon prejudice or that there is a place for both, depending upon the product desired or the fruit that is to be handled.

The illustration shows the Burrell power pricking machine

with grader and spreader, capacity fifty tons per day. This machine has a device by which the pitch of the needle board

may be changed while the machine is in motion. Hand pricking machines or larger power machines are made.

A discussion of the good and bad points of the two methods probably will not make converts among many of those who have already formed their opinions, but it may enable those who are beginning in this phase of the industry, if they think it necessary to either dip or prick, to make a choice. Right here it may be well to say that lye-dipping has by far more advocates in Oregon than the pricking,—the latter process being comparatively new in this state.

The chief objections to lye-dipping are :

1. It is a nasty process as generally practiced. Without the most scrupulous care, lye, over-dipped prunes, and the drippings and scum, accumulate, produce foul odors, and attract insects.
2. It is unsystematic and unscientific. Scarcely any two men use the same amount of lye, or dip the same length of time, and since several brands of lye are used the strength of a solution is uncertain.
3. It takes in every case a most experienced man to tell whether the operation is rightly done, whether the prunes are dipped enough or over dipped. These three objections, I must admit, do not mitigate against the use of lye, but rather

the abuse of the process. A more important objection is :

4. Lye-dipping, because of cost of fuel, material and labor, is expensive.

The points in favor of lye-dipping are :

1. The prunes are generally better cleansed.
2. Their evaporation is hastened to a greater extent.
3. The skin is rendered less tough.
4. For those who desire a finely wrinkled skin and a bright amber color, lye-dipping gives the prunes a better appearance.

The chief objections to pricking are :

1. The great object sought, that of facilitating drying, is not so well accomplished as by lye-dipping. This is the greatest objection.

2. In evaporation pricked prunes drip and sugar more than dipped ones.

3. A very current objection, which has but little foundation, is that the needles break off in the prunes. They rarely do in a good machine.

4. Another current objection is, that the flavor is not so good as in the dipped prunes. The difference in flavor in dipped and pricked prunes is inconsiderable and may be to the advantage of either according to one's taste ; it cuts no figure in the markets. It is true that the skin is a little tougher on the pricked prunes.

The special good points are :

1. That the process is cheaper, notwithstanding it takes longer to evaporate pricked prunes.

2. Pricking is more cleanly and systematic.

3. The prunes dry more evenly and there are less frogs and bloaters produced.

4. For those who like a shiny, black, smooth prune, the appearance is better.

In conclusion, it may be said, that both processes, have a place in the prune industry. The choice of method must depend largely upon, the special conditions of fruit, congeniality of either the one or the other to the operator, and the appearance of the prunes that the producer likes best. It may be that the consumer's or the buyer's taste will eventually have something to do with settling the question.

Final Processes.

After dipping, or pricking, the prunes are ready for the evaporating chamber. It is impossible to give detailed directions for treatment in the evaporator, since the process must necessarily vary with the character of the evaporator.

But, in general, in evaporators which have an ample circulation of air, the temperature should be about 120° to 140° at the start to be gradually increased to 160° to 180° when the fruit is taken out. Too much heat at first, causes the fruit cells and consequently the fruit to expand and burst, then the prunes drip. Too high a heat, by cooking the fruit, also hinders chemical changes and causes discoloration. In evaporating where the temperature greatly decreases with the distance from the furnace, the fruit should be placed in the coolest part of the evaporating chamber and then gradually be moved to the warmest part.

The time required for drying prunes differs with various varieties, and with each variety depends much upon the circulation of air, since circulation governs the degree of heat allowable. Lye-dipped Italian prunes require from 24 to 36 hours; Petites, 12 to 24; Silvers, 36 to 48 hours. All three varieties are cured in less time, but seldom well cured. A common fault is to hasten the process too much.

There are other factors entering into the process of evaporation,—such as circulation of air, convenience in handling, trays, labor, fuel, etc., but these will be considered under the head of evaporators.

A prune is well cured when it feels soft, smooth, and spongy; the pit should be loose, but should not rattle; the flesh should be yellow in color, elastic and “meaty,” the skin should be bright and lively and free from drippings and exudations. An over-cured prune is harsh and coarse and has a dried up appearance. In prunes not cured enough there is risk of loss through molding or fermenting. The Petite prune, well cured, is of a clean, bright, amber color; the Italian, very dark red, approaching black, in color. The Silver must have a beautiful golden hue. This brings us to the matter of sulphuring.

All light colored prunes must be bleached with sulphur fumes. This process without doubt injures the quality of the prunes, but buyers will have to be educated to see this before

they will pay as good a price for the unsulphured prunes as for the lighter colored sulphured ones. Until this time comes the producer cannot do otherwise than make use of a process which adds from one to two cents per pound to the value of his product. Only fresh fruit, just before going into the evaporator, should be sulphured. The rejuvenating of old, discolored, cured prunes, has no legitimate place in the prune industry.

The process of sulphuring is an easy one. The most common method is to build a chamber about six feet high, and as wide and a little deeper than the tray. On the sides of the chamber are cleats which allow the trays to be easily slipped in and out. The door occupies all of the front side. In placing the trays in the chamber, alternately leave a space at the back, and at the front, so the sulphur fumes will pass back and forward over the trays. The sulphur is put in a metal vessel in a pit at the bottom of the chamber and ignited by hot coals or other burning material. The fumes are distributed by means of simple ventilators at the bottom and top of the room, after which all openings are closed and the fruit allowed to be affected from one to two hours. The chamber should be nearly air tight. The trays of fruit are transferred directly from the sulphuring room to the evaporator where the sulphur is expelled by heat, its poisonous effects being thus reduced to the minimum.

After the fruit is taken from the evaporators it is put in bins or piles to sweat. The sweating room is generally kept at a temperature of from 70 to 80 degrees. To facilitate the process the fruit is occasionally turned with a scoop shovel. The sweating is sometimes omitted, but at a risk, as fruit will oftentimes discolor and possibly ferment if not allowed to "go through the sweat."

Preparatory to packing, the fruit is graded to sizes, the various grades indicating the number of prunes to the pound, as 30s to 40s, 40s to 50s and so on to 110s to 120s. By some the prunes are dipped in boiling water and glycerin, or other solutions, but such dipping is in disrepute as indicating an undue amount avarice to secure weight. However, intelligently done, "glossing" or "finishing" prunes, may be made a valuable process.

In packing, many different methods are used. A producer will adopt which ever one for his particular reason, or his partic-

ular market or conditions, will give him best results. Only experience can teach this. Much fruit is packed in cotton sacks, many buyers preferring it so packed as it gives a chance for repacking. Producers with a good product like to establish a reputation for their brands and so pack in boxes. There is a gain in weight by this method as the fruit does not dry out so much as in the sacks.

Packing fruit is an art and must be learned by observation. Lining with paper, filling, facing, etc., all require a little education. If the boxes are to be faced, average specimens of prunes should be flattened and neatly laid in the box which should be upside down. Fill the box, press, nail on the bottom, invert, and brand, or put on the label.

IV. Evaporators.

HE MOST important question prune growers have to deal with at the present time, is that of securing good evaporators. Those who have built evaporators are not satisfied with them; those who intend to build cannot find one that suits them. Men have been stumbling rather blindly about since the beginning of the prune industry in Oregon hoping to bring forth an invention that would meet all requirements for making a good product. But no one has been eminently successful. It is true that great progress has been made, and much valuable experience gained; so much, in fact, has been accomplished, in a short time, that we can quite confidently look forward to the evolution in the near future of evaporators of very superior excellence to those now in use.

The following chapter is published, not with a view of adding to what is already known about evaporators, or of making suggestions for their improvement, but to bring before the prune-growers descriptions of the types we already have that they may choose more intelligently if they intend to build, or study more carefully if they think of making improvements upon evaporators they now have.

The importance of the erection of better evaporating plants, and more efficient management of them, can hardly be over-

estimated. A good evaporator is the prime essential to success, not only for the individual but for the industry; if, for no other reason, than, that there is at present, such a wide range in the quality and style of our product that it has no established place in the markets, in consequence of which we lose much, buyers always preferring fruit with a good reputation. This would be largely overcome if we had standard evaporators producing, necessarily, a more uniform product.

In connection with this subject we are glad to publish the following from Hon. Henry E. Dosch, Horticultural Commissioner for the 1st District, who has had much experience with evaporators and with the evaporation of fruit.

Evaporators and Fruit Evaporation.

The construction of evaporators on correct principles and the art of evaporating fruit, has engrossed the minds of scientists and layman alike, both at home and abroad, and it seems as yet, we have not reached the wished for goal, but we are on a fair way to it.

To dry fruit is one thing, but to evaporate it, quite another,—simply to put a lot of fruit on a tray, put it into an oven, fire up and wait until it has shriveled away to a bony state, almost any one can do; but to properly “evaporate” fruit, so it is a fine marketable article, requires a good deal of care and intelligence on the part of the operator. It is in this, like in all other business or trades; the principles involved, must be thoroughly understood, in fact the operator must be educated to it, the same as any master mechanic.

The two great principles involved are heat and circulation: without these two, it is useless to attempt to make good fruit—It cannot be done.—And it matters little whether the heat is supplied by a brick furnace with large radiating pipes or by coils of steam pipes, so long as it can be controlled; for remember hot air in space is a very different thing to control, and can only be accomplished in a properly constructed evaporator with thorough circulation.

I have experimented for many years in fruit evaporation in variously constructed evaporators and we have made rapid strides forward, and as I said, while we have not yet reached our goal, we are very close to the line. I will not attempt to describe the many patented and non-patented evaporators, all of which have good points, and while some operators can make fair fruit on any of them, none are yet perfect.

My own experience however has led me to the conclusion; that all fruits must be started at a low heat and finished at a high heat, in order to prevent the loss of the aromatic juices and fruit meats, essential to fine fruits and in order to accomplish this, the evaporator must be so constructed, that the trays of fresh fruits are placed in, furthest from, and be made to gradually advance toward the furnace or steam pipes. There ar

now two evaporators made in Oregon, in which this principle is employed, but it is hardly proper for me to recommend any particular evaporator.

The dipping in lye solutions, so objectionable to consumers of refined taste must be done away with. Thanks to Prof. Hoersch Durren, this is no longer necessary as fruits "steamed" prior to evaporation, make a much finer product. He says, "it will open the pores of the skin to facilitate evaporation and prevent dipping; it makes the skin tender and eliminates that leathery substance found in most of our dried French prunes; it requires less heat and *"fruit will dry heavier or more meaty"* than unsteamed fruit." This alone is a strong recommendation and worth all the trouble and expense; the pressure in the steam box should not be over $\frac{1}{8}$ pound; prunes to be subjected from 10 to 15 minutes; pears 15 to 20 minutes; and apples $1\frac{1}{2}$ to 2 minutes, and on removal immediately transferred to the evaporator.

Experiments made recently by Mr. Adam Fleckenstein in his new evaporator, in which both the foregoing principles were introduced, proved decidedly successful; French prunes yield 45 pounds to the hundred, and Italians 33 pounds of evaporated product to 100 pounds of fresh fruit.

Rapid evaporation as claimed by some patentees as a point of merit, is a great mistake; nature if left to her good offices, will dry fruit very slowly in order to develop the saccharine matter, and the closer we follow her, the nearer right we are; nature makes no mistakes; French prunes should never be evaporated in less than 24 to 30 hours; Italian and Silver prunes 36 to 42 hours; apples in 6 hours; peeled pears in 24 hours and unpeeled pears 48 to 60 hours.

I hardly think it necessary to add, that all prunes must be dead ripe.

HENRY E. DOSCH.

Kiln and Box Evaporators.

The first prunes produced in Oregon, were, if I am rightly informed, evaporated in a kiln, or as we commonly know it, a hop drier. The essential parts of which were, a room with a slatted floor underneath which heat was produced by a furnace. It was a primitive affair and has long since been relegated to the past in the prune industry. The kiln was followed by the box evaporator an evaporator still in use and from which, when well operated, oftentimes a product is turned out which is indistinguishable from that produced in the best patent evaporators. In box evaporators the fruit is placed upon trays which are arranged in rows in an upper room or division of the building, the furnace being in the lower division. Various contrivances, depending upon the ingenuity of the builder, furnish ventilation and a draught for carrying off moisture laden air. The particular merit of the box evaporator is its simplicity and cheapness.

The Steam Evaporator.

The steam evaporator is a modified box evaporator. The trays are arranged in tiers; under and above each tray or two trays, is a coil of steam pipes, several runs in each coil. Narrow horizontal doors allow of the insertion of trays, and enable the operator to examine or handle fruit without regard to other trays. These alternate tiers of pipes and trays are of a convenient height for a man to reach, or they may extend through two stories. In width, the evaporator will only allow, conveniently, two trays to be placed side by side, but in length the number is limited only by economy in laying pipes for heating. At the top of the tiers, a very large shaft, or a number of smaller ones carry off the moisture laden air; openings at the bottom allow an inflow of air. The main defect of all steam evaporators coming under the writer's observation is, that poor ventilation causes excessive drip. We believe that the man who solves the problem of building a steam evaporator on the general plan outlined above, in which the moisture laden air can be carried off, so that fruit will not drip, will solve the problem of getting a good evaporator. Good work is being done in several large steam evaporators in the Northwest.

Without question, for a large plant, heating by steam is the most efficient and economical method; this is particularly true because in such a plant power is wanted for running graders, dippers, elevators, and pumping water.

The Carson Evaporator.

The Carson evaporator is a patented, modified, box, evaporator, its particular merit is an ingenious method for securing good ventilation. The Carson is used, perhaps, more than any other one evaporator in Oregon. It is sometimes built in a modified form to overcome an inconvenient way of handling the trays of fruit. Plate III shows a cross section of a pair of Carson evaporators.

The evaporator may be built of various sizes, but the usual size is 18.5 $\times$ 8 feet, such an evaporator has a capacity of 5000 pounds of ripe fruit per day. The lower part of the building consists of a furnace room, built of brick, and contains a furnace in each end. The walls of the furnace are 8 inches thick and 16

PLATE III. THE CARSON EVAPORATOR.

inches high, and are connected by an arch made of one thickness of brick. Care in regard to material and workmanship must be exercised in order to prevent danger from fire. Two 10 inch pipes carry the effects of combustion from the furnaces and discharge them in a 12 inch pipe, which passes through the wall of the room into a brick chimney, situated at the side and center of the evaporator. At the connection of the small pipes with the large one, each of the small ones has a damper; as it passes in the chimney the large pipe has a damper. These dampers give the operator full control of the temperature.

Cold air is admitted to the furnace-room at the bottom of the walls. It is necessary to admit a large volume in order to create sufficient draught to carry off the moisture from the fruit. The draught is created by this air becoming heated and passing out through ventilators at the top of the building.

In the cross-section shown in Plate III it is seen that the frames for holding the trays incline inward toward the top of each dryer. The frames being thus arranged allow open spaces between the trays and evaporator walls; the outer edge of each tray is 7 inches higher than the inner edge. The space, E contains hot air from the furnace below; the room is tightly ceiled from A to A so that air cannot pass from one side to the other. On the inclined frame, at the upper edge of each tray, represented in the illustration by one inch, eleven-twelfth inch, ten-twelfth inch, etc. are graduated cracks, running the whole length of the evaporator; these cracks open into the hollow wall, C, between the tray frames and evaporator walls. The cracks are graduated so as to overcome by draught the tendency of the hot air to rise to the top of the room. At the top of the hollow space there are on each side, five up-take ventilators shown by B, 12 × 12 inches and 6 feet high. These remove the humid air from the hollow wall. Each up-take has a cover working on a hinge, by means of which the circulation of air is controlled.

The philosophy of this plan of ventilating is, that the hot air in space E is carried above and below each tray and through the graduated cracks into the space between the tray frames and the wall and out through the up-take ventilators. The arrows indicate the direction air will take from the time it comes in until it goes out. Thus the humid air from the lower trays passes out without oppor-

tunity to condense and settle upon fruit in the upper trays, causing drip and hindering the proper chemical changes from a green prune into a first-class cured prune.

The Carson evaporator has several points of excellence : its cost is small ; there is no machinery to get out of repair ; it is easily operated ; any good mechanic can build it ; and the expense for heating is reduced to the minimum. One objection to the evaporator, offered by many, is that it is inconvenient to place all of the trays in the drying chamber from the ends ; this has been remedied by several builders by having doors on the sides. For a large plant, steam pipes may be used instead of a furnace for heating.

The Penniman Evaporator.

The Penniman evaporator is an ingenious invention in which the trays of fruit are placed on a sort of Ferris Wheel and forced through the heat. The essential features of the evaporator can be readily seen in the accompanying cut.

A narrow, arched, brick building forms the evaporating chamber ; a furnace at the bottom of the chamber furnishes heat ; a revolving shaft in bearings, is mounted in the side walls above the furnace. Two large wheels, their rims united with rods, are fitted to the shaft. Hangers, with a series of transverse cross-ways to hold the trays of fruit, are loosely attached to the cross bars ; the trays are thus maintained in a horizontal position at all times simply by the law of gravity. The trays are put in place through a door at the front, the wheel being slowly rotated by hand. The fruit may be examined, in the process of evaporation, by opening the door or through windows in the upper part of the building. The system of flues, drums, and dampers, is ingeniously arranged to regulate heat. Ventilators admit cold air below and permit heated, moisture-laden air to escape above.

In the process of drying, the fruit is first subjected to a high heat, being on the bottom of the wheel, but as evaporation progresses it is carried to the cooler upper part. At the end of the revolution of the wheel the evaporation is finished. A simple device of cogs and a shaft enables the operator to turn the wheel. Various sizes of the evaporator are made. In the one shown in the cut the diameter of the wheel is 14 feet ; the space between the rims, 6 feet. There are 24 hangers each containing 5 trays,

the trays being 5×2 feet, making a spreading surface of 1200 square feet. The makers claim that its capacity is from 6000 to 7000 pounds of green fruit per 24 hours.

The Penniman evaporator is largely used and is highly

recommended in California. In the fall of 1895 the writer saw one in operation in Southern Oregon, and while the product, in this particular instance, was not first-class, the reason for which might be attributed to lack of care and attention on the part of

the operator, yet there were some points of excellence about the machine. Its durability, safety from fire, the ease with which fruit may be handled, equal distribution of heat, therefore, approximately, uniformity in drying, are the points that commend it.

The Allen Evaporator.

The Allen evaporator is one of the popular evaporators in Oregon; more of them having been built, perhaps, in this state than of any other style excepting the Carson. It is a so-called horizontal evaporator in which the trays of fruit are moved horizontally across the heating surface. The American evaporator was, I believe, the prototype of this style of evaporators, but the Allen is a great improvement upon the old form.

The accompanying cut, a very poor one, represents the Allen evaporator with one side cut away; it shows the inside of a "tunnel" and the position of the cars therein. The details of the evaporator are so meagrely shown by the cut, that a full descrip-

tion will not be attempted; the essential principles of the drier can be readily seen, however.

Mr. Allen believes that prunes should be subjected to a low temperature when first placed in the drying chamber, and as the juice coagulates in the cells, gradually be given a higher temperature; the great majority of those experienced in evaporating prunes believe this, but the Allen evaporator is built with special reference to this point. To secure which, the prunes are put in at one end of the drying chamber and taken out at the

opposite end. The device by which this is done is a series of cars running down grade in "tunnels," from the place where the fruit enters the drying chamber to the furnace. The foremost car is pulled across the entrance through which heat enters the chamber, this permits an opening between the cars and brings the upper end of the tray nearest the fire, thus answering the same purpose as turning the tray around would. The car is now in front of the door of exit and the fruit can be examined at will and taken out when the proper stage of evaporation is reached.

A current objection to the evaporator is, that the fruit can only be examined as it comes before the door in the last stages of evaporation. I have been told by those who have had considerable experience with the evaporator that the objection is not well taken, as the circulation of air is such that the fruit dries, in proportion to the distance from the fire almost perfectly.

A great point of excellence in the Allen evaporator is, the way in which the hot air reaches the fruit, absorbs the moisture, and passes off. The tramways for the cars are constructed so that the edge of the car farthest from the heat is highest—the cars slant forward; as the heat ascends from the furnace it is carried between the trays, the driest air on the driest fruit. The cars are running toward the furnace, hence as the moisture leaves the driest fruit it passes out without condensing as it would should it pass over the greener fruit first. All the moisture from freshly dipped fruit passes out immediately. It is not saying too much to say that the heat is under as perfect control, by means of a novel system of dampers and ventilators, as in any evaporator we have.

Various sizes are made ranging in capacity from 25 to 175 bushels of green fruit per 24 hours. The cost is not excessive, it is economical in fuel, and it is easily operated,—all valuable points.

The Beck Evaporator.

It may be that our California neighbors, with their longer experience and greater resources, have brought forth better evaporators than those commonly in use in Oregon. But a general criticism upon such evaporators from that state as have been introduced into Oregon is, that they are far too expensive, with their complicated manipulating machinery for our conditions,

and, especially as it is doubtful if better results are accomplished than with our simpler devices.

The evaporator under consideration, the Beck, while free from the many novel inventions of fans, blowers, domes, and other accessories has in its construction a feature, which, unless overcome by a much greater capacity gained by it, is objectionable; namely, the revolving tray rack involving as it does extra cost and a greater expense in running. The same criticism applies with equal force to the Penniman described before and the Kurtz to be described hereafter, and the rule may be laid down, in general, that evaporators that require a constant power to run them, or complicated machinery to be built and kept in repair in order that the fruit may be forced through the air instead of the air being forced by nature's laws through the fruit, must greatly exceed in efficiency the simpler and less expensive evaporators.

These criticisms must be taken as general and not as applying to the Beck in particular, an evaporator, which we consider of its style, the very best, and as having by increased efficiency, overcome some of the objections noted in the above paragraph. Its principle of construction is certainly most ingenious and well deserves the attention of every fruit-man.

The cut on the following page shows the plan of the Beck. Two circular, brick walls, one within the other, several feet apart, according to the size of the evaporator, are built about nine feet high. In the enclosed space formed by the two walls, a furnace of cast iron, two and one-half feet wide and nine feet long, is placed; attached to this is a heating drum eighteen inches in diameter which circles around the inner wall, passing into the smokestack near the furnace front. Upon the inner circular wall, is a turn-table upon which is a tray rack which extends out over the heating chamber to within half an inch of the outer wall.

The outer wall, from the brick work up, is built circular, as a continuation of the wall, the frame-work being covered on both sides with closely matched lumber thus making an air-tight compartment; at the top is a conical roof in the center of which is a ventilator with a damper to control the draught.

The trays slide into the revolving rack at an angle of six inches to three feet and edge to edge so that they wind around

the inner wall from bottom to top in a spiral twist. The space between the twists of trays, are, in a sense, flues of the dimensions of the distance between trays and the width of a tray, and the hot air is supposed to ascend through them as it does in a chimney. To further facilitate the passage of air between the twists of trays, the tray rack is kept in motion thus forcing the air through the spiral flues under and over the trays of fruit, thus, seemingly, distributing the air current uniformly over the the fruit surface.

The power for turning the tray rack may be hand power in small evaporators, or, as of course would be better, a vapor engine or steam power may be used. In a plant of any magnitude the consideration of power is not so great as would at first appear, because there should be some such power for running graders, dippers, elevators, pumping water, etc. There being but little friction to overcome in revolving the tray rack, strong power is not needed.

The inventors claim that because of the rapid and continuous currents of air caused by the rotary motion the temperature may be raised from fifty to seventy-five degrees higher than it could were the trays kept at a standstill. This of course means a greatly increased capacity for drying. In regard to convenience and mechanism, the machine is as nearly perfect as any upon the market.

The Fleckenstein Evaporator.

The Fleckenstein is one of the latest evaporators to claim attention in Oregon. It was invented by Mr. Adam Fleckenstein of Woodlawn, Oregon; last year was its first season before the public and because of the failure of the prune crop in this state it could not be thoroughly tested. In the trials made, however, it was evident that its merits would rank it among the best of our evaporators.

The Fleckenstein is a most decided departure from any style of evaporator now in use in the Northwest. It falls in the category of so-called stack or tower driers, devices common in the berry and apple evaporating industry, but not in the prune industry. The fundamental principles involved in this evaporator are not new, there being several prototypes in the East, notably the old Alden, the Williams, and the Automatic,

perhaps one or two others. But many of the accessories and details of mechanism are new and are great improvements upon similar parts used in other evaporators of this type. This is especially true of the lifting device.

The essential principle of a stack evaporator, which provides that the trays of fruit be placed in tiers in a shaft, admitting air only at the bottom and allowing it to escape only at the top, thus forcing hot air directly through the fruit, is a principle directly opposite to that involved in any other evaporator described in this bulletin. The inventors of all the other devices have sought to provide means by which air once touching the fruit could be passed out as quickly as possible without touching more fruit. It is not to be wondered at then that the splendid reports given of this evaporator by horticulturists of unimpeachable standing have created no little surprise.

The method of operating the Fleckenstein, as recommended, differs very radically from the method generally used in most other stack evaporators. The fruit in this case is put in the stack, not necessarily but recommended so, at the top, the coolest part, and is finished at the bottom at the warmest part. In this the inventor agrees with the great majority of our experienced prune producers that evaporation should start at a low temperature, but disagrees with most manufacturers of Eastern stack evaporators who advocate that the fruit be "finished" at the coolest part of the evaporator. In fact, Prof. L. H. Bailey* in a bulletin on evaporators, in speaking of a certain evaporator says its chief disadvantage is, "that the fruit is 'finished up' or removed in the hottest part of the stack, instead of being taken out at the top which is the coolest part of the stack." I think I make no mistake in saying that this is counted an advantage in in all the types of evaporators in use in Oregon, and the fact that this can be done in the Fleckenstein is considered one of its strong points.

The accompanying cut represents one stack, holding twenty-five trays, of the Fleckenstein. An evaporating plant may consist of as many of these towers as may be necessary, all to be built over one furnace or several at the option of the builder.

The trays of fruit are handled in the stack as follows:

*Bulletin No. 100, Cornell University Expt. Station.

The bottom tray rests on four small wheels imbedded in the frame-work of the stack ; the front end of the second tray

rests on the bottom tray and the back end rests on two four inch wheels raised about three quarters of an inch above the bottom

tray, so that when the second tray with those above it are raised to a level, which is easily done by means of an ingeniously arranged lever placed under the front end of the second tray, the bottom tray is free and may be removed or examined and returned to place. If removed, the second tray, aided by the two four inch wheels behind slides gently down in the place vacated by tray number one. The bottom tray, it will be observed, is shoved forward an inch or two by the action of the wheels behind, upon which the back end of tray number two is forced to remain. Trays of fresh fruit are put in at the top.

One of the supposed requirements of the evaporator is, that it be air tight at all places except at the ventilator at the bottom of the stack, where air enters, is heated in the fire chamber, and drawn up through the fruit by a strong draught, created mainly by the smoke pipe of the furnace entering the ventilating shaft at the top of the evaporator.

Heat may be furnished by a furnace of any style, or by steam desired. The inventor, however, has for a single stack or a small plant a furnace that is so simple, cheap, and efficient, that I take pleasure in describing it here.

The furnace consists of three lengths of common tile pipe twenty inches in diameter, encased in sheet-iron which is reduced at the back end to the size of a common smoke pipe and to which piping is fitted, carried around the air space under the fruit chamber once or twice, passed out and up into the ventilating shaft over the fruit chamber. It is an easy matter to doors, grates, and dampers. Mr. Fleckenstein has had such a furnace in operation in an old box drier on his place for six years. It has the merit of being exceedingly cheap, economical as to fuel, and the danger from fire is reduced to a minimum. A more elaborately constructed furnace is to be recommended for a large plant, however.

A strong point of excellence in this evaporator is its compactness. Twenty stacks of trays capable of drying 12000 to 20000 pounds of fresh fruit per twenty-four hours only occupies a space of $7\frac{1}{2} \times 17$ feet. The mechanism is extremely simple and so the cost of evaporator and building will compare very favorably with the cheapest evaporators we have.

In the test made so far it is claimed that a first-rate quality

of evaporated Petite prunes can be produced in from eight to ten hours, the prunes having a fine ruby color and the clear yellow flesh characteristic of a perfectly evaporated Petite prune. The Italian was as well dried in from ten to twelve hours, though it is considered best to take at least ten hours for the Petite and fourteen for the Italian.

The Kurtz Evaporator.

The cut on page 60 gives a view of the Kurtz evaporator, an evaporator with a revolving tray-frame somewhat similar to the Beck, differing from it in the manner of support of the tray-frame, and in not requiring continuous motion. The remarks made regarding the merits and demerits of this style of evaporator under the discussion of the Beck applies with equal force to the Kurtz.

The lower part of the evaporator consists of two circular brick walls, forming a furnace and hot air compartment. Above the inner circular wall, the tray-frame and apparatus for manipulating it are placed. The upper part of the outer wall consists of a tight wooden shell. The construction of these walls can easily be made out by an examination of the cut.

Formerly, the tray-frame rested on a track on the circular foundation, but it is now suspended from above upon supports resting upon the foundation; the frame is revolved upon roller bearings which operate between two tracks the lower of which is stationary, and the upper one, to which the frame is fastened, rotating upon the rollers. An endless chain passes entirely around the machinery and connects with a crank outside of the evaporator; by turning this crank the tray-frame is made to revolve so as to bring each upright section in turn in front of the door where fruit is put in and taken out.

The working theory of the evaporator is as follows: A horizontal row of trays of green fruit is put in at the bottom every two hours and a similar row of evaporated fruit is taken out at the top at the same time. In order to do this it is necessary to lift up each column of trays the space of one tray, hold it there by means of a spring dog, put in a tray at the bottom, take out one at the top, drop the column and repeat the operation until the trays have been changed in all the columns.

The lifting of the columns is done automatically as the tray-

frame turns so that when the the frame stops in front of the door the column has been lifted and is ready to receive a tray. This is accomplished by means of a bridge to be seen in the cut exactly in front of the upper edge of the door if the door were closed. As the tray-frame is revolved, the roller attached to the

column of trays below rolls over this bridge and lifts the column which is then held by a dog which automatically springs out and catches it.

One of the current objections to the Kurtz evaporator has

been that the fruit had to be subjected to the greatest heat immediately upon entering the drying chamber. Mr. Kurtz writes me that this year he has improved the tray-frame machinery so that green fruit can be put in at the top and the finished product taken out at the bottom if so desired. This plan will meet with the approval of most of our prune men though a few will contend that the old way is the better. One of the merits of the evaporator is that it can be used either way.

While in practice it is not generally so operated, yet the manufacturer recommends that the tray-frame be constantly rotated by machine power in order to create a greater circulation of air. Three or four revolutions per minute may be made and it is said that by this means at least one-third more fruit can be evaporated—a matter of much importance when there are large quantities of fruit to dry. The power required to do this work need not be very great.

As in all evaporators the furnace may be built largely according to taste. Mr. Kurtz, however, recommends the one ordinarily built with his evaporator; briefly it may be described as follows: The furnace is built in the inner circular part at the bottom of the drying chamber and consists of a simple curving arch through which pass small air pipes from the outside, arranged so that all air entering the drying chamber is thoroughly heated before doing so. Mr. Kurtz says that one cord of wood will cure 200 bushels of green prunes.

Accessories.

This chapter may well close with a few words concerning the accessories of a good evaporator. The profit in evaporating establishments is often fixed more by the convenience of arrangements for handling fruit, and by the skill, care, and cleanliness, given by the operator in the various processes, than it is by the style of the evaporator.

In the matter of cleanliness there is a wonderful chance for improvement about many of the evaporating plants I have visited in Oregon. Where floors are covered with spilled or refuse fruit, allowed to accumulate from day to day to sour and to be tramped under foot, an evaporating establishment becomes a most unpleasant place indeed. Not a little harm is also done by the

swarms of flies, bees, and yellow jackets attracted to such places and by germs of rots and molds that find a congenial medium for propagation. Scrupulous cleanliness is one of the essentials of a good establishment.

But to get back to the matter of the topic. Particular attention should be given to the accessories of the evaporating plant. First of all there should be plenty of room. The building should be planned so that there may be a receiving room for the green fruit; a working room containing the dipping apparatus or pricker, the grader, and the sulphuring chamber; these and all the minor apparatus should be upon the first floor. If possible a second floor should be built for a sweating room and store-room, and also to hold the apparatus for packing the product. It is almost absolutely necessary to have an unlimited supply of good water. An elevator is convenient and will save its cost in a single season. Tools and a place for making and mending trays, preparing packing boxes, and doing odd jobs of carpentry, is quite necessary. It will be found that the evaporating apparatus proper will occupy but comparatively a small part of a good plant, and that the general outfit will have quite as much to do with the success of the establishment.

In Conclusion:

To have described in detail all the evaporators and appliances used in evaporating prunes would have led us far beyond the scope of a brief bulletin. Other evaporators than those mentioned, especially some that have gained prominence in the evaporating industry in the East, well deserve to have been spoken of but it was impossible to discuss all, and I have simply tried to give an idea of the most prominent types in use in Oregon. Good prunes have been produced with all of them and none should be entirely condemned from hearsay. One thinking of purchasing an evaporator should investigate as many styles as possible; he should see them in operation; talk with the operator; and always take in consideration as to how much success or failure may be due to the man using the evaporator.

V. Diseases of the Prune.

THE STONE fruits in Oregon suffer from the attacks of comparatively few pests. Curculio, black-knot, and brown-rot to any appreciable extent, have not as yet made their appearance in our orchards. This immunity may be largely ascribed, I think, as far as the fungous diseases are concerned, to climatic conditions. It is certain at any rate that both of the diseases mentioned above have been from time to time introduced and yet black-knot cannot be found to my knowledge in any orchard at present, and the brown-rot is confined to very limited areas; neither has ever manifested a tendency to spread with the fearful rapidity and destructiveness characterizing them in the East. We have then in this chapter to describe but few diseases, the worst of which is:

Shot-Hole Fungus.—*Cylindrosporium Padi*, Karsten.

This disease is prevalent in all parts of Oregon and is troublesome not only on the plum and prune but on the peach and cherry. It is the most grievous pest that growers of stone fruits in this state have to contend with and the necessity of spraying in order to protect prune, peach, and cherry from its ravages is now an established fact.

In the prune orchard it makes its appearance in June or a little before the leaves are full size. It first manifests itself on the leaves in little purplish or reddish spots, or brownish in the center and purple at the circumference. These spots enlarge, sometimes by coalescing, until they are from a sixteenth to a quarter of an inch in diameter. As the disease progresses the affected spots wither, turn brown, and finally break away and drop out of the leaf. The holes thus formed, sometimes a score of them being found in a single leaf, gives the foliage the appearance of having been riddled with shot hence the name, shot-hole

fungus. The disease is well shown in Plate IV, Fig. 1, reproduced from a photograph.

Shot-hole fungus oftentimes may not attract attention unless as happens frequently the foliage drops prematurely; this generally takes place in August or September, the leaves turning yellow before dropping. It is obvious that any trouble seriously affecting the health of the foliage must be disastrous to the general health of the tree and must, in proportion to its seriousness, affect present and future crops. Fruit-growers do not always realize this and the presence of any pest that is not actually killing a tree seems to give them but little anxiety. The fact needs to be pressed home as forcible as possible that anything that in any way injures the foliage, in the same ratio injures the productiveness and longevity of the tree. Shot-hole fungus, because of its universal prevalence in Oregon prune orchards, does more damage than all the other prune troubles combined, and in the aggregate, yearly causes an enormous loss of fruit and a great retardment of our orchards.

Fortunately the disease is easily controlled. The Oregon Station has done but little experimenting in the way of preventing the disease, but the treatment recommended by other Stations has been given with success in our orchard. The disease has been thoroughly studied and for those who desire a more comprehensive knowledge than can be given here, I append at the bottom of the page a list of the most prominent reports of investigations concerning it.

Bordeaux mixture is the preventive for the disease. The shot-hole fungus appears in midsummer and applications for it must be made late in the season. The first spraying should be given very soon after the leaves make their appearance, this to be followed by a second and third application,—in a very wet season a fourth, at intervals of three weeks. It may sometimes be necessary to spray when the fruit is nearing maturity, if so, one of the clear copper sulphate solutions should be used instead of the Bordeaux mixture.

S. A. Beach, Bulletin 98, N. Y. Ex. Sta., Rep. N. Y. Ex. Sta. 1893: 688-693.

D. G. Fairchild, Bull. U. S. Div. Veg. Path. 1894-6: 39-40.

W. J. Green, Bull. Ohio Ex. Sta. 1891. II 4: 216.

Roland Thaxter, Rep. Conn. Sta. 1889: 176, 1890: 102.

Brown Rot.—*Monilia fructigena*, Pers.

In the fall of 1895 a number of prunes affected with brown rot were sent to the Station. Upon making inquiry it was found that in the infested area nearly the whole product of several orchards had been destroyed by the disease. The writer could find no previous notice of its existence in Oregon and assumed that it had been but recently introduced. Subsequent inquiry developed pretty conclusively that it has been in Oregon for some time but seems to have been dangerous and troublesome only under particularly favoring conditions,—fortunately enough as the brown rot as found in most localities is the most serious fungous disease with which plum growers are obliged to contend.

In the East all the stone fruits are attacked by brown rot, the disease being especially prevalent in the Middle and South Atlantic states. In some seasons in Georgia, brown rot takes a third of the peach crop; in Michigan the aggregate damage done to the stone fruits is as great as that done by all other diseases combined, if we except peach yellows. A bad feature of the disease is that the fruit is often attacked after being picked, as was the case with one of the Oregon orchardists who lost fruit year before last; about 60 bushels of prunes ready for the evaporator in standing over Sunday were almost entirely destroyed by the rot. If it is true that the fungus has been in Oregon for some years without becoming more widely distributed there is but little to fear from it, but knowing its character elsewhere we need to be watchful.

The following is a brief description of the disease. Leaves, twigs, and fruit, are attacked, but most of the damage is done to the fruit. The rot makes its appearance about the time the prunes begin to mature, and the favoring conditions are, warm, moist weather, a certain amount of moisture being necessary at the point of contact of the fungous spore in order that germination take place. After germination the fungus enters the cells of the fruit and robs them of their contents and cell degeneration, or rot, ensues. The affected fruit becomes covered with clusters of ashy-grey spores which enable one to easily distinguish it from ordinary decay. If the fruit is not harvested it becomes persistent and shrivels on the tree, it being no uncommon sight to see the shriveled fruit hanging on the trees in midwinter. Oftentimes the twigs of the trees, especially of the peach, are attacked. The blossoms

are also sometimes affected and destroyed.

The life history of brown rot has been well worked out and experiment station literature abounds with references to it, some of the prominent notices of it being found in the bulletins cited at the bottom of the page.

The application of Bordeaux mixture which every prune grower should make for shot-hole fungus will keep brown rot in check though the rot may make, under favorable conditions, its appearance later in the season than the shot-hole; if it does, and at a time when the fruit is approaching maturity, the weak copper sulphate solution should be used or the ammoniacal carbonate of copper solution, the formulas for which are found at the end of the chapter. With this disease, more than almost any other, prevalence will depend on weather conditions, hence changes in temperature and moisture must be closely watched.

Black-Knot.—*Plowrightia morbosa*, Sacc.

Black-knot is a common and destructive fungus on stone fruit trees in the East, and is occasionally found in Oregon though here, as yet, it has never been plentiful enough to do harm. It, therefore, needs but a brief mention in this Bulletin.

Black-knot, as its name implies, is a blackish swelling on the twigs or limbs of the plum and cherry. These swellings are caused by a fungus and not by insects as one might be led to believe by the presence of the latter in many of the old knots. The disease makes its appearance at the beginning of growth in the spring when it may be seen as a light discoloration, growing gradually darker until in June it is purple; the bark at this time seemingly having a thin coating of purplish velvet, caused by the presence of myriads of spores with the organs bearing them. By midsummer the "velvet" has disappeared and the swellings are jet black. At the beginning of winter, minute, black elevations, on the surface of the knots, indicate the presence of the winter spores. They are distributed before spring and new growths are propagated from them. The knots are generally from three to

H. Carman, Ky. Rept. 1889 31—36.

C. McCarthy, Bul. N. C. Ex. Sta. No. 76: 14.

T. E. Humphrey, Mass. Rept. of Expt. Sta. 1890: 213—216.

L. R. Taft, Bul. Mich. Expt. Sta. No. 83: 17—18.

B. D. Halstead, Rept. N. J. Expt. Sta. 1891: 288—260.

F. D. Chester, Bul. 55, Del. Expt. Sta. 10—12.

five inches long, although additions of new swellings from year to year often make them much longer.

The treatment generally recommended is to cut out the knots as soon as discovered and destroy them; of course the earlier in the season that this can be done the better in order not to allow a crop of spores to mature. The sprayings recommended for shot-hole fungus will tend to keep black-knot in check should it make its appearance. For the benefit of those who may wish to make further investigations of the subject the references at the bottom of the page are recommended.

Prune Rust.—*Puccinia pruni*, Pers.

In some parts of Oregon, the foliage and fruit of the prune have been seriously affected with a rust. Opportunity has not offered so that a study of the disease could be made at the Oregon Station, but I take it to be the same rust that troubles the California prune growers, a study of which has been made, and the results published, by Mr. Newton B. Pierce,* of the U. S. Department of Agriculture.

The rust is known to affect all drupaceous fruits, but does most damage to plums and prunes. It is widely distributed, being found to some extent wherever members of the plum family are found. In some localities the peach suffers greatly from the ravages of this fungus. Judging from what is said by Mr. Pierce in his article, referred to before, the disease is much more virulent in California than in Oregon. There, it seems, trees and orchards are sometimes almost defoliated and the damage done in the way of reducing the aggregate vigor and productiveness of prune, peach, and almond orchards, is immense. In Oregon the most apparent loss to the prune growers is in the quantity of the current year's fruit, or, sometimes, the fruit itself is attacked, the skin assuming a rough, russeted, condition, that greatly injures the appearance of the prune, and also makes it difficult to evaporate it well. But, as in California, the greatest damage is done through the weakening of the vigor and productiveness of the tree and the shortening of its life.

The fungus begins its work early in the season, and may be

E. G. Lodeman, Cornell Expt. Sta., Bul. 81, Ithaca, N. Y.

S. A. Beach, N. Y. Expt. Sta. Bul. 40.

*Journal of Mycology, Vol. VII, No. 4, pp. 354—363.

seen soon after the leaves come out in the spring. Yellowish, irregular, blotches on the upper surface of the leaves, first indicate the presence of the rust. Soon after the spores make their appearance in brown patches on the under side of the leaf, and if the fungus makes a strong growth such portions of the leaf are usually entirely destroyed, presenting an area of brown, lifeless, seared tissue. In different years, localities, and conditions, the appearance of the rust varies somewhat. If the fungus attacks the fruit, the parts attacked swell slightly, become light brown in color, and of a rough texture.

The disease will be pretty well kept in check by the sprayings of Bordeaux mixture recommended for the shot-hole fungus, but in case the rust is particularly troublesome, an added spraying earlier in the season would be of value. The spores are borne on the underside of the leaf and probably germinate there; therefore the under surface should be thoroughly drenched with the spray to obtain the best results in spraying.

Gumming of the Prune Tree.

The prune, in common with all drupaceous fruits in Oregon, is much injured by the exudation of gum from the trunk and limbs of the tree. The trouble is called gummosis. The writer has never seen gumming elsewhere, except as a normal condition of the trees of this class, but inquiry shows that it damages plums, peaches, and cherries in other localities in the United States, as parts of California, Colorado, Texas, the South Atlantic States and Pennsylvania, and is also troublesome in certain parts of Europe.

Notices of the disease, however, in scientific literature, are short and very fragmentary. In fact none of our experiment stations, so far as the writer can ascertain, have attempted to assign causes for the excessive gumming or to prescribe treatment for it. On the other hand, it has frequently received attention in the horticultural press, where I find various causes assigned; as, a bacterium, a fungus, frost, sunscald injuries, over cultivation, etc. About as many remedies are prescribed.

As one of the greatest hinderances to successful prune and cherry growing in Oregon, gummosis has for several years received more or less attention at the Oregon Experiment Station. Most of the efforts put forth have been along the line of controlling the

gumming and in this some results worthy of note have been obtained. During the past year a study of gummosis from a botanical standpoint has been made with a view of ascertaining the cause, and while conclusions have not been reached that warrant positive statements regarding all phases of the disease, yet enough has been done to warrant the stating of a hypothesis as to the cause, and to suggest remedies.

Gummosis may make its appearance at any time of the year if proper weather conditions prevail. It is most prevalent in the spring, especially if the growth has started prematurely, or if the trees have been injured by frost. Trees frequently gum badly, also, in midsummer after a hot wave, or a shower of rain. The first indication of the coming of the gumming, is the tight, smooth glistening appearance of the outer bark. This is closely followed by a swelling of greater or less magnitude, sometimes being not larger than a dollar, but oftentimes extending in irregular patches the whole length of the trunk of a medium sized tree. After a time these swellings burst and gum oozes out, continuing to do so for an indefinite period. If the diseased spot be cleansed it is found that the tissues of the tree have degenerated, and a pocket of some extent, according to the length of time the gum has been exuding, is discovered.

The gum is the same mucilaginous substance that exudes from the cultivated stone fruits the world over, occurring, however, generally as a normal condition, and, perhaps, serving some definite purpose of life. Its consistency varies considerably, ranging from a gelatine-like mass to a thick liquid slime, depending upon the period of growth, or, perhaps, primarily upon the amount of available water in the plant cells. The gum is insoluble in alcohol, slightly so in water and always swelling up in this menstruum; it is colorless, tasteless, and transparent. Chemically, the gum is one of the vegetable mucilages, and is a mixture composed chiefly of bassorin together with arabic acid and its isomer, metarabic or cerasic acid. These occur as compounds of calcium, potassium, and magnesium. The elements found in the acids are carbon, hydrogen, and oxygen in the proportion represented by the general formula, $(C_6H_{10}O_5)_n$.

The gum is formed by a chemical metamorphosis of the cellulose composing the cell walls into the mucilage, in consequence

of which it obtains the property of imbibing or absorbing water thus causing the swelling. The consistency of the substance depends upon the quantity of water absorbed. This degeneration of the cell wall may not, as is often the case, affect the health of the tree, but in the circumstances under consideration is always a diseased condition. The degeneration of plant tissue to form gum is to be distinguished from the gum—gumming from vesicles—found in many plants, as the Malvas, Elms, Basswoods and Pines. On the other hand it is formed much as is the gum-arabic, tragacanth, and bassorin of commerce. Like other secretions, they may under certain circumstances, be of use to the plants, but they have no value whatever as a means of adding to the food store of a plant. It was formerly thought that the powerful endosmotic attraction of water in plant cells, so necessary for plant growth, could only be brought about if the cells contained quantities of dissolved substances of the nature of gums, sugars, and proteids. This may be the function of the gum and would explain its presence in the trees in normal quantities.

As stated before, the most common cause popularly assigned for the excessive gumming is bacteria, or other micro-organisms. But in attempting to prove that micro-organisms cause the trouble, only negative results have been obtained; all things tending to show that such organisms appear subsequently and not as the cause of the gumming. From the orchardist's standpoint the theory that the disease is the effect of the work of some lower plant is even more untenable; for, gumming does not appear to be contagious; it is not in the least affected by sprays; all other fungous diseases are restricted in area in Oregon, but gummosis is found in all our orchards; affected trees often fully recovered without treatment of any kind; moreover, there appear to be other causes that clearly, and definitely, influence the flow of gum, and it is these that we assign as the chief cause of gummosis.

Injury to the plant cells seems to be the chief if not the only cause of the gumming. This injury seems to be done by two agencies, frost and heat. Hon. J. R. Cardwell,* President of the State Board of Horticulture, in the last biennial report of that Board, cites definite years and definite cases, dating from 1883

*Fourth Biennial Report Oregon State Board of Horticulture.

in which gummosis, after late spring frosts, and after conditions which greatly favored sunscald, appeared so plentifully that one could only assign the coincidences as cause and effect. Mr. Geo. Coote, the Assistant Horticulturist at the Station, an old and experienced orchardist, has for twenty years observed the same relations between these agencies and gummosis. Hon. Chas. L. Dailey, Horticultural Commissioner for the Second District of Oregon, in a lengthy correspondence, details results of investigations and observations from an orchardist's standpoint, extending over two years, the results of which have well convinced him that gummosis is the effect of frost and sunscald, the former more particularly. Reports of this nature from prominent practical orchardists might be multiplied but these are sufficient.

Both scientific and practical work, then, lend color to the view that gummosis is the result of a degeneration of the tissues of the tree brought about by injuries, principally by frost and secondly, sunscald. Of course, whatever affects the general health of the tree, as lack of drainage, or over cultivation, would make the plant tissues much more easily affected than if perfect health prevailed, and it is possible that these may be at times a primary cause of the trouble.

It may seem needless to carry the discussion of a simple matter of injury by frost and sun so far as has been done in thus discussing gummosis, but I have treated the subject in detail hoping to set at rest the mooted question of what causes gummosis. It now remains to briefly speak of the proper treatment to give an orchard suffering from gummosis.

The great aim that an orchardist seeking to avert gummosis, should have in view is, to have the wood of his trees fully matured and hardened at the end of each season's growth and to keep them back from that luxuriance of growth, indicated by bark-bound trunks and long willowy branches, which seem to be present in trees presenting favorable conditions for gumming. An orchard may be treated in four ways to secure this condition of the wood.

1st.—It may receive a soil treatment that favors the maturity of the wood. Cultivation should be stopped as soon as the trees have made a growth of from two to three feet and every means should then be taken to have this growth harden and mature.

Fig. 2.

PLATE IV.

Fig. 1.

This may be accomplished by in any way restricting the water and food supply, as by planting a catch crop of any plant having large leaf surface, as crimson clover or buckwheat.

2d.—The trees may be pruned or rather pinched and so hasten the maturity of the wood. A removal of the terminal buds a month before the leaves fall will check growth and a removal of a few branches bearing the youngest leaves, which actively assimilate food, will do the same.

3d.—The slope or exposure of the land may favor maturity of wood, a northerly exposure being best.

4th.—The trees may be protected from sun and frost by wrapping with heavy paper, cloth, or straw. This treatment has been found effective in numerous cases with both prunes and cherries.

Curl-leaf of the Italian Prune.

A curious phenomenon is to be observed in relation to the Italian prune in the Pacific Northwest. Beginning in midsummer the leaves begin to curl conduplicately without withering, but shriveling somewhat. As the season advances the leaves become a yellowish brown and many of them drop. Plate IV, Fig. 2 shows the nature of the trouble.

This curling of the leaves is reported from all parts of the Pacific Northwest and practically affects all of the Italian prune trees there being but rarely a tree that escapes. As far as I can learn all other varieties are exempt. In some orchards the trees are almost wholly stripped of their foliage. It goes without saying, that the damage done is very great, not only to the fruit crop of the present year, but to the vigor and longevity of the trees. In fact, should this trouble continue, and every year be as serious as last season, and no means be found to check it, the Italian prune must be given up as a standard variety, as trees cannot produce good fruit or live long when subjected to such a drain of vitality as this curl-leaf entails upon the Italian prune.

There are several theories as to the cause of the trouble, but most of them are mere surmises to be rejected at first glance. The commonest belief is that some micro-organism causes the curling, but after a careful microscopic study, this theory seems to me untenable. Moreover the trouble does not act in the orchards as if it were caused by a micro-organism; for instance,

it is found in all orchards no matter how isolated or how far removed from a source of contagion. Some say that only trees upon peach roots are attacked, but I am fully convinced that those upon plum roots are as badly attacked. The appearance of the foliage suggested to many, drouth. But trees are as badly affected in Eastern Oregon where orchards are irrigated as upon dry soil. While the trouble is greatly augmented by lack of drainage, poor cultivation, poverty of soil, and lack of pruning, yet it is prevalent to some extent when there is a surfeit of the opposite of any or all of these conditions, hence any one of them cannot be considered as a cause.

In a lecture given to the students attending the Short Course in Horticulture held at the College last winter Mr. M. O. Lownsdale* first made public a theory which seems to many the most fitting of any yet enunciated. Briefly, it is, that the trouble comes from a physiological or an anatomical defect or weakness in the leaf of the Italian prune under certain conditions, in which the contractile powers of the breathing pores of the leaf, or the guard cells surrounding the pores, are affected in a way that greatly hinders proper transpiration and respiration. Mr. Lownsdale suggests that Bordeaux mixture, by closing up the pores, may prevent much of the curling and orchards so treated coming under his observation seemed benefitted.

On my own part, the first surmise, after having given up the idea of any extended cause, or of the foliage being preyed upon by a micro-organism, was that the trouble might come from a weakness in the epidermal system of the leaves though I did not associate it to any extent with transpiration and respiration. This was suggested to me because the cells in the epidermal system seemed to be the only parts affected: they, always assuming, in the latter stages of the curling and yellowing, a shriveled, corky, appearance. Upon a comparative examination it was found that these cells in the Italian leaves were much larger, seemingly having a more delicate cell wall structure, and differing in general from similar cells in other varieties much more than cells in other varieties differ among themselves.

The first appearance of the trouble last season was immediately after a very hot wave in July. The second bad attack

*See Short Course Lectures, Oregon Agricultural College, 1897.

came after a hot wave in September. These hot waves extended pretty well over the whole Northwest. The fact that heat is the only unvariable factor that could possibly have to do with the trouble, lends much color to the view that heat, in connection with the weakness in the structure of the leaf of the Italian, as stated above, may be the cause. I offer this theory only as a hypothesis, hoping that another season may bring forth definite conclusions as to what the trouble really is, and, if any, the remedies for it.

Formulas for Fungicides.

I shall recommend but three formulas for fungicides, believing these three sufficient for all practical purposes. Bordeaux mixture is the favorite fungicide ; the following are directions for making it :

BORDEAUX MIXTURE.

Copper sulphate.....	6 pounds.
Lime (unslaked).....	5 "
Water.....	45 gallons.

Pulverize the copper sulphate ; place it in a coarse sack and hang it in a quarter of the water to dissolve. . Slowly slake the lime adding water only as fast as it is taken up ; dilute until the lime-water is of the consistency of milk or cream, and then strain through a sieve or a piece of burlap into the barrel containing the copper sulphate solution. When ready for use dilute to 45 gallons. The principal object in adding the lime is to neutralize the acid copper sulphate. If sufficient lime is not added the foliage will be injured. Therefore, *always test as follows*: Dissolve ten cents worth of ferro-cyanide of potassium in a small bottle of water. Add a few drops of this solution to the Bordeaux mixture and if a brownish discoloration appears in the water where the drops fell, add lime until such discoloration does not appear. A little surplus of lime is always desirable.

The strength of Bordeaux mixture can be much reduced and yet be efficient in some cases. For the third and fourth applications 60 gallons of water may be used instead of 45. No fears of burning the foliage need be entertained if the lime is fresh, of proper amount, and carefully slaked. When needed, Paris green can be used as an insecticide with the Bordeaux, thus saving an extra spraying. Some Oregon growers recommend a

greater quantity of lime, thus adding to the sticking qualities of the mixture. Four pounds of molasses added to the mixture will be perhaps more effective in making the mixture stick than the added quantity of lime.

When a large orchard is to be sprayed, a stock solution should be made as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water. Slake 50 pounds of fresh lime in a box. When to be used add the lime to so many gallons of copper sulphate solution. A sufficient quantity is added when no change in color is produced by the test given above. Dilute with 10 times as much water.

COPPER SULPHATE FOR WINTER SPRAY.

Copper sulphate.....	1 pound.
Water.....	25 gallons.

The above is a cheap, simple, effective, winter and early spring spray. Its effect on the fungi is the same as the Bordeaux though the mixture is not so lasting. It is obvious that it should never be applied to any plant then when the leaves are out.

COPPER SULPHATE SOLUTION FOR SUMMER SPRAY.

Copper sulphate.....	1 pound.
Water.....	250 gallons.

This is to be used when fruits are nearing their ripening period, when Bordeaux mixture would discolor them. This spray takes the place of the copper carbonate solution and is, we believe, preferable to it. It is too strong for any but the hardiest plants. For peaches there should be 500 gallons of water to 1 pound of copper sulphate.

THE FRUIT SOILS OF OREGON.

G. W. SHAW, A. M., Chemist.

WITHIN THE limits of this article it is out of the question to publish a detailed description of the soils of Oregon. Nor indeed has a very exhaustive study been made, hence in some cases it would preclude the possibility of very accurate generalizations. Still the question of soils is such a vital one to the horticulturist that he should be made acquainted with any facts, favorable or unfavorable, that are likely to affect the horticultural interests of the state.

Owing to the topography and climatic conditions of the state, sharp contrasts in agricultural possibilities are forced upon us. The Cascade range, 150 miles from the coast, divides the state into two parts, differing from each other so much in climate as to render the terms arid and humid strictly applicable respectively to the eastern and western parts of the state. The western area of this grand natural division is subdivided by the Coast range, between which and the Cascade lies the Willamette valley. While under the term humid area, we must include the entire western part of the state, yet the geological formations of the southern part of this area are so different from those of the Willamette valley as to give rise to an entirely different character of soils, and render it necessary to give them a place by themselves. Hence the retention of the term "Southern Oregon," as popularly used, to denote that portion of the western or humid

area south of Lane county, is very apt for our present purpose. The area east of the Cascade range is so radically different from the humid area of the western part of the state as to bring about distinctly different soil conditions, but not different from those of other parts of the world having a scanty rainfall. It is in this sense of limited rainfall that the term arid is used. It does not in the least imply that the lands are not of equal value with those of the humid area. Indeed, it is true that this same "arid" soil, is from natural causes, likely to be the very richest in plant food.

With these few remarks as to the natural divisions of the state, I proceed to discuss some of the more prominent features of the soils as they appear from an examination of a considerable number of samples.

In the following pages only those elements which are of chief importance in having often to be replaced in the shape of commercial fertilizers, will be considered, viz., lime, potash, phosphoric acid and nitrogen. Just what constitutes a sufficiency of these materials for successfully growing a crop will differ somewhat with the nature of the crop, and *very largely with the physical condition of the soil*. Prof. Hilgard, than whom no one is more competent to judge, gives the following as to the minimum percentages for a thrifty growth of green crops :

"LIME.—0.10 per cent in the highest sandy soil ; 0.25 per cent in clay loams ; 0.30 per cent in heavy clay soils, and it may rise with advantage to one or two per cent.

"PHOSPHORIC ACID.—In sandy loams, 0.20 per cent when accompanied by a good supply of lime. The maximum found in the best Mississippi table lands was 0.25 per cent ; in the best bottom land of the same region, 0.30. His investigations in connection with the Northern Pacific survey also showed that this ingredient was more abundant in the soils of Oregon and Washington than in the soils of California.* In the basaltic soils it may even run as high as .30 or more.

"POTASH.—The potash percentage of heavy clay upland soil and clay loams ranges from about 0.8 to 0.5 per cent ; lighter loams from 0.45 to 0.30 ; sandy loams below 0.30 and sandy loams of great depth may fall below 0.10 consistent with good productiveness and durability. Virgin soils with a less percentage than .09 he finds deficient."

The same author says in another article that "no virgin soil having .50 per cent, or over of potash will wear out first on that side of the store of plant food ; and much less will suffice in the presence of much lime and humus."

"HUMUS.—This is of great interest to us since it is the storehouse of

*Cal. Expt. Station Report 1888.

the nitrogen supply and its determination serves as a measure of the nitrogen. In oak uplands of the cotton states the range is usually between .70 and .80 per cent; in the poorer sandy soils from .40 to .50 per cent; in black calcareous 1.2 to 2.80 per cent. In Western Oregon it is not uncommon to find 3 and even 6 per cent."

It is not our purpose to discuss at this time individual soils except so far as they serve the purpose of illustration, but rather to discuss general soil propositions and to point out some of the differences existing in the typical soil areas. As a basis for discussion, below will be found a table showing the average composition of the Willamette valley soils, made up from 42 analyses, and in parallel columns will be found the average composition of California soils, and of the humid region farther east. When studied in the light of the preceding principles of interpretation much information may be gleaned.

TABLE 1.

ANALYSIS OF FINE EARTH.	Willamette Valley.	Average for States.* (Humid.)	Average for California.* (Arid.)
Insoluble Matter.....	65.18	84.03	67.88
Soluble Silica	5.02	4.21	8.96
Potash (K_2O).....	.23	.22	.94
Soda (Na_2O).....	.18	.09	.28
Lime (CaO).....	.83	.11	1.08
Magnesia (MgO).....	.76	.23	1.49
Manganese (Mn_2O_4).....	.08	.13	.06
Iron (Fe_2O_3)	16.45	7.43	15.02
Alumina (Al_2O_3)	.03	.05	.05
Sulphuric Acid (SO_3).....	.21	.11	.08
Phosphoric Acid (P_2O_5).....	10.77	3.64	4.40
Water and Organic Matter.....	99.77	100.19	100.05
Humus.....	1.63	1.50†	.75

Turning attention at first to the lime content, we find it to be .83 per cent, a somewhat higher figure than that given as probable from data at hand four years ago. Basing our judgment on the principles previously laid down, the valley soils as a rule could not be considered deficient in this ingredient, the figures in many text-books notwithstanding. It is popularly

*"Relation of Soil to Climate," Hilgard.

†From limited data.

supposed that the valley soils are deficient in this ingredient, hence I feel that on account of this widespread idea, and its great importance to the horticultural interests, the matter demands a careful consideration. I am at a loss to understand the general acceptance of this idea, unless it be, *first*, that no considerable deposits of lime occur within this area, *second*, that the older text-books have placed the limits for a calcareous soil altogether too high (from 4 to 20 per cent), as shown in more recent experiments, *third*, that poor results are often obtained with clover which is known to be a lime-using plant. However it may have sprung up *it is a fallacy*, at least so far as the bottom lands are concerned. Waiving the first possible cause of this notion as indicating nothing on the negative side of the lime question, as there are other compounds which may give rise to lime in soils, we come to the text-book statement concerning a calcareous soil. It is admitted that the soils are not *markedly* calcareous, yet "very much smaller percentages suffice to do all that lime can do: in very sandy soils less than two-tenths of one per cent impart the calcareous character to vegetation; in very heavy clay soil, from one-half to three-fourths of one per cent is necessary for the same purpose. But any further addition of lime to such soils changes the character of the vegetation no further, unless pushed to the extent of modifying materially its physical condition."* It is admitted as true that poor results with clover are often obtained, but that this is due rather to the present physical condition of the soil than to any inherent deficiency has been amply proven by results obtained at the Station, and also *by those farmers who have solved the problem of a proper physical condition for the crop. At the present time lack of drainage lies at the root of the difficulty with this and many other crops in the Willamette valley.* The presence of lime is well shown in the trouble so often experienced with the drain tile made in the valley. The tile are often found to blister and crack, which under the condition may be easily explained from slaking of the quicklime formed in the burning of the calcareous clay. The soils of the Willamette valley seem to be moderately supplied with lime, but carry a much less amount than either the soils of Southern or Eastern Oregon, the former on account of geological

*"Soil Studies and Soil Maps," (Hilgard) in Overland Monthly.

reasons, and the latter on account of climatic conditions. That these soils should be fairly well supplied with lime would be expected from *a priori* reasons on account of the basaltic origin a large part of them. The lime in the valley soils is not altogether in the form of a carbonate, indeed it is rare that sufficient carbonate is present to cause evident effervescence with acid, but even a casual examination shows a very common occurrence of *easily decomposable zeolites*, from which, by weathering, the lime may be constantly supplied. The decomposition of such rocks as those mentioned above *would naturally produce soils rich in lime and poor in potash*. Referring now to the minimum per cent of potash for a strong clay loam we find it ought to carry at least .30 per cent, to be consistent with good productiveness and durability, but in referring to the average content of the valley soils we find but .23 per cent, an amount much smaller than could be desired. But this is as consonant with our premise that such soils are likely to be low in potash as is the high lime content. It is altogether probable, however, that the potash of these soils is of a high general availability on account of the widespread disintegration of basaltic rock and zeolites. It is a well known action of lime to render available potash compounds otherwise inert. Just here, methinks, is, in a measure at least, the explanation of the wonderful fertility of the Northwest soils, but long continued draughts on the side of potash, as will be made by prune culture, is likely to rapidly deplete the soils of this ingredient. Knowing this about the potash content of our soils is it not reasonable to assume that this fact has something to do with the lack of thrift of old apple orchards as well as a lack of flavor in the fruit? For it is a fact well known to science that when potash is deficient in soils plants suffer greatly in their woody portions, which is likely to render them susceptible to attacks of fungous diseases, and in the fleshy part of the fruit, hindering the formation of starch and its conversion into sugar. Taken altogether, then, this question of the relation of potash supply to the health and thrift of our prune orchards, which remove large amounts of this ingredient, is a most important and interesting one, and will demand careful study on the part of the Station. *In the light of the present indications it is altogether likely that when the valley soils "give out" it will be first on the*

side of potash, and that in not a few instances could it be used to advantage now.

Analysis shows the phosphoric acid content to be about .21 per cent, which is all that could be desired, yes, even abundant. It is not at all likely that this will be demanded for many years to come, and this will be particularly true of the hill lands. *This heavy per cent of phosphoric acid in our soils, together with the probably high general availability of what potash does exist, will go a long ways toward explaining the long continued productiveness of the Northwest soils, when sowed to grain. But when the conditions are so changed as to bring the draught very heavily on the side of potash, as will be done in prune culture, if we may judge from the chemical nature of the soils, it is not at all probable that anything like these lasting qualities will be shown.*

The humus content of the soils—a fair measure of nitrogen—is excellent, 1.63 per cent, and largely exceeds that of California, .75 per cent, in whose soils the potash content is high. With proper care in the treatment of our soils it will be a long time before high-priced nitrogenous manures will have to be resorted to. It is not at all uncommon to find soils showing 2.5 per cent, and in rare cases even more.

I am now to speak briefly of the classes of soils, but limit it to those most prominent, for to undertake a consideration of the varieties due to local causes would demand much more data than is at our command.

In general in the bottom lands of the Willamette valley the soils have a tendency toward clay loams, with clay subsoils forming a hard-pan at varying depths. There are apparently two classes of these soils, one a dark loam, and the other more properly described as a gray loam, running into the so-called "white lands." These are really of about the same chemical nature, and probably represent only different stages of drainage capacity, which has brought about subsequent difference in their composition. Even the so much despised "white land," when properly drained, rapidly takes on the appearance of the other soils both as to color and texture, the better drainage of the darker soils, excepting the adobe, allowing more perfect humification, and preventing the loss of much valuable plant food. *These loams are rich in phosphoric acid, and humus, well supplied with lime, but*

weak in potash. Below will be found their average composition.

Analysis of Fine Earth. (Bottom Lands.)

Insoluble matter.....	64.72
Soluble Silica.....	4.39
Potash (K_2O).....	.24
Soda (Na_2O).....	.18
Lime (CaO).....	.83
Magnesia (MgO)...	.81
Manganese (Mn_3O_4).....	.08
Iron (Fe_2O_3)	}
Alumina (Al_2O_3)	
Sulfuric acid (SO_3).....	.03
Phosphoric acid (P_2O_5).....	.19
Water and Organic matter.....	10.57
Total.....	99.19
Humus	1.69

On account of the greater depth and lime supply of these soils they are perhaps the better prune soils, but the red hill soils *of sufficient depth* may equal them in potash and humus content, and surpass them in phosphoric acid, but it is not probable that the potash of the hills lands is as available. These red hill lands are nearly always better drained, and unless careful attention is paid to drainage of the bottom lands, they may well be chosen in preference to the latter. No better soil could be desired physically than that upon which the Belfontaine Prune Co.'s orchard is located, an analysis of which is here given. Physically it does not differ materially from the average of these lands.

Analysis of Fine Earth. (No. 411.)

Insoluble matter	65.74
Soluble Silica.....	4.94
Potash (K_2O).....	.21
Soda (Na_2O).....	.40
Lime (CaO) ..	.46
Magnesia (MgO).....	.05
Manganese (Mn_3O_4).....	.01
Iron (Fe_2O_3)	}
Alumina (Al_2O_3)	
Sulfuric acid (SO_3).....	.02
Phosphoric acid (P_2O_5).....	.34
Water and Organic matter.....	14.82
Total.....	99.55
Humus	5.96

There are many prune orchards now on bottom land that will be short-lived unless attention is soon given to draining them. Wretchedly bad drainage is the most common fault of prune

orchards in the valley, either from ignorance concerning the necessity of this all important matter, or from a "penny wise and pound foolish" policy of large acreage instead of a well prepared soil. This matter of drainage demands the attention of all horticulturists.

The following shows the average composition of the red lands:

Analysis of Fine Earth. (Red Lands.)

Insoluble matter.....	63.43
Soluble Silica.....	7.76
Potash (K_2O).....	.27
Soda (Na_2O).....	.59
Magnesia (MgO).....	.62
Manganese (Mn_3O_4).....	.01
Iron (Fe_2O_3)	}
Alumina (Al_2O_3)	
Sulfuric acid (SO_3).....	15.46
Phosphoric acid (P_2O_5).....	.01
Water and Organic matter.....	.29
Total.....	11.89
Humus	99.33
	1.34

To summarize the matter of valley fruit soils, the bottom lands offer, as a rule, the following advantages over the hill lands:

- 1st, Greater accessibility.
- 2d, Greater depth.
- 3d, Greater lime content.
- 4th, Probably a greater availability of potash.

As an offset the following advantages are offered by the hill soils:

- 1st, Better drainage, and therefore a more friable soil.
- 2d, Better supply of phosphoric acid.

In other respects there appears to be little to choose between them chemically.

Southern Oregon Soils.

There are two prominent valleys included in this area within which prunes are grown to a greater or less extent, the Rogue and the Umpqua river valleys. On account of the limited amount of work done upon the soils of this area it is not possible to present data with so much certainty as in the case of Willamette valley soils.

The characteristic soil of the southern area seems to be a reddish clay, which terminates in the high plateaus. The

characteristic dark loams, resulting from the decomposition of carbonaceous slates, occur in abundance throughout the valleys. Granite soils are also a common feature of the Rogue river valley.

From analyses that have been made it appears that *the soils of Southern Oregon in general carry considerably more lime than do the soils of the Willamette valley*—it least twice as much—the average so far stands 2.22 per cent for the former against .83 per cent for the latter. Such a condition we would expect to find from geological reasons, this section having been the area of fringing and barrier reef lime deposits in the early geological history of Oregon. The lime is most frequently present as a carbonate. The approximate average composition of the soils is as follows :

Analysis of Fine Earth. (Southern Oregon.)

Insoluble matter.....	62.45
Soluble Silica.....	8.74
Potash (K_2O).....	34
Soda (Na_2O).....	.21
Lime (CaO).....	3.22
Magnesia (MgO).....	.80
Manganese (Mn_3O_4).....	.25
Iron (Fe_2O_3).....	15.35
Alumina (Al_2O_3).....	.01
Sulfuric acid (SO_3).....	.13
Phosphoric acid (P_2O_5).....	9.52
Water and Organic matter.....	100.02
Total.....	2.25
Humus.....	

It is safe to say that the soils are stronger than the Willamette valley soils, not only in lime, but also in potash, *but weaker in phosphoric acid. It is not likely that these soils will first wear out on the side of potash, but rather on the side of phosphoric acid.* In this respect they approach the California soils as will be seen upon examination of the table given on page 78, although richer in phosphoric acid. The humus content of the soils of Southern Oregon thus far examined has been considerably higher than in the Willamette valley. We are not prepared to offer an explanation of this fact at present, although it may be due to the long continued wheat crops grown on the latter soils, and the open culture thus necessitated.

Taken all in all *the most lasting soils for the prune in Western Oregon will doubtless be found in the dark loams of the Umpqua valley.* These are fairly represented by the following analyses :

Umpqua Valley Soils.

ANALYSIS.	No. 612.	No. 613. (Sub-soil.)
Coarse Material.....	93.00	90.00
Fine Earth.....	7.00	10.00
ANALYSIS OF FINE EARTH.		
Insoluble matter.....	64.84	66.03
Soluble Silica.....	5.57	8.33
Potash (K_2O).....	.33	.21
Soda (Na_2O).....	.26	.13
Lime (CaO).....	2.32	5.15
Magnesia (MgO).....	.83	.72
Manganese (Mn_3O_4).....	Trace	Trace
Iron (Fe_2O_3).....		
Alumina (Al_2O_3).....	15.77	12.78
Sulfuric acid (SO_3).....		
Phosphoric acid (P_2O_5).....	.04	.14
Water and Organic matter.....	9.52	7.05
Total.....	100.58	100.54
Humus	3.55	.11

The red soils of the foot-hills of the southern area are likely, from their origin, to be quite variable in their composition, which will, perhaps, account for the ill esteem they have acquired. Before orchards are placed on these soils there should be a very thorough investigation of their lasting qualities. *The granite soils are proverbially short-lived.* They usually carry a high per cent of potash, but are sure to be very variable. While orchards are likely to do well on these soils for a time, they will not be found durable for prune culture.

I have been asked several times as to the "adobe" soils of Southern Oregon and have replied, and do reply now, as follows, and it is as true of the Willamette valley as of Southern Oregon:

There are two classes of soil that commonly pass under the term "adobe" in each of these sections--one a soil sour on account of an excessive amount of organic matter, and consequently after neutralizing the acidity by applications of lime this soil is as easily handled as most others. The soil is well supplied with plant food and is likely to be durable. The other passing under this name is an intensely tenacious black soil, rich in organic matter and usually in other plant food, being weakest in potash. On the following page an analysis is presented.

Adobe Soil No. 454.

Coarse Material > 6 m. m.....	32.79
Fine Earth.....	67.21
Capacity for water.....	46.00

ANALYSIS OF FINE EARTH.

Insoluble matter.....	52.68
Soluble Silica.....	6.85
Potash (K_2O).....	.19
Soda (Na_2O).....	.09
Lime (CaO).....	.65
Magnesia (MgO).....	.46
Manganese (Mn_2O_4).....	.23
Iron (Fe_2O_3).....	18.56
Alumina (Al_2O_3).....	
Sulfuric acid (SO_3).....	.04
Phosphoric acid (P_2O_5).....	.13
Water and Organic matter.....	13.60
Hygroscopic Moisture.....	6.62
Total.....	100.00
Humus.....	5.59

It is impossible to treat this satisfactorily except by tile drainage.

When so drained it forms a most excellent soil for fruit and other crops. In its present condition it is not at all suited to fruit, although pears, and possibly some varieties of apples, might be placed upon it, after it has once been well cultivated, if kept in excellent tilth for an inch or so. The first cultivation, however, is difficult to secure for it must be made at exactly the right time. Mulching would be beneficial to prevent rapid surface evaporation which causes compacting and cracking. Straw could be utilized to good purpose in mulching this land. *No permanent remedy can be expected except by under-draining.*

Soils of Eastern Oregon.

The appearance of the soils in Eastern Oregon is altogether different from those of the western part of the state. By far the larger part is of a gray, ashy appearance, darkening much on being wet. One coming from the darker soils of the Eastern States would be unfavorably impressed, but experience teaches that these soils are abundantly supplied with plant food, and analysis shows that they are probably the most fertile soils of the state. The wonderful fertility of these soils is shown in their enormous yield of crops from year to year. The soil is exceedingly deep in most localities, and of such a texture as to be easily worked.

The difference in composition between the soil of Eastern

and of Western Oregon is well shown by the following table, giving averages of a considerable number of analyses.

Analyses of Fine Earth.

	Willamette Valley.	Eastern Oregon.
Insoluble matter.....	65.18	66.59
Soluble Silica.....	5.02	13.12
Potash (K_2O).....	.23	.43
Soda (Na_2O).....	.18	.22
Lime (CaO).....	.83	1.22
Magnesia (MgO)....	.79	.75
Manganese (Mn_2O_4).....	.08	.10
Iron (Fe_2O_3) {		
Alumina (Al_2O_3) }	16.45	10.68
Sulfuric acid (SO_3)....	.03	.04
Phosphoric acid (P_2O_5).....	.21	.14
Water and Organic matter.....	10.77	6.21
Total.....	99.77	99.51
Humus.	1.63	1.44

Comparing the soils of the arid with the humid areas along the lines of so-called critical elements, it will be noted that the two sections differ markedly in lime content—the *Eastern Oregon soils carrying much more lime than those of the humid or western area*. There is one feature that differs materially so far as observed, viz., that *there appears to be no great difference between the lime content of the uplands and the lowlands of the arid area*. This conforms with conditions pointed out by Prof. Hilgard, of California, that *all arid soils are naturally calcareous*.* The converse of this, however, is by no means true, for there may be local causes which will very materially alter the conditions. We have an illustration of this in the southern area of the humid region, where the lime supply surpasses that of the arid area. (See page 78.)

The potash supply of the Eastern Oregon soils is also superior to that of the humid area, standing .43 per cent against .23 per cent. In view of this abundant supply *it is not at all likely that these soils will wear out on the side of potash*. The greater abundance of potash in these soils is augmented much by being in a very soluble form thus rendering it even more available than that in the soils of the Willamette valley. The phosphoric acid supply of the humid area, however, is superior being .21 per cent against .14 per cent for the Eastern Oregon soils. This is doubtless the weakest point in the soils of the arid area of the Northwest.

*Report of California Station, 1892-1893.

The humus percentage is excellent, although, as might be expected from climatic reasons, not as high as in the Willamette valley, *but recent experiments indicate that the humus of the arid regions carries much more nitrogen than do those of humid areas in the ratio of 3 to 1.** If in future experiments this proves to be true in our state, as without doubt it will, it means that while the humus per cent is lower the actual nitrogen content is higher in the Eastern Oregon soils than in those of the western area. Summarizing the lime, potash, and phosphoric acid of the three great areas we find it as follows :

TABLE II.

	Willamette Valley.	Southern Oregon.	Eastern Oregon.
Lime (CaO).....	.83	2.22	1.22
Potash (K ₂ O).....	.23	.34	.43
Phosphoric acid (P ₂ O ₅).....	.21	.13	.14

The climate has much to do with these differences, although the abundance of lime in the southern area is mainly due to geological reasons as mentioned before. The difference in rainfall, forming the basis of our classification into humid and arid areas, is admirably set forth in an article by Mr. B. S. Pague, so long at the head of the Weather Bureau in this state.†

"The air, laden with moisture, passes from off the ocean, and meets its first obstruction, the Coast Range of mountains, on which and to the westward to the ocean the moisture is condensed and falls in the form of rain. * * * * The moisture which is not precipitated on and to the west of the Coast Range is carried across the Coast Range and distributed through what is locally called the Willamette, Umpqua, and Rogue River Valleys extending from the Columbia River to the California line. These are the interior valleys; and in them the moisture decreases from the north to the south, the average rainfall at Portland, in the north, being 49 inches annually, while at Ashland, on the south, it is but 21 inches annually. The moisture-laden winds, continuing on their eastern course, pass over the Cascade Mountains; and having deposited a large proportion of their moisture already, but little remains for the vast area east of the Cascade Mountains, termed Eastern Oregon. This section of the State has an elevation south of the Columbia Valley of from two to six thousand feet, and has an average annual rainfall of from 10 to 15 inches. In the Columbia River Valley the annual rainfall varies from 14 to 20 inches. This brief resume shows a decline in the amount of precipitation from the west to the east."

Thus it is seen that there is a difference of from 20 to 30 inches in the annual rainfall of the two sections. *This difference in rainfall and the lower level of the bottom water, or country drainage, ex-*

*California Station Report, 1892-93.

†Resources of Oregon.

plains the accumulation of lime, potash, and other soluble compounds in the soil of the eastern area In not a few instances have these accumulated to such an extent that the salts appear on the surface in the dry season as alkali. In a later bulletin it is intended to discuss this more at length, but inasmuch as in a few instances orchards have been placed on these soils they demand a passing notice. It is well to state here that the material composing alkali is no different than that being formed constantly everywhere, and that its appearance on the surface is simply due to the fact that the rainfall is insufficient to carry these soluble salts into the country drainage, but from year to year they are periodically washed into the soil to the depth of a few feet only to rise again with the evaporation of the water at the surface. Hence it is seen that the deeper the water penetrates—provided only it does not reach the country drainage—and the greater the evaporation, the more salts will there be brought to the surface to appear as alkali. The depth to which the water of precipitation penetrates in most cases is marked in most by the existence of a hardpan at varying depths. This hardpan has invariably been formed by the cementing action of the lime upon the diffused clay carried down by the storm water. These basins are always found underlying bad alkali spots and *before any permanent cure can be effected the impervious layer must be destroyed, otherwise, whatever may be done will be but a mere makeshift.*

It is well known to those who live in regions where alkali prevails that there are two kinds, viz., the white and the black varieties. Of these the former is by far the least injurious on account of its comparative neutrality. The main ingredient of the white variety is sulfate of soda, which, not having the power to dissolve the organic matter of the soil, remains white. It is comparatively harmless, and unless it has accumulated in excessive amounts is easily managed. *The most permanent remedy will be under-draining the land with tile and then thoroughly washing out the salt.* This is the best as well as the most expensive means of removing the difficulty. There are other cheaper and less expensive remedies such as digging open ditches lower than the level of the surface of the land to be treated, running these drains into the nearest natural outlet. Then by flooding these lands, not allowing the water to stand long enough to soak into the soil

and thus carry with it the dissolved salts, most of the alkali that has collected on top can be removed. This treatment repeated a few times and followed by thorough and deep cultivation will be all that is required. In many cases, where the white salt has not accumulated in too great quantities, deep and thorough cultivation will be all that is needed. Such frequent and deep tillage keeps the ground in good tilth, and prevents the rapid surface evaporation. It also mixes the top, which is likely to be the strongest, with the soil lower down, and therefore dilutes the salt. It would be far better to avoid these soils for fruit unless they are permanently cured by under-drainage, devoting them to other crops which can be used to advantage.

The black variety of alkali is far more difficult to deal with on account of its ability to dissolve the organic matter, *humus*, of the soil. In times of drought these spots are marked by a series of black rings left about the margins of the dried up pools. The active alkaline ingredient of these soils is sodium carbonate, commonly called sal soda, the corrosive action of which is well known to housekeepers. When water is available, chemical remedies, coupled with those given above, may be successfully employed. By means of gypsum applied at the rate of 500 lbs. per acre, the black form will be changed to the white, which may then be given the above treatment. *Gypsum is the only practical antidote for black alkali.* It should be sowed broad-cast, and well harrowed in.

Certain crops also have the power to remove a considerable amount of alkali from the soil if grown for several years in succession. Among these are beets carrots, turnips, and any crop which will shade the ground thereby lessening the amount of surface evaporation.

These alkali soils are the very richest in the state, a number of the compounds composing the alkali being recognized as of direct value as fertilizers, as sulfate of potash, phosphate of soda, nitrate of soda, chlorid of soda, and carbonate of ammonia, which occur together with the sulfate of soda, and carbonate of soda mentioned above. Thus it will be seen that from the very nature of the case these soils are bound to be very lasting, and in many instances will well repay for the trouble required to recover them.

THE COMPOSITION OF OREGON PRUNES.

By G. W. SHAW, A. M.

OUTSIDE OF the state of California but little systematic investigation of the chemistry of fruit has been undertaken in the United States, and if grapes and wine be excepted, but a limited amount of work has been done there. Quite extensive plans had been formulated for studying undried prunes the past season, but the conditions which prevailed rendered it impossible to prosecute the plan in full. It is intended that these investigations shall be a part of the continuous work of the Station, and to study not only the composition of prunes and other fruit, but also the draught of the various fruits on the soil. It must be borne in mind that such work is extremely intricate, and requires a large amount of time and labor, hence amid the multitudinous duties pressing in other directions, progress is necessarily slow.

The prune has been selected for the first work since at the present time it is demanding a large share of attention in the state, and is undoubtedly to be one of the leading fruits of the Northwest. The work here presented is far too meagre to serve as the basis for broad conclusions, but there is a sufficient number of analyses to serve as an indication of the condition of our fruit. It is hoped by the continued study of the proximate and ash composition of the various fruits, and their varieties, to determine something of value as to their relative merits as food, and as to the influence of climate, soil and fertilizers upon them. The question of soil exhaustion is bound to be a burning one, and by "taking time by the forelock," we hope to show the lines of heaviest draught upon soil ingredients. This together with a study of the soil capabilities is of the utmost importance to the horticulturist. Again, the question of food composition is rapidly oreing itself to the front, and ere long

TABLE III
Showing Analyses of Fresh Prunes.

Laboratory No.	Variety	Grower	Locality	Average Weight in Grams.	Number per Pound.	Per Cent of Flesh.	Per Cent of Pits.	FLESH.			SUGAR.			Acidity in Juice, Terms of SO ₃	Nitrogen in Flesh.	Albumenoids in Flesh. N x 6.25	Crude Ash.	Water.	Organic Matter.	Crude Ash.	Total.	Laboratory No.
								Per Cent of Juice, Pressed.	Per cent of Pulp.	In Fresh Flesh.	In Juice.	In Fresh Fruit.										
579	Italian	Wm. Hardless	Corvallis	29.5	15.4	97.29	2.71	75.8	24.2	14.04	18.55	13.66	4.3	2.12	1.33	74.26	24.09	1.63	100	579		
580	Petite	H. F. Fisher	"	30.8	14.8	95.08	4.92	73.5	26.5	17.52	23.02	16.66	6.1	2.65	1.66	75.26	24.29	.45	100	580		
581	Silver	"	"	47.8	9.5	95.29	4.71	73.5	24.5	10.26	13.59	9.77	4.2	2.57	1.61	81.43	18.00	.57	100	581		
582	German	S. Whiteside	"	16.7	33.7	95.38	4.62	73.5	25.0	8.16	10.99	7.70	3.8	1.53	.96	79.48	19.91	.69	100	582		
583	Italian	John Hall	"	36.6	12.4	93.01	6.99	61.0	39.0	12.92	21.28	12.01	...	1.61	1.13	77.89	21.24	.87	100	583		
584	Petite	"	"	29.2	15.5	92.17	7.83	78.6	21.4	16.42	20.89	15.13	5.7	2.33	1.56	74.11	25.22	.67	100	584		
585	Italian	"	"	31.5	14.4	95.28	4.72	68.2	31.8	11.44	16.77	10.89	9.2	1.70	1.06	75.34	24.78	.88	100	585		
586	Petite	J. D. Johnson	Corvallis	23.0	19.7	92.00	8.00	75.8	25.0	8.90	11.86	8.19	6.5	2.33	1.56	83.41	25.02	1.02	100	586		
587	Petite	E. Witham	"	57.0	7.9	93.18	6.82	63.2	36.8	15.16	23.97	14.03	6.5	1.70	1.06	69.91	29.02	1.07	100	587		
588	Silver	D. C. Rose	"	17.7	25.7	92.60	7.40	73.7	24.3	15.08	19.79	14.04	3.5	2.00	1.24	77.70	21.67	.63	100	588		
720	Petite	J. K. Shepard	Zena	32.1	14.2	94.56	5.44	70.2	29.8	8.52	12.13	8.08	3.7	...	...	69.92	29.07	1.01	100	720		
721	Italian	"	"	32.1	14.2	94.56	5.44	70.2	29.8	15.08	19.79	14.04	3.7	...	...	77.70	21.67	.63	100	721		
722	Silver	"	"	36.3	12.4	92.77	7.23	83.0	17.0	14.86	17.83	13.80	3.9	...	...	77.58	21.71	.71	100	722		
733	Petite	"	"	24.2	18.7	94.12	5.88	73.4	26.6	16.54	20.67	15.61	2.4	...	...	76.35	22.80	.85	100	733		
742	Italian	G. A. Hobbs	Freewater	...	...	...	...	80.0	...	14.93	17.52	...	4.0	...	1.32	...	...	...	...	742		
743	Italian	Geo. Thompson	McMinnville	...	...	...	...	73.0	...	12.38	...	...	...	...	1.37	...	...	...	...	743		
744	Silver	C. L. Dailey	Salem	...	...	...	...	...	...	14.58	...	...	...	...	1.25	...	...	...	...	744		

properly balanced rations will demand the careful attention of the housewife. The physical data as to pits, flesh, juice, etc., from a commercial standpoint, and the albumenoids and sugar content, the nourishing parts of the fruit, render it important to the consumer to know the relative merits of varieties, and no less is this true of the producer, who should be made aware of the real worth of the fruit he grows. It is only in this way that the special merits of fruit grown in different localities can be determined. Further it is proposed to examine the different methods of curing the fruit, which is of itself worthy of consideration, for to be able to produce a better quality and quantity of fruit may mean the difference between profit and loss to many a man. To illustrate, if it is possible to demonstrate that for every 100 lbs. of fruit now cured by a certain method there would be a gain of no more than 5 lbs. by the exercise of particular care in certain lines it would return, many times over, the cost of the work. Thus the question of the composition and curing of fruit is not of minor interest either from a scientific or economic standpoint, but is one of paramount importance to the industry.

The accompanying table shows the composition of some Oregon prunes as analyzed at the Station.

Notes on the Analyses.

WEIGHT OF PRUNES.—The range of all prunes examined is from 16.7 grams in No. 582 to 5.70 grams in No. 588. The average weight of the Petites was 24.9 grams. This is against 23.6 grams, the weight of California French prunes so far published. Thus the Oregon French prune requires 18.2 prunes for a pound while those of California require 20.4. The average weight of the Italian prunes was 32.4, which would require 13.4 prunes for a pound. Italian prunes No. 584, from the Umpqua valley are worthy of notice on account of their large size; and they are also significant on account of the size of their pits, which constitutes more than one-fifth the weight of the prune. It will be interesting to watch future work as to whether all prunes of that region are characterized by these same features.

PROPORTION OF PITS TO FLESH.—The percentage of pits ranges from 2.71 in Italian No. 579 to 8.60 in Silver No. 587. The average for the Petite prune, 6.81 per cent, indicates that the fruit contains about 14 times as much flesh as pits. The

California analyses show a little smaller pit, making the per cent of flesh about 3 per cent higher. The California prune approaches more nearly the European in this respect, for the average pit percentage for the European fruit is 5.4. After further investigation 14 may be found too low a number to express this relation of flesh to pits, yet it is hardly probable that it will be changed so much as 3 per cent. The Italian prune seems to carry about 19 times as much flesh as pits, making them so far as the *amount* of flesh is concerned much the more economical fruit. At this point it is interesting to refer again to analysis 584, and recalling the large size of these prunes together with their large pits, and to note that the proportion of flesh to pits is as 13 to 1 while the average for Italians was as 19 to 1. I deem it to be the more interesting to follow future analyses from this locality closely since the exceptionally large and apparently well developed fruit from that region has attracted much attention, and it is popularly supposed to be the best region in the state for prune culture.

PROPORTION OF JUICE TO FLESH.—The largest proportion of juice is shown by the French prune, the average being 75.5 per cent, exceeding the Italian by about 9 per cent.

THE SUGAR AND ACID CONTENT.—The chief interest in prunes centers about the sugar and nitrogen content. The honors can be divided about equally between the California and the Oregon fruit, for the former evidently excels in sugar and the latter in nitrogen. An examination of the table shows the average sugar content for all prunes analyzed to be 17.52 per cent *in the juice*, or 14.03 per cent in the flesh, or edible part. The soft-fleshed French prune shows 2.21 per cent more sugar in the juice than the average for all prunes, i. e., 19.25 per cent against 17.52 per cent, and a difference of 2 per cent in favor of the French over the Italian, which contained on an average 17.18 per cent sugar in the juice. It is regretted that data is not at hand to indicate the difference in the sugar content of early and late picked Petites. Some indications may be had from the following little table showing the composition of ripe and unripe prunes when dried. These prunes were selected of about the same size, and those marked *ripe* were such as fell from the tree after a *very gentle* shake, while those marked *unripe* required a *very vigorous* shake to remove them. The flesh of the former

was just beginning to soften, while that of the latter was still quite hard and unyielding. The two samples were dried in the same tray at the same time, and contained respectively when dried 18.82 and 18.47 per cent of water.

Ripe fruit (735) contained 25.60 per cent sugar in flesh.

Unripe fruit (734) " 19.18 " " " " "

Analysis of the undried prunes from which the above samples were taken showed them to have a much lower sugar content than the average Petite, and it will be noted that the sugar content of the dried product is very low as well, yet the analyses serve to illustrate what may be expected from drying prunes, when too green. Neither of the samples were sufficiently ripe, and do not represent what should be expected of well ripened prunes when correctly dried. Such prunes should carry at least 10 per cent more sugar than the best of the above mentioned, (735).

There is still another reason, one which appeals more directly to the financial side of the case, why the fruit should be allowed to become thoroughly ripe. This lies in the fact that 100 lbs. of ripe fruit when dried will yield a greater per cent of the dried product than will unripe fruit. This is well illustrated by results obtained in drying the prunes mentioned above.

TABLE IV.

Lab. No.	Condition.	Lbs. used.	Dry Fruit obtained.	Lbs. Dry from 100 lbs. Green.	Hours Dried.	Water
734	Unripe	5	1.75	35	23	18.47
735	Ripe	5	2.00	40	24	18.82

That the importance of observing this simple precaution in the drying of prunes may be the better appreciated attention is directed to the following figures: Assuming that the above figures represent average amounts of fruit obtained under the conditions given, and that an average yield of a mature orchard is 12,000 lbs., the saving of this small amount on the product of an acre would be 600 lbs. of dried fruit, which at 5 cts. a lb. represents a saving of \$30 for each acre, a sum not to be ignored by any means, even if the results in future experiments should lessen it by one-half.

The California Reports show the French prune to contain on an average (13 analyses) 23.69 per cent sugar in the juice, indi-

cating a difference in average sugar content in favor of the California fruit of about 4 per cent. The average sugar content of all analyses (13) is related to those of California as 17.52 to 20 per cent in the juice. From the difference in the climatic conditions, we might expect, *a priori*, such a difference to occur.

While it is possibly no positive injury to Oregon prunes to to be characterized by a distinct tartness, yet care should be exercised that this is not unnecessarily increased. The tartness may be reduced to a minimum by seeing to it that the fruit is thoroughly ripe before drying. After careful observation and experiment I am satisfied that it is an altogether too common practice to dry prunes before they are sufficiently ripe, thus securing a prune which is not only of low food value, but also of increased tartness. Carelessness in this direction will tend much to lower the standard of Oregon prunes in the market, and cause them to lose the position they might otherwise occupy.

Contrasting the Oregon fruit with 17.52 per cent sugar in the juice with that of Germany carrying 6.15 per cent sugar, we see that the prune product is nearly 3 times as rich in this ingredient. In this respect the sample of German prune, No. 582, is significant in carrying 10.90 per cent sugar in the juice, which is 4.75 per cent higher than the average of all prunes for Europe.

In the acid content the prunes examined present a wide variation. The average acidity in terms of sulfuric acid was found to be .46 per cent.

ALBUMENIDS.—This is a class of bodies which contain about 16 per cent of nitrogen, and which in all ordinary analyses is determined from the nitrogen content by multiplying it by 6.25. It is the function of this class of bodies, and of this class alone, to form flesh or muscle in the animal body. So far as we know none of this material is elaborated in the body, but must all be obtained from external sources, hence the great importance of the albumenoids in any article of food.

Referring to the table, the maximum, 1.66 per cent of albumenoids, will be found in the Petite, No. 580, and the minimum per cent, .96, in the German, No. 582. The average for Petites was 1.50 per cent against 1.20 per cent in the Italian, and 1.30 per cent for Silvers (in the case of Italian and Silver inclusive of of one analysis each not given in the table because incomplete).

Nos. 580 and 585 are particularly rich in these ingredients. In this connection it is interesting to note that the report of the California products show as an average of 20 analyses .837 per cent albumenoids in the flesh against 1.32 per cent for Oregon fruit. No analyses showing the albumenoids in the edible portion of European prunes is at hand, but in the whole fruit there is reported .78 per cent.

It is indicated that Oregon prunes carry *double* the albumenoids contained in the European product, and have a somewhat higher per cent of this ingredient than the California product. This is evidently one of the strongest points of the Oregon fruit, and as the study of human foods progresses in the United States will tend to bring our fruit into greater prominence.

Food Value of Prunes.

Below is given a table showing the average food constituents of the prunes so far analyzed.

TABLE V

Showing Food Constituents in the Edible Portion of Oregon Prunes.

CONSTITUENTS.	Petite.	Italian.	Silver.	German.	Average.
Water.....	77.62	74.33	76.31	79.40	76.35
Solid Matter	22.38	25.67	23.69	20.60	23.65
Total.....	100.00	100.00	100.00	100.00	100.00
Sugar.....	14.89	11.75	13.70	8.16	14.03
Albumenoids.....	1.50	1.20	1.30	.96	1.32
Crude Fiber	5.04	11.16	7.61	9.59	6.99
Fat					
Nitrogen-free Extract }					
Ash.....	.69	1.02	.78	.69	.85
Acid.....	.26	.54	.30	.20	.46
Total.....	22.38	25.66	23.69	20.60	23.65

An examination of this table indicates that the French prune exceeds the Italian in water by about $3\frac{1}{4}$ per cent, and that it leads in albumenoids, or flesh forming matter, the Italian carrying less of this substance than either the Petite or Silver. On the side of carbohydrates, of which sugar is the principal ingredient, the Petite also leads with 14.89 per cent in the edible portion. In relation to the distribution of nitrogen in the *whole* fruit, concerning which we have made no investigations on account of pressure of work in other lines, I quote :*

*

*

*

"The flesh holds 85 per cent of

*California Station Report, 1892-1894.

all the nitrogen, leaving 15 per cent of it as waste, so far as food values are concerned. Second, the proportional distribution of nitrogen in the pits of the prunes and apricots to the kernels and shells rate on the whole about the same (12 to 1) although we note great variation in this respect in both fruits."

Below a table is given showing the food constituents of 13 samples of dried prunes, all but the last two of which are Petites, Nos. 746 and 747 being Silver prunes.

TABLE VI
Showing Composition of Dried Prunes.

Laboratory Number.	Water.	Albumenoids.	Ash.	Sugar.	Other Carbohydrates.	Acid, as SO ₃ .	Total.
724	22.45	2.38	2.83	23.76	48.02	.56	100
726	19.22	1.94	2.03	.....	.....	.28	100
728	20.11	2.38	2.12	29.64	45.40	.35	100
729	21.46	1.41	2.21	36.66	37.86	.40	100
730	21.03	1.94	2.92	24.74	49.05	.32	100
731	19.75	1.56	2.42	31.26	44.62	.39	100
734	18.47	2.12	2.62	19.18	57.29	.32	100
735	18.82	1.37	3.02	25.60	50.87	.32	100
736	16.85	2.00	2.52	28.55	49.80	.28	100
741	25.82	2.43	1.58	27.36	42.49	.32	100
745	18.84	2.00	2.05	22.92	54.01	.18	100
746	26.68	2.62	1.78	16.42	52.25	.25	100
747	27.49	1.68	1.86	18.06	50.94	.29	100

In examining these results it must be distinctly understood that they are in all respects preliminary, and are recorded as indications which are very likely to need more or less modification as our work progresses.

ASH AND ITS COMPOSITION.—Among the most important considerations concerning any crop is the composition of the ash, for the constituents of the ash represent the draught upon the soil. An article recently appeared in the "Rural Northwest" from which I quote :

"There is no doubt that the many failures in fruit production in the East are largely due to the exhaustion of important elements of plant food in the soil. All farmers realize the importance of keeping up the fertility of the soil for the production of their annual crops of grain and vegetables, but somehow the idea has been prevalent that a tree can take care of itself. Men look at the great trees of the forest and see how they grow and how the soil increases in fertility under their influence, and think that the same should be the result in the growing of fruit trees, while they are carrying

off continually, not only the fruit that the orchard produces, but in many cases expect the land also to produce food for their stock. And then, when the orchard fails to give the expected fruit, and its decrepit condition makes the trees alike the prey to insects and fungous diseases, they declare that the climate has changed and we can no longer produce crops for that reason. It has really been because they and their fathers have robbed the soil until the needed food for the production of healthy trees and perfect fruit is no longer available."

It is essential to future prosperity, then, that careful study be made as to the draught not only of our prunes but also the other fruits on the soil of the state. Work in this direction has progressed sufficiently to say that the Petite prunes carry less than the average per cent of potash—about two-thirds as much as the California fruit. When the condition of our soils as set forth by the writer elsewhere in this Bulletin is considered this low content of potash in the ash is not at all surprising. Again the phosphoric acid content of the ash is in excess of the average of prunes elsewhere.

This matter will be treated more at length in a future publication for which experiments are now in progress.

INSECTS OF THE PRUNE.

By A. B. CORDLEY, Entomologist.

HE PRUNE, wherever grown in the United States, has been unusually free from insect injury. Nearly or quite two hundred kinds of insects feed upon the apple. Probably half as many feed upon the pear, or peach, or cherry, and yet scarcely a score of species are known to feed upon the prune. The apple has its codling moth, its woolly aphis, and its green aphis. The pear has its blister-mite and its pear-tree psylla. The cherry has its slug and the plum its curculio; but fortunately no insect has as yet established a claim to being distinctively classed as a serious prune pest.

There is no good reason, however, for hoping that this immunity from insect injury will long continue. Prunes have been grown extensively in Oregon only within recent years; hence there has been no opportunity for the rapid multiplication of insects that feed upon it—no opportunity for those species which may have accidentally acquired a taste for the various parts of the tree, or for the fruit, to transmit that taste to any great numbers of their progeny.

So soon, however, as any crop is grown extensively in a given locality, experience has shown that, in their intense struggle for existence, native and introduced species of insects will be driven to acquire the habit of feeding upon it, and some of them will eventually multiply to such an extent as to become more or less serious pests. Such has been the history of insect depredations upon numerous other crops, and there is no good reason for hoping that the prune is to be an exception.

Already, scattered reports begin to come in from different parts, of more or less serious injury from insects that, hitherto, have not been known to feed upon this plant. Even within our own state several species have become quite generally injurious.

while others are doing more or less serious damage in certain localities.

In view of the above facts, it has been thought best to conclude this Bulletin with a preliminary report on prune insects, in order that the grower may be enabled to recognize some of the worst pests as soon as they appear upon his trees, with the hope that it may aid him in subduing their attacks, and that it may create an interest in the subject which may lead to many new and important observations in the future. We expect to continue our investigations along this line, and sincerely hope that every one interested in prune-growing will aid, by sending to us any insects they may find injuring either the tree or the fruit of the prune.

For the greater convenience of those who may wish to refer to the following pages, the insects have been classed under the following heads :

- A. Insects injuring the roots, Nos. 1 and 2.
- B. Insects injuring the trunk, Nos. 1, 2 and 3.
- C. Insects injuring the branches, Nos. 4, 5 and 6.
- D. Insects injuring the leaves, Nos. 7, 8, 9, 10, 11 and 12.
- E. Insects injuring the fruit, No. 13.

No. 1. The Peach-Tree Borer.

Sanninoidea exitiosa, (Say).

This insect, which promises to be one of the very worst insect enemies of the prune, is the well known Eastern Peach-tree Borer. It was first described by Mr. Say nearly seventy-five years ago under the name *Aegeria exitiosa*.* Several years ago the species was transferred to the genus *Sannina*, since when it has been known as *Sannina exitiosa*. Recently, however, Mr. Beutenmuller, who is making a critical study of the North American Sesiidae, has concluded that the species should form the type of a new genus, *Sanninoidea*,† so that henceforth this insect will probably be known scientifically as *Sanninoidea exitiosa*, (Say).

Prevalence in Oregon.

My attention was first called to the work of the borer upon prunes very soon after I arrived in the state, by Mr. Brady Bur-

*Jour., Phil. Acad. Nat. Sci., Vol. III, p. 216, 1823.

†Bul. Am. Mus. Nat. Hist., Vol. VIII, p. 126, 1896.

nett, a graduate student in entomology, who, early in October, 1895, brought me a number of the larvæ of various sizes that he had taken from prune trees just south of Corvallis. Since then, observation in different parts of the state, and numerous letters of inquiry from various localities show that it is widely distributed at least in Western Oregon.

Under date of July 27, 1896, Mr. C. L. Dailey, Horticultural Commissioner for the Second District, wrote me as follows:

"I find in my district that the Peach-tree Borer is doing a great deal of damage to prune trees—it seems to make no difference whether the trees are grafted on peach or plum stock. As old a pest as this is and as familiar as I am with it, I find very little authentic information has been published as to its life cycle and description. I am not convinced that the borer, that we have here to contend with in our prune trees, is the same as the Peach-tree borer of the East. They are serious this year and I should like more definite information regarding them."

Aug. 8, 1896. Mr. Dailey sent me specimens of the larvæ and pupæ of this insect and wrote:

"We are cutting out as high as twenty larvæ from a single tree. They have done a world of damage. Many trees will die. *The trouble is mostly with my Silver prunes, the Italians not nearly so bad.* The trees have been "grubbed" every year, but I have never seen them so badly infested as now."

Aug. 19, 1896, Mr. R. V. Pratt wrote from Lookingglass, Oregon:

"I have now inspected some 4000 out of 6000 trees. We have found several hundred trees infested by this pest. In quite a number they have penetrated the heart of the tree and it breaks easily when bent. Many of the trees have been entirely girdled and will die. I found from one to six "grubs" in a tree. *About all the damage is to the Italians.*

The above extracts from my correspondence, together with the fact that during a recent visit to Southern Oregon, the borer was found doing considerable injury to both peach and prune trees, and a recent examination of about 1200 trees about Corvallis, revealed that nearly ten per cent of them were infested, are sufficient to show the injury being done to prune orchards by this pest.

Introduced into Oregon.

Just when and where the peach-tree borer was introduced into Oregon is not known, but it probably made its first appearance at Salem nearly twenty years ago. Mr. S. A. Clark, who has been so long and intimately connected with the fruit interests of the state, writes as follows:

"My first acquaintance with them was about 1881, when I purchased trees from a local nursery. I found, when too late, that they were infested."

Mr. J. H. Settlemier & Son, proprietors of the Woodburn

nurseries, write that to the best of their knowledge the borer was introduced near Salem about 1880. They write :

"It is presumed that they came in trees from eastern nurseries, as at that time there were quite a few trees sold here from nearly all the large eastern establishments."

Is Spreading Rapidly.

Although this borer has been present in Oregon nearly a score of years, yet as Mr. Dailey says, very little authentic information has been published regarding it. What few references there are to it, in the horticultural literature of the state, would lead one to infer that only within the last two or three years has it attracted attention as a prune pest, and when viewed in the light of our recent observations, show conclusively that it is multiplying and spreading very rapidly in prune orchards.

Prof. F. L. Washburn mentioned it as "one of the worst pests with which Oregon orchardists have to contend," and adds that in addition to peach trees, "cherry trees and plum trees sometimes suffer from their attacks."* In a later publication he states that it is abundant, but under the head of plants injured mentions only peach trees.† Mr. Varney writes that it is "quite troublesome" in some localities, but lists it as the peach-tree borer and does not mention that it injures other trees.‡ In a still later publication, Prof. Washburn evidently reiers to the prune in the statement that the moth "lays its eggs on the plum, cherry, and peach trees (*or peach stock whatever the tree may be*).§ Mr. E. W. Allen refers to it in a short illustrated article and states that "it also works on the plum."|| At the time the Third Report of the State Board of Horticulture was issued (1895) the borer seems still not to have been recognized as a serious enemy of the prune, since the only reference to it is to cite readers, who desire information, to the First and Second Reports. In his last publication as Station Entomologist, Prof. Washburn makes the first definite reference to the work of the insect upon prunes in Oregon, that I have been able to find, stating under the head of "Prune Insects" that "the peach-tree borer is a troublesome pest wherever any tree is grafted on peach or plum stock."¶ Mr.

*Bul. No. 5, Ore. Expt. Sta. 1890.

†Bul. No. 14, Ore. Expt. Sta. 1891.

‡First Biennial Rpt. Ore. State Bd. of Hort., 1891, p. 27.

§Bul. No. 18, Ore. Expt. Sta., 1892.

||Bul. No. 5, Ore. State Bd. of Hort., 1891, p. 76.

¶Bul. No. 38, Ore. Expt. Sta., 1895.

C. L. Dailey has recently written that "the worst insect pest of the prune and peach trees in the Willamette valley and probably over the entire state is the peach-root borer."*

Description and Life-History.

The adult insects are beautiful wasp-like moths, the males and the females of which differ so much that they are readily mistaken for entirely different species. They are from one half to three-fourths inch long, and have a wing expanse of from four-fifths to one and one-half inches.

The body of the female (Plate V, *a*, Fig. 1.) is deep steel blue in color, with the fourth and sometimes the fifth segment of the abdomen, orange. The fore wings are of the same color as the body, while the hind wings are clear, transparent, bordered by a band and fringe of deep blue, and with a few scales of the same color at the base and along the front margin.

The male (Plate V, *b*, Fig. 1.) is somewhat smaller than the female, has small flecks of yellow, upon head and thorax, the second, fourth, fifth and sixth segments of the abdomen are narrowly banded with yellow, and all four wings are transparent, with a narrow border and fringe of steel blue.

TIME THE MOTHS APPEAR.—I have no direct evidence concerning the time of year at which the moths appear in Oregon: but a large series of larvae collected in October contained specimens varying in size from those not more than one-fourth grown to those fully grown. This indicates that the period of egg deposition extends over a considerable time, thus corresponding with the well known habits of the insect in the East, where the moths are known to continue to issue and deposit eggs, from early in May until the first of October. We may safely infer that any time between May and October, these beautiful wasp-like moths are flying about in the bright sunshine depositing eggs upon the bark of prune and peach trees.

THE EGG.—These eggs are scarcely more than one-fiftieth of an inch long by half as broad, and are nearly oval in shape. They are usually deposited at or near the surface of the ground, but occasionally one occurs high on the trunk or even on the lower branches. They are deposited singly and are stuck to the outside of the bark by a gummy substance, no effort being made

*Fourth Biennial Rept. Ore. State Bd. of Hort., 1897, p. 133.

by the moth to secrete them in crevices of the bark as is generally supposed.

THE LARVÆ.—The eggs in a few days hatch into very minute and very active larvae which immediately bore into the bark, usually entering through some minute crack. Having once entered the inner layer of bark the larva bores downward until it is just beneath the surface of the ground, where it remains feeding upon the inner bark and sapwood throughout the remainder of the season. During the winter it remains dormant in its burrow, but on the opening of spring commences to feed and continues to do so until fully grown. In the case of the larger ones this is only for a short time, but the smaller ones undoubtedly continue their injury until well past mid-summer.

A recent examination of some twelve hundred trees has shown that at this season of the year (April) larvae can be found in all stages of growth from those not more than one-fourth inch long, to those nearly or quite fully grown. They are yellowish white in color, nearly cylindrical, the head and first segment is brown, and when fully grown, they are about one inch long. (See Plate V, *c*, Fig. 1.)

THE PUPA.—When grown the larva usually leaves its burrow, enters the ground and builds from its own frass and particles of bark held together by silken threads, an elongate cell or cocoon in which it transforms to a rather slender brown pupa. (Plate V, *d*, Fig. 1.) Although no pupae have been found as yet this season, a number of fully grown larvae were present, in the soil at the base of the trees, where they had evidently begun to construct their cocoons. From this fact it is inferred, since the pupal stage lasts but a few days, that the earliest moths emerge in this locality not far from May 15th, and since larvae in all stages of growth can be found it would seem that they will continue to pupate, and to emerge as moths throughout the summer.

Injury Done.

In badly infested trees, the larger roots and even the base of the trunk may be entirely girdled and the tree greatly injured or even killed outright. The presence of a borer in a tree is always indicated by a mass of jelly-like gum mixed with sawdust-like castings about the base of the tree, at or just beneath the surface

of the ground, or at least by the presence of the sawdust-like castings.

So far as our observation goes all varieties of prunes are alike attacked, irrespective of whether they are grown upon peach or plum stocks. Mr. Dailey states that they have injured his *Petites* most; Mr. Pratt, that in his orchard the Italians are worse affected.

Preventives and Remedies.

All successful means of preventing injury from these borers are based upon the fact that the moth deposits her eggs upon the outside of the bark, and the young larvae when hatched are compelled to eat their way into the tree from the outside. Bearing this fact in mind it is evident that any application to the tree during the summer months, that will prevent the moth from depositing her eggs upon the bark, or that will poison or otherwise destroy the young larva at the beginning of its career, will prove perfectly effective in preventing all injury from these borers.

Many methods have been employed to accomplish these results, all of which can be conveniently grouped under two general heads, viz., (1) mechanical protectors; and (2) various destructive washes.

MECHANICAL PROTECTORS.—Several kinds of tree protectors, warranted to prevent all injury from borers and other pests, have been placed upon the market. Some of them are very effective; but for cheapness and efficiency there is probably nothing better than to wrap the base of the tree with a band of heavy paper eight or ten inches wide. The earth should be removed from about the base of the tree, the wrapping applied so that it will extend two or three inches below the surface of the ground, and the soil replaced. Care should be taken to confine the wrapping closely to the trunk with strings, otherwise the moth is liable to crowd in and deposit her eggs upon the bark. Instead of paper, a wrapping of straw may be used successfully if care be taken to leave no crevices through which the bark is exposed. At first thought this process would seem to be very expensive, but Mr. Dailey, who has wrapped a very large proportion of the trees in his thirty-five acre orchard, tells me that

the expense is almost nothing as compared with that of cutting the grubs from unprotected trees. He found that with a little experience one man could wrap 600 trees per day, and that the expense for material is very slight indeed. The total cost of wrapping his trees was about sixteen dollars, whereas he had just previously expended nearly three hundred dollars in "worming" the same trees. It is hardly necessary to add that his trees will be protected by wrappers in the future.

WASHES.—Various washes are used to prevent the moth from depositing her eggs, or to coat the bark with a substance impenetrable to the larva, or to destroy it before it has penetrated the bark.

For the first purpose Dr. Lintner recommends a wash made by mixing one pint of crude carbolic acid in one gallon of soft soap, then diluting with eight gallons of water.

For the second purpose probably no wash is better than a good stiff whitewash, to which a little glue has been added to make it more permanent and impenetrable, while for destroying the young larvae nothing is better than some poison, applied with some substance that will make it stick to the bark.

For all practical purposes the combined effect of all three of the above washes may be obtained by using a good whitewash to which has been added a little glue, a small amount of carbolic acid, and a little Paris green. Use about one pint of the acid and two or three ounces of Paris green to each ten gallons of whitewash, and apply the mixture thoroughly with an old broom or good stiff brush. The application should be made between the first and fifteenth of May, and should be repeated whenever it appears that the coating is becoming imperfect. We are of the opinion that this is, withal, the cheapest effective preventive of injury from the peach-root borer.

REMEDIES.—The above mentioned measures are only preventive. When once the larva has entered beneath the protecting cover of the bark and exuding gum it is beyond the reach of any external application of insecticide substances. The only satisfactory remedy then, is to examine the trees carefully, once in the fall and again in the spring, remove a little of the dirt from the base of the tree, and whenever the presence of a borer is indicated by the exuding gum or sawdust-like castings, cut it out. It is then a

good plan to prevent decay by covering the wound with grafting wax.

Even with experience, this method of controlling the root borer is quite expensive, and should be employed only as supplementary to one of the preventive measures above described. At best it removes the borer only after the injury is done and then only at the expense of a more or less serious wound to the tree. First use one of the preventive measures, then if an occasional tree becomes infested use the knife.

Various other methods of destroying the borer have been recommended. Apparently good results have been obtained by scooping out a shallow basin about the base of the tree and filling it with hot water, while others by using a small oil can, or similar device, inject a small quantity of kerosene oil or bisulphide of carbon into the burrow made by the borer, and report that it is effective.

All of these methods, however, are fully as expensive and troublesome as the "knife remedy" and have the disadvantage that one leaves the tree not knowing that the work has been effective.

No. 2. The Pacific Peach-Tree Borer.

Sanninoides opalescens (Hy. Edw.)

This insect is undoubtedly present in the state, and in fact may very largely take the place of *S. exilis* in Southern Oregon, where it seems to have been introduced from California between ten and fifteen years ago.

It so closely resembles the latter, however, both in general appearance and in habits, that it is unnecessary to speak of it in a work of this kind other than to state that the same preventive and remedial measures that have been recommended for the eastern peach-tree borer, will prove equally effective against its western relative, except that the latter is somewhat more difficult to remove with the knife, since it frequently bores more deeply into the solid wood.

It is probable that the letter of Mr. R. V. Pratt, above cited, refers to the work of this insect where it states that "they had in many cases penetrated the heart of the tree." The larvae of *S. exilis* confines itself almost entirely to feeding upon the inner bark and sapwood.

Fig. 3.

Fig. 2

FIG. 1, *Peach-Tree Borer*.

FIG. 2, *Cicada*.

FIG. 3, *Work of Flat-Headed Apple-Tree Borer*.

No. 3. The Flat-Headed Apple-Tree Borer.

Chrysobothris femorata (Fab.)

In addition to injuries by both of the above mentioned root-borers, trunks of prune trees are sometimes attacked by the larvae of this well known apple-tree pest.

During the last two years I have received several reports of such injury by this insect, and have recently received from Mr. Julius Priester, of Oregon City, a section of the trunk of a young prune tree containing a borer which I have been able to identify as the larva of this insect.

Description and Life-History.

The adult insect, *d*, Fig 1. is a beetle belonging to the family *Buprestidae*, to which many of the worst enemies of fruit and shade trees belong. It is nearly $\frac{1}{2}$ inch long, flat and rather oblong in shape, and is of a greenish-black color above with the surface uneven, but polished and shining. Beneath it has a brilliant coppery lustre.

The beetles are most abundant in neglected orchards where they may be seen running actively about on the tree trunks in the bright sunshine of a May or June day.

Although most commonly known as a pest of the apple they originally worked upon the oak, and in addition are also known to attack the soft maple, willow, mountain ash, box elder, linden, peach, pear, cherry, and prune.

When working upon fruit trees the female usually selects one that has been injured by sun-scald or by "winter killing" or that is for some other reason unthrifty, and deposits her eggs under the loose scales or in the crevices of the bark, fastening them in position with a glutinous substance. Usually only one is deposited in a place, but occasionally several are placed together in a group. A small tree trunk, about four inches in diameter and three feet long, that is before me, shows the work of no less than fifteen of these borers. Plate V, Fig. 3, shows one of the burrows near the origin of which are the beginnings of two similar ones.

The eggs soon hatch and the young larvae, after boring through the outer bark, continue to feed upon the sapwood, the burrows gradually becoming broader and broader as the larvae in-

crease in size. One such borer may completely girdle and kill a small tree, and several of them will greatly injure or even kill trees of the size above mentioned, or even larger. When fully grown each larva bores deeply into the solid wood, or at least excavates a chamber or cell in which it changes to the pupa shown at *b*, Fig. 1. Just before the change, it is about $\frac{3}{4}$ of an inch long and its head and anterior segments are enormously developed. Its characteristic appearance is well shown at *a*, Fig. 1.

Dicercia divericata (Say), another borer very similar to the above, but somewhat larger, has also been reported by Prof. F. L. Washburn as occasionally injuring the prune.*

Preventives and Remedies.

Since these insects rarely attack perfectly healthy vigorous trees the best method of preventing injury is to insure such trees by extra care and cultivation, by preventing so far as possible all injury from "sunscald" and "winter killing" by shading the trunks of young trees with a piece of board or something similar stood upright in the ground by the south-west side of the tree, or by wrapping them as for the peach-tree borer. However, trees that are not vigorous or that have been injured in any way may be effectively protected from borers by

applying the poisoned whitewash or the wrapping recommended for the peach-tree borer. They should be applied for this

purpose about the middle of May.

No. 4. Cicadas or Harvest Flies.

Platypedia putnamii Uhler.†

One of the injuries to prune branches most often referred to the Entomologist is shown at *a*, Fig. 2, Plate V. It consists of a conspicuous irregular double row of punctures in the bark, through each of which a small "brush" of splintered wood protrudes. This injury is caused by a female cicada in the act of depositing her eggs. These insects are closely related to the celebrated seven-

*Bul. No. 38, Ore. Expt. Sta, p. 19.

†Determined by Mr. C. F. Baker.

teen-year "locust" which occasionally does such serious damage to fruit and forest trees in the Eastern States, but differs from that insect in several respects, the most important of which is the fact that, whereas, that occurs in a given locality only once in seventeen years, our native species occurs annually.

The young, or *nymphs*, (*b*, Fig. 2, Plate V) of this insect live entirely under ground and do no appreciable harm. When fully grown they emerge from the ground, ascend trees or other objects and soon become firmly attached. In a short time the skin splits down the bark and the adult insect (*c*, Fig. 2, Plate V) emerges.

After pairing, each female resorts to some tree and proceeds to deposit her several hundred eggs. Selecting a suitable twig, with her strong saw-like ovipositor she makes a ragged double puncture in it, and deposits an egg in each. Then moving forward she repeats the operation. This process is continued until a row of perhaps a dozen punctures have been made, when she repairs to another twig and repeats the operation. One female may thus injure a large number of twigs before her supply of eggs is exhausted.

The wounds made by this process are almost invariably found on twigs not more than one-half the diameter of an ordinary lead pencil, and so weaken them that they are easily broken by the wind during the first or second season. If this does not occur no serious injury is done, since the young cicadas as soon as hatched drop to the ground without working upon the tree at all.

Fortunately these insects are not numerous, and a very large proportion of their eggs are deposited upon other than fruit trees. It is the conspicuous nature of the injuries, rather than their frequency, that brings them so prominently before the attention of orchardists. There is, however, no cause for alarm, and no remedial or preventive measures need be employed, unless the attacks become much more serious than they have yet been. It is usually recommended to cut off and burn the freshly punctured branches, but since the injury itself would not do more than cause the loss of the twig, and since the very few eggs destroyed would not perceptibly diminish attacks in the future, I do not see the necessity for such a course. *d*, Fig. 2, Plate V represents a less common species with wings folded.

No. 5. The Branch and Twig Borer.

Polycaon confertus Lec.

Very rarely prune trees in this state are injured by this beetle, which bores into the smaller branches and twigs. The axil of a bud or of a small branch is usually selected as the spot to begin operations and from there the comparatively large open burrow extends downward and inward to the center of the branch. The injury itself is insignificant, except that the branch may be so weakened that it readily breaks in a strong wind.

Very little is known regarding this insect and its habits. The adult beetle, which does the injury is one-half inch long, is nearly cylindrical and is brown in color. In California it is said to be partial to olive trees, but has also been reported as attacking the peach, apricot, almond, apple, pear and grape, and the grub or larva has been found boring in live oak, and almond trees. In this state, adult beetles in freshly made burrows in prune twigs were received at the Experiment Station in January.

Remedies.

Unless this insect becomes much more injurious than it has been no means of preventing its attacks will be necessary. Should a remedy become necessary, it is probable that a spraying with lime, sulphur and salt, or with whale oil soap, at the time the attack begins, would repel the beetles from the trees. If Paris green should also be added to either of these sprays it would probably poison any of the beetles that should attempt to eat into the twigs.

No. 6. The San Jose Scale.

Aspidiotus perniciosus Comst.

Scales in General.

There is no group of insects of greater economic importance than that which contains the peculiar creatures known as scale insects, or simply scales. There is hardly a shrub or tree that is not subject to their attacks, and often entire orchards are seriously injured by their ravages. The often minute size of the creatures and the difficulty of destroying them, together with their wonderful prolificacy, all combine to make them formidable pests of the orchardist. It is only necessary to mention the mealy bug of greenhouses, the fluted scale of California,

the peach scale of the south-eastern United States, the New York plum scale, or the well known subject of this article to establish the truth of this statement.

The life history of scale insects is very peculiar and bears an intimate relationship to the proper remedies to be used in destroying them. The fully grown individuals are covered with a waxy excretion which may be of a white fluffy nature, or may form a dense protective scale. These scales vary in size, shape, color and markings with the different species or kinds, and give to the insect a peculiarly lifeless appearance, so much so that it is difficult, in many cases, to realize that they are covering living organisms which may be seriously reducing the vitality of the infested plant. But if some of these scales be carefully lifted from their resting places there will be found under them either soft fleshy bodies, the insects themselves, or numerous eggs. In the former case the females will usually begin to produce living young or eggs on the advent of settled warm weather, and will continue to produce them for several weeks. In the second case the eggs will all hatch nearly at the same time.

In either case the very young scales are active, six legged microscopic creatures, which at first crawl rapidly about but

soon attach themselves firmly to some tender growth and feed upon the sap. When first hatched the males and females are very similar, but their future development differs greatly. The females grow rapidly, but when fully grown consist only of a fleshy body covered by a more or less dense scale. The legs, antennae and eyes have entirely disappeared, and of all the appendages of the body only the well developed mouth parts remain. The body gradually becomes distended with eggs or young and after they

FIG. 2. *Female San Jose Scale.*

are produced the female dies. The fully grown male instead of being motionless and without appendages, as is the female, is a minute active creature with two broad wings, long antennae, six legs, well developed eyes but no mouth parts.

Distribution of San Jose Scale.

Of all scale insects that attack our deciduous fruit and forest trees the San Jose scale is by far the worst. Dr. Howard, United States Entomologist, writes that "there is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps in the world, than the San Jose scale."

This pest was discovered at San Jose, California, about 1870. Where it came from is not definitely known, but at the present time it is pretty well distributed throughout the states of California, Oregon and Washington, and in British Columbia. It has also invaded Idaho on the north and Arizona and New Mexico on the south, and within the last few years has become widely distributed over the Eastern States, where it seems equally at home and equally as injurious as on the Pacific Coast. In Oregon it is found at Ashland, Rogue River valley, Umpqua Ferry,

FIG. 3. *Male San Jose Scale.*

and at several localities in the Willamette valley in the western part of the state, and at The Dalles, Walla Walla valley and Union in the eastern part. Everywhere it infests the apple, pear, peach, plum, prune, cherry, currant, rose, willow, and numerous other deciduous trees and is a serious pest of each, occurring as it does on all parts of the plant, the limbs, the leaves and the fruit. It does not attack coniferous trees nor does it breed upon rocks, as has been several times reported by observers in different parts of the state.

General Appearance of San Jose Scale.

The worst feature of an attack by this pest, is the fact that the insect is so small and inconspicuous that it often remains un-

noticed, while at the same time it spreads so rapidly over the branches, leaves and fruit that it is rarely a tree can survive an unchecked attack for more than two or three years. The tree may be seen to lack vigor but often the cause of the disease is overlooked. And yet the San Jose scale is easily recognized when once seen. On badly infested plants the small, nearly circular, grey scales lie close together, even overlapping one another, and give the appearance of a grey scurfy deposit on the infested part. The natural, rich red, or brown color of the branch is

FIG. 4. *Stages of Development of Male San Jose Scale.*

obscured and appears as though covered with fine ashes. If this scurfy covering be scraped, so as to crush the insects under the scales, a yellowish oily ap-

pearance is produced. When present in comparatively small numbers on smooth bark, or on the fruit, the appearance of the scale is even more characteristic since each individual scale is surrounded by a distinct reddish discoloration. This is so conspicuous that it is of great use in enabling one to recognize, at the beginning, an attack which otherwise might remain unnoticed for some time.

Life-History.

Although the San Jose scale has been known as a fruit pest for more than twenty years, its full life-history, which has an important bearing on the subject of remedies to be used, was not worked out until three years ago. At that time Dr. Howard, aided by Mr. Pergande, demonstrated that the insect develops as follows

"The winter is passed by the nearly full-grown insects under the protection of the scale. Early in April in this latitude (Washington, D. C.) the hibernating males emerge, and by the middle of May the over-wintered females mature and begin to give birth to a new generation, continuing to produce young for a period of upward of six weeks, when they reach the limit of production of young and perish.

"The adult gives birth immediately to living young, differing in this respect from most other scale insects. Ordinarily eggs are deposited beneath the scale, which in the course of a longer or shorter time hatch, and the young larvae make their escape and migrate to different parts of the

plant. In the case of some scale insects the female fills its scale with eggs in the fall and perishes, the eggs wintering over and hatching the following spring. In others the insect hibernates in the nearly mature condition, as does the San Jose scale, and deposits eggs in the spring or early summer. The viviparous habit, or the giving birth to living young, possessed by the San Jose scale, finds a parallel in many other insects and frequently in plant lice." * * *

"The newly born larva, Fig. 3, is an almost microscopic creature of pale orange yellow color, with long oval body, and with the customary six legs and two feelers. The long thread-like proboscis with which the juices of the plant are sucked up is doubled on itself and lies in an invagination of the body wall, the tips only projecting.

"After crawling about for a few hours the young larva settles down and slowly works its long bristle-like sucking beak through the bark, folds its antennae and legs beneath its body and contracts to a nearly circular form. The development of the scale begins even before the larva becomes fixed. The secretion starts in the form of very minute white fibrous waxy filaments, which spring from all parts of the body and rapidly become more numerous and dense. * * * The scale is formed by the slow matting and melting together of the filaments of wax. * * *

"The male and female scales are exactly similar in size, color, and shape until after the first molt which occurs twelve days after the emergence of the larva. With this molt, however, the insects beneath the scales lose all resemblance to each other." * * *

Fig. 4, Page 114, illustrates the different stages in the development of the male which emerges as the adult shown at Fig. 3, Page 113, early in April. Fig. 2, page 112, shows the adult female.

"The length of a generation is determined by the female, and covers a period of from thirty-three to forty days. Successive generations were followed carefully throughout the summer, and it was found that at Washington four full generations are regularly developed, with the possibility of a partial fifth generation."

It was further shown that among the wintering individuals the males greatly predominate and that

"The numbers of both sexes are insignificant compared with the progeny of the later generations. The males still predominate in the second generation, but in the third and fourth generations the females considerably outnumber the males, in one instance the females from a single mother reaching the astonishing number of 464, which, with 122 males from the same parent, makes the progeny of this female 586 insects. Taking 200 females as an average of the different generations for the year, the product of a single individual from spring to fall amounts to 1,608,040,200 females.

* * * The males may be estimated at the same number, giving a total of 3,216,080,400 descendants from a single insect in a single season. It is not to be expected, of course, that all the individuals from a scale survive and perform their function in life, but under favorable conditions, or in the case of a tree newly infested or not heavily incrustated, the vast majority undoubtedly go through their existence without accident. Neither the rapidity with which trees become infested nor the fatal effect which so early follows the appearance of this scale insect is therefore to be wondered at.

"Owing to the long period during which the female is continually producing young, the different generations or broods in the course of the

summer are not distinctly marked and merge insensibly into each other—so much so that at almost any time there will be found young larvae running about over the trees and scales in all stages of development. * *

In this latitude the first young appear, as noted, by the middle of May. * * The larvae are continuously present on the trees until further hatching is prevented by severe frosts.

"In autumn, or when further development is stopped by cold weather, hibernation is begun by scales in all stages of development, from the white, minute, down-covered recently hatched young to the mature and full-grown females and males. Unquestionably many young perish during the winter, and normally in spring quite a percentage of the smaller or half-grown scales will be found to have perished. It is very probable that many females have union with the males in the fall, but the majority of them are unquestionably immature, and are fertilized in this latitude early in April by overwintered males which, as we have noted, appear nearly a month before the first young of the spring brood."

How the Scale Spreads.

Since the female scale is motionless and permanently fixed to the branch on which it feeds, it is frequently asked how it is that the scale has spread so rapidly over such a vast territory. Observation has shown that even in its active larval stage the insect is incapable by its own exertions of getting more than a few feet from the tree on which it was born. But by crawling upon birds, insects or other animals or by being wafted short distances by the wind, it is readily transported from tree to tree in the same or neighboring orchards. From one locality to another it is invariably carried upon infested fruit or nursery stock. It would therefore seem that the State Board of Horticulture, the nurserymen of the state, and everyone else should be encouraged in every way possible to continue the efforts to prevent the sale or shipment of nursery stock, except under a certificate of inspection, and to prevent the sale of infested fruit. A strict enforcement of the law would undoubtedly cause serious inconvenience and loss to a few individuals, but considered from the point of view of the growing horticultural interests of the state, it is seen to be essential.

Enemies of the San Jose Scale.

In our warfare against this insect we are aided by several minute parasitic insects and by some predaceous ones.

The most important of the latter is perhaps the twice-stabbed lady bug, *Chilocorus bivulnerus*. This is a shining black species, a little more than one-eighth of an inch long and nearly as wide, and with a bright red spot on each wing cover.

In the east the most useful of these lady-bugs is a minute

black species known as *Pentilia misella*. It is scarcely as large as a pinhead and is shining black in color. Until recently it was supposed to be a distinctly eastern species but in 1894 it was found at Marysville, California, and in March, 1896, Mr. H. E. Dosch, Horticultural Commissioner of the first district, sent me for identification specimens he had observed feeding upon the scale at Hillsdale. I immediately wrote Mr. Dosch as follows:

"The small beetle * * * is evidently *Pentilia misella* a little coccinellid beetle which is one of the most efficient enemies of the San Jose scale in the east. * * * I would suggest that specimens be sent to each of the other commissioners to enable them to recognize the species, and that they search for it in their localities. If it should prove to be not very widely distributed in the state, undoubtedly much good could be done by introducing it in the localities in which it does not exist."

Later my identification of the species was verified by Dr. Howard.

Remedies.

The most satisfactory remedy for the San Jose scale is to thoroughly spray the trees in winter with the lime, salt and sulphur wash. Summer sprays are almost entirely useless against this particular insect. This is due to the fact that the female insect, herself protected under a scale that is practically impervious to any spray that the tree can endure when in leaf, continues to give birth to living young for a period of several weeks; and the young scales, which at first are easily destroyed, inside of two or three days secrete a covering that is also practically impervious to any washes that can be applied. Hence to eradicate the insect by summer spraying would require an application every two or three days for several weeks.

The lime, salt and sulphur wash is best prepared as follows: Slake fifty pounds of lime, then add fifty pounds of sulphur, and fifty to seventy-five gallons of water. Boil the mixture for an hour or more, or until the ingredients are practically all dissolved. Then dilute to one hundred and fifty gallons. This formula is based upon results obtained by Mr. Emile Schanno in his extensive experiments in the Fourth Horticultural District.

The best results are obtained by applying the mixture while still warm, and by applying it with considerable force in the form of a rather coarse spray. The insects multiply with such astonishing rapidity that it is essential, if one hopes to satisfactorily control them, to destroy nearly every specimen. It is therefore necessary that the spray be dashed upon the infested

PLATE IV. THE BUD MOTH AND ITS WORK.

branches with such force that it will drench every part. One such thorough application of the above wash each year will prove entirely satisfactory in keeping the scale in check in the worst infested orchard.

No. 6. The Bud Moth.

Tmetocera ocellana Schrif.

I am not aware that this destructive insect has before been recorded as present in this state, although it has been present in the Eastern States for more than half a century and has come to be recognized as one of the most destructive of orchard pests as well as one of the very hardest insects to combat.

Present at Portland.

April 21st of this year, I received from Mr. J. J. Borg, of Portland, a quantity of cherry leaves that were being seriously injured by numerous small dark-colored Tortricid larvae. I at once suspected that these larvae represented the skirmish line of the bud moth, but to be certain I sent a few of them to Dr. Howard, who under date of May 7th replied that "there is little doubt that the larvae which you send are the larvae of the eye-spotted bud moth, *Tmetocera ocellana*." May 24th all doubt as to the true nature of the pest was removed by the issuing of several moths of this species.

Distribution.

This insect is of European origin and was first described more than a century ago. In this country it first attracted attention as an injurious species about 1840, the first account of its work apparently being the one published by Dr. Harris in 1841. Since then it has spread over the New England States, the Middle States, and Canada, and has been reported from Washington, D. C., Michigan and Missouri. In 1893 it was introduced at Genesee, Idaho, on nursery stock from Rochester, N. Y.,* and now it has obtained a foothold in Oregon. Whether the Portland specimens have spread from the Idaho importation or whether they have been introduced from the East on infested nursery stock I do not know.

Nature of the Injury.

The small, brown, half-grown larvae of this insect pass the winter in minute inconspicuous cocoons on the twigs and branches

*C. V. Piper, Bul. 17, Wash. Expt. Sta., p. 24.

of infested trees. Early in spring, as soon as the buds begin to open, they leave their temporary winter quarters and attacking both fruit and leaf buds, injure many of them so seriously as to stop their growth. On large thrifty trees this injury is of but little account unless the insects are very numerous; but in young orchards or in the nursery it seriously interferes with the proper shaping of the trees. Some of the larvae bore into the buds before they have opened, but the larger proportion attack the half-opened buds and feed upon the expanding leaves and flowers, tying them together with silken threads. See Fig. 2, Plate VI. Some of the partly eaten leaves turn brown and thus render the work of the insect quite conspicuous. The tying together of the opening leaves and flowers and the brown appearance of many of them, are the most characteristic indications of the work of this pest.

Description and Life-History.

The half-grown larvae winter in inconspicuous temporary cocoons which are usually secreted about the buds, on the twigs and smaller branches. See Fig. 3, Plate VI. When the buds begin to open in spring the larvae leave their cocoons and attack both leaf and fruit buds as above described. Some of the larvae received from Mr. Borg, April 21st, were nearly or quite full grown, while others were scarcely more than one-half grown. They were dark brown in color with black head and thoracic shield, and were thinly covered with light colored hairs arising from minute black elevations. The largest ones were nearly one-half inch long.

Soon after being received they began to spin their silken cocoons within the folded mass of leaves, and on May 12th the first pupa was observed. It is shown at *a*, Fig. 1, Plate VI. May 24th the first moth appeared and by June 1st apparently all had issued.

During the daytime the moths remain quietly resting upon the trunks and larger branches of the tree, with their wings folded roof-like over the back as shown at *c*, Fig. 1, Plate VI. In this position they so closely resemble the Lark in color that it is difficult to detect them. The moths probably live two or three weeks, and beginning a few days after they emerge fly about from tree to tree, mostly in the night, and deposit their eggs singly

or in small clusters upon the leaves. In from seven to ten days these eggs hatch. The young larva, which is at first green, at once begins to feed, usually upon the lower epidermis of the leaf. It soon spins for itself a silken tube open at both ends, and usually located beside the midrib. Fig. 4, Plate VI shows a leaf that has been partially destroyed. Throughout the summer the larvae work upon the leaves in this manner, but towards fall they retreat upon the twigs and branches and construct the temporary cocoons in which they pass the winter as before described.

Food Plants.

So far I have received only specimens that were attacking cherry leaves. It is, therefore, somewhat early to consider this insect as a prune pest, but in the Eastern States it has been known to attack the buds on apple, pear, peach, cherry, quince and plum trees, and blackberry bushes, and there can be little doubt that, since it is now present in the state, it will soon attack our prunes.

Remedies.

In the East this pest is proving an exceedingly hard one to combat. No satisfactory results have been obtained in destroying the larvae in their winter quarters, but it is possible that in this climate a winter spraying with strong kerosene emulsion, or lime, salt and sulphur wash would be effective. It is also possible to destroy a very large proportion of the larvae by spraying the trees with Paris green just before the flowers open. The opening buds should be kept coated with the poison so that the larvae may be killed before entering within their protecting cover. We are also of the opinion that a thorough under-spraying of the leaves with Paris green, between June 1st and June 10th, would prove effective. In either case one pound of the poison should be used in two hundred gallons of bordeaux mixture.

Most of our information regarding this insect has been derived from the publications of Mr. Mark Vernon Slingerland who first worked out its complete life-history.*

No. 8. The Clover Mite.

Bryobia pratensis Garman.

In this state this mite is generally known as the "red spider." The pest was first recorded as present in Oregon in 1889. Since then it has spread rapidly until now it is present in nearly all

*Bul. 50 and 107, Cornell Univ. Expt. Sta.

the fruit-growing regions of our state, but has so far done no serious injury. During the winter of 1895-6 the extraordinary abundance of the eggs, principally on prune trees, attracted general attention throughout the state.

The eggs are shining red and are so small that when placed singly they are difficult to find. When at all abundant, however, they are deposited in masses, preferably at the base of the buds, or in other protected places on the bark, and give to such spots the appearance of being "rusty."

Our observations show that these eggs under favorable conditions begin to hatch as early as March 20th and continue to hatch for at least six weeks. By April 21st, '96, the young mites in all stages of development were present in unlimited numbers upon the leaves of various fruit trees. Even at this early date the leaves on the worst infested trees began to look pale and sickly and there was every indication that the attack was to be a serious one; but the long continued cold rains following that date were so fatal to the young mites that by June 1st only a few adults could be found.

Remedies.

Mr. C. P. Gillette, of the Colorado Experiment Station, has shown that the eggs are effectively destroyed by spraying the trees in winter with a solution of whale-oil soap, one pound to four gallons of water, or one part of kerosene emulsion diluted with four parts of water. We have also shown that the mites in all stages may be perfectly destroyed in summer by spraying the infested trees with one part of kerosene emulsion in fifteen parts of water.

No. 9. The Red Spider.

Tetranychus Sp.

This mite is probably the well known "red spider" of the greenhouse *Tetranychus telarius*. At Corvallis it is even more abundant upon prune trees than is the clover mite, but it does not seem to have attracted such general attention in other parts of the state. To the unaided eye it appears very similar to that mite and the general appearance of infested trees is the same. The clover mite, however, is rarely found in the adult stage upon the leaves, and the eggs are always deposited upon the branches or trunk, while the "red spiders" may be found in all stages upon

the leaves,—the eggs, the young in all stages and the adults being protected under a delicate web on the undersides of the leaves.

The winter eggs, are deposited upon the trunk and branches, as are those of the clover mite and when abundant give the bark the same "rusty" appearance. The remedies for the pest are the same as those used for the clover mite.

No. 10. The Prune-Leaf Weevil.

Tricolepis inornata Horn.

The unpublished notes of Prof. F. L. Washburn, record this little grey weevil as feeding upon the leaves of prune trees at Corvallis, May 17th, 1891. May 12th of the same year, Mr. J. H. Albert, of Salem, Oregon, sent specimens of the same insect to the United States Department of Agriculture, with the report that they were "eating the foliage of young prune trees, stripping them in a short time." No other reports of injury from this insect have been received.

No. 11. Plant Lice or Aphids.

Two or more species of plant lice occur upon prunes in this state. Early in November, 1896, a small prune tree was observed on the College grounds, the leaves and twigs of which were completely covered with rather dark wingless and winged aphids which we somewhat doubtfully determined as the plum aphid, *Apis prunifoliae* Fitch. May 31st leaves of the French prune were received from Halsey, Oregon, which were badly infested with the hop louse, *Phorodon humuli*. The report accompanying them stated that the aphids were very thick on French prunes, but that the Italians had not been attacked. When received they were fast acquiring wings and, no doubt, a few days later all had migrated from the prunes to the hops.

In their early stages these plant lice are pale green in color and are found on the undersides of the leaves. They winter in the egg state on the twigs, and the young lice appear upon the leaves principally in spring and fall. When abundant they cause the leaves to become curled or twisted and discolored.

The best remedy is to under-spray the leaves with kerosene emulsion, using one part of the emulsion to 12 or 15 parts of water. The spray should be very fine and mist-like so that it will, if possible, touch every insect.

No. 12. The Peach-Twig Moth.

Anarsia lineatella (?) Zeller.

June 9th, 1895, Mr. Hugo Garbers, of Hugo, Or., reported to this department that the twigs on his peach trees were being destroyed by a small worm boring in at the tip. A few days later, Mr. H. E. Dosch, Horticultural Commissioner for the First District, reported the same injury to prunes as very common throughout his district. Up to and including the 18th of June many similar reports were received, some of which were accompanied by injured twigs each of which contained a single larva.

These larvae were reddish-pink in color with the head and shield of the first segment pale brown, and corresponded in every particular with Mr. William Saunder's description of the larvae of *A. lineatella* as quoted by Dr. Lintner in his first report on the "Injurious and Other Insects of New York."

June 22d, 1896, some of these larvae were observed to have left the twigs and to have pupated in various parts of the breeding jars, the pupae being held in position by a very slight cocoon consisting only of a few silken threads. July 3d four moths issued from these pupae. These moths agreed perfectly with the description of *A. lineatella* as quoted by Dr. Lintner in the article referred to above.

No further reports of injury to prune trees were received, and nothing more was observed concerning this insect until Oct. 2, 1896, when the strawberry plants on the College grounds, and in a neighboring patch were found to be very badly infested by reddish-pink larvae which were not to be distinguished from those that had attacked peach and prune twigs in June. Several infested plants were removed to the insectary, and together with plants out of doors, were examined from time to time throughout the winter, with the result that it was found that the larvae pass the winter in their burrows in the strawberry crowns in a nearly dormant condition. During the winter infested strawberry crowns were received from several localities and in every case the burrows were found to contain the larvae.

May 19th, 1897, one moth issued in a cage in the insectary, although an examination of plants out of doors showed that the larvae were just beginning to pupate, and it was June 1st before any considerable number of pupae could be found. At the

THE TWIG-BORER AND ITS WORK.
PLATE VII.

present time, June 15th, moths are still continuing to issue. These moths are exceedingly similar to, if not identical with those reared from peach and prune twigs last July.

From the fact that there was a somewhat extensive attack by the twig-borer last June, and still no evidence throughout the summer, fall, and early winter months, of any attack on prune trees by a second brood of these larvae, and since in early fall strawberry plants were so generally attacked by great numbers of apparently identical larvae, I have been led to infer that the July brood of moths deposits its eggs almost entirely upon the strawberry, although that inference is somewhat opposed to the statement made by Professor Comstock that "the fruit-inhabiting larvae are found [in peaches] during the latter part of July and August and mature during September."* and is entirely opposed to the statement of two prominent California authorities, that the small larvae bore into the bark of infested trees and there pass the winter in the larval stage.†

April 20th, larvae of a twig-borer were received from Halsey, Or., and between that time and May 25th, when the last specimens were received, the work of this insect was reported from Halsey, Hugo, Lookingglass, Oakland, Dundee, Yoncalla, Junction, Bellefontaine and Granger and were observed at Corvallis, Liberty and Rosedale. Mr. H. E. Dosch, Horticultural Commissioner for the First District, also writes me that he has numerous letters regarding this pest from various parts, and Mr. C. L. Dailey, Commissioner of the Second District, writes that the "pest is everywhere and small trees are literally denuded of terminal buds."

The first larvae received were slightly more than one-fourth inch long, and were of a dirty brown or dull greyish black color, with head, first and last segments, and true legs shining black. In general appearance they so closely resembled the larvae of the bud moth that at first I mistook them for that insect. I soon noticed, however, that the habits of the two species were entirely different and that every larva of the twig-borer was readily distinguished by its shining black terminal segment. But this character, together with the general color of the larvae, rendered

*Rept. Com. Agri. 1879, p. 255.

†Alexander Craw, Fourth Biennial Rept. Cal. Bd of Hort.

†C. W. Woodworth, Rept. Cal. Expt. Sta. 1894-5, p. 244.

them so unlike the larvae of *Anarsia lineatella* (?) as described, and as seen in strawberry plants, and in prune twigs last June, that it did not occur to me that they could belong to that species, until May 17th when four of the moths issued. One of these moths was at once sent to Dr. C. H. Fernald who wrote that it is *Anarsia lineatella*.

If this determination is correct, and there can be no reasonable doubt of its accuracy since Dr. Fernald is without doubt the best American authority on the microlepidoptera, we are brought face to face with the peculiar phenomenon of a well known insect—one which was described in Europe nearly sixty years ago and which has been an important insect pest in this country for nearly forty years—being bred, in May, from larvae which are entirely different from those which are supposed to produce it: while on the other hand a very similar but evidently quite distinct insect is bred from apparently normal larvae of *A. lineatella* which winter in strawberry crowns, and the second brood of which occasionally attacks the twigs of peach, prune and plum trees in June. Either two species must be involved in this phenomenon or the larvae of *A. lineatella* must exhibit a *double dimorphism* due to different food plants and seasons. It appears to us very probable that hitherto two very similar but entirely distinct species have been united under the name *Anarsia lineatella*; that one of these species breeds normally in strawberry plants but may occasionally attack young shoots of the genus *Prunus* in June and July; while the other so far as known breeds only upon trees of the same genus, wintering in the half-grown larval condition in shallow burrows in the bark. If this supposition proves true, the interesting question arises, which of the two is *Anarsia lineatella* and what is the other species? May it not after all be the *A. pruinella* Clem., which has been discarded, as a synonym of *A. lineatella* Zeller. The proper answers to these questions are of considerable scientific and economic importance since they may have a direct bearing on the efficiency of certain remedial measures.

Description and Life-History.

The twig-borer moth is shown at *c* and *d*, Fig. 1, Plate VII, enlarged two diameters. The fore wings are dark grey, almost black in color, and are splashed with a few short black lines or

streaks. The mounted specimens greatly resemble the moths reared from the larvae in strawberry crowns, but are slightly larger, and darker in color. The habits of the living moths are quite different. Those reared from the strawberry crowns crawl down among the vines even into crevices in the soil, apparently for the purpose of depositing eggs upon the crowns, and when disturbed run or flutter about with wings half spread. On the other hand the moths of the twig-borer invariably take an elevated position in the breeding cage, and with the fore part of the body slightly raised, and the labial palpi held rigidly upright in front of the face, they present a very characteristic and alert appearance. When disturbed they dart rapidly about, suddenly alighting again in the same characteristic attitude upon another portion of the cage. When out of doors upon the trees, it must be nearly impossible to distinguish them from buds. The moths began to appear in our breeding cage May 17th, and continued to emerge until June 5th.

The larva is shown greatly enlarged at Fig. 2, Plate VII. It is brownish black or dull dirty black in color, with head, shield, anal segment and true legs black, and is covered sparsely with light colored hairs which arise from minute elevations. When full-grown the larvae are nearly one-half inch long. They then spin a very loose silken cocoon, wherever they may be feeding, in which they pupate. The first pupa was seen May 8th, and since the first moths appeared May 17th, the pupal stage lasts about ten days. The pupa and empty pupal case are shown at *a* and *b*, Fig. 1, Plate VII.

Injury Done.

The half-grown larvae pass the winter in minute burrows in the bark of infested trees. See Fig. 3, Plate VII. In spring soon after the buds begin to open, some of the larvae leave their winter quarters and bore directly into the center of the buds in such a manner as to destroy the terminal ones. The shoot, therefore, fails to develop although often the dead terminal leaves may be surrounded by a whorl of well developed leaves. Later they attack the rapidly growing shoots, entering them either at the tip, or in the axil of a leaf, and boring in the pith as shown in Fig. V, Plate VII. As soon as the fruit begins to develop, it is also attacked, the larvae usually boring directly to the pit upon which they seem to prefer to feed. See Fig. 4, Plate VII.

Other Generations.

During the summer we shall attempt to determine where the moths deposit their eggs, how many generations of larvae there are and how they feed. It is probable, however, that the one or more summer broods of larvae feed upon the leaves of the prune and that unless very numerous they do but little injury. As fall approaches the half-grown larvae probably retreat upon the branches, where they burrow into the bark and pass the winter, ready to emerge and attack the young shoots as soon as they begin to develop in spring.

Remedies.

It is possible that a winter spraying with strong kerosene emulsion, or lime, salt and sulphur wash would prove effective in destroying the half-grown larvae in their winter quarters; but since they must be exceedingly well protected in their burrows, we are strongly of the opinion that the best and cheapest remedy is to spray the trees just when the leaf buds are unfolding with Paris green, so that the larva's first meal in the spring will be a poisonous one. The best results will be obtained by applying the poison in bordeaux mixture, using one pound to each 200 gallons. It is also possible that a more complete knowledge of its life history will show that this insect may be successfully controlled by spraying at other times.

No. 13. The Box-Elder Plant Bug.

Leptocoris trivittatus Say.

This insect, which in a general way resembles an ordinary squash bug with fine red markings, is quite generally distributed throughout the state. Mr. Emile Shamo, Horticultural Commissioner for the Fifth District, has reported them as being exceedingly abundant in some old orchards at The Dalles, and that they seem fond of sweet plums, etc., clustering upon them in great numbers and sucking the juice.

Probably there is no better remedy than to spray them with strong kerosene emulsion or to jar them on to a sheet or blanket and quickly throw them into a tub of water to which a little kerosene oil has been added.

The cuts illustrating these articles have been prepared by Prof. E. F. Pernot of the Department of Photography and Engraving. Fig. 1 is after Riley; Figs. 2, 3, and 4 are after Howard; *b*, Fig. 1, Plate V is after Marlatt; and Figs. 2, 3 and 4, Plate VI are after Slingerland. All others are original and are from material prepared by the author.

OREGON AGRICULTURAL

Experiment Station.

BULLETIN NO. 46---JUNE, 1897.

A Plant that Poisons Cattle.

CICUTA

(*Cicuta vagans* Green.)

By U. P. HEDRICK.

The Bulletins of this Station are sent free to all residents of Oregon who request them.

AGRICULTURAL COLLEGE PRINTING OFFICE
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1897.

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PLATE I. LEAVES AND FLOWERS OF CICUTA. *Cicuta vagans* Greene.

A PLANT THAT POISONS CATTLE.

Introduction.

PLANT growing in the low pasture lands of Oregon, poisons cattle in the late winter and early spring. Last spring probably not less than one hundred cattle were poisoned in those parts of the state where this plant grows. The inquiries as to what this plant is, has been a common and urgent one made of the Station men at the Oregon Experiment Station. Several attempts have been made to answer it. Such investigations may be briefly noted as follows:

In the summer of 1889, Professor P. H. Irish, then in charge of the Department of Chemistry of this Station, fed the following plants to stock:* Common Larkspur (*Delphinium exaltatum* Ait.), Camass (*Camassia esculenta* Lindl.), Sanicle (*Sanicula howellii* C. & R.), degenerated cultivated Parsnip (*Pastinica sativa*, L.) and Cow Parsnip (*Heracleum lanatum* Michx.); all had been reported as having poisoned cattle, but as fed by Professor Irish proved harmless.

In the spring of 1896 a farmer in Linn county sent to the Station a quantity of roots of Larkspur, saying that he felt sure that cattle of his had died from eating them. A cow at the Station was made to eat the roots sent and no ill effects followed, again proving the harmless nature of the roots of Larkspur.

The following letter, recieved January 6, 1897, from Waldport, Lincoln County, Oregon, is published as being typical of letters received every spring, and as indicating the time that reports of cattle poisoning begin to come in.

"I send by to-day's mail a root that is playing havoc among the cattle in this section of the state. A number of cattle have died in this vicinity from eating it, several having died on my ranch. What will counteract the poison that the plant contains?

Yours respectfully,
W. H. Harrison.

The roots proved to be those of *Cicuta vagans* Greene,—a

*Bul. No. 3, p. 25, Ore Expt. Sta.

plant of the Parsnip (*Umbelliferae*) family. Upon request, Mr. Harrison sent a quantity of the roots to the Station. A few of these were fed experimentally to two cows, and, though but a small quantity of the roots was taken into the stomachs of the animals in both cases, death resulted within two hours. The behavior of these animals under the influence of the poison and the remedies tried, will be described in another part of the bulletin.

Following the above experiment, several plants belonging to the Parsnip family, closely related to *Cicuta*, and generally found growing with it, and often suspected as being poisonous, were fed and proved to be harmless. This, and a more thorough investigation of the properties of *Cicuta*, seem to indicate, conclusively, that the latter is the plant that poisons cattle.

Before attempting a further discussion of the plant in question, it may be said that its description for popular identification, is attended with many difficulties; for it belongs to a family, many of whose members are so nearly alike in appearance and habits that a skilled botanist can identify some species only by minute differences in plant structure. I must, therefore, in my description, enter into details that might seem unnecessary to one not apprised of the difficulties to overcome. But, by the aid of the plates, made from photographs,* and the descriptions of plants that might be mistaken for *Cicuta*, the average reader should have but little difficulty in identifying the plant in question.

Name.

The name, *Cicuta vagans* Greene, was given by Professor Edwin L. Greene, now of the Catholic University, Washington, D. C., in 1889.* Previously, it had been considered as identical with *Cicuta maculata* Linn, the Eastern species of this genus. In all text-books, applicable to the Pacific Coast, the plant is yet called *C. maculata*, but botanists have adopted the name given by Greene.

In the matter of common names there is much confusion regarding this, as of many plants in the Parsnip family. The *Cicutas* are known in the various localities in which they are found by a number of common names. Gray, our best authority, alone, gives five popular names to the common *Cicuta*, as

*Pittoria, Vol II, Part, 7, Dec. 1889.

PLATE II. BULBS OR ROOT-STALKS OF CICUTA. *Cicuta rugans* Greene.

follows: Water Hemlock, Musquash Root, Spotted Cow bane, Beaver Poison and Muskrat Weed. Other botanists add to these, Wild Parsnip, Water Parsnip, Cow bane, and Snake Root. All these show how inaccurate and unsatisfactory are common names. If any one of these popular names is to be used, Water Hemlock is most applicable, but there cannot be any reasonable objection to calling the plant *Cicuta*, a name, about which, there could be no confusion.

Description.

The *Cicuta* found in Oregon, is a tall, smooth, coarse growing plant; its stems are round and hollow, branch from the base, may be erect or reclining in growth, and reach a height of from 3 to 6 feet; the stems spring from a bulb-like, perennial root and after flowering in mid-summer soon die down; the leaves are from 2 to 3 feet long, smooth and glaucous, sometimes with a purplish cast, two or three times divided (bi or tri-pinnate); the leaflets are borne on the upper third of the leaf, there being, generally from 4 to 6 pairs, they are oblong and lance-shaped, about 2 inches in length, $\frac{3}{4}$ of an inch wide, coarsely toothed, sometimes unequally divided or lobed, and with small veins running from the midrib to the notches in the edge of the leaflet. A part of an old and of a young leaf are shown in Plate I.

The plant blooms in midsummer and bears an umbel or umbrella shaped cluster of small, white flowers at the end of a long stalk or peduncle (Plate I); from the blossoms, broadly ovate, kidney-shaped, ribbed fruits about $\frac{1}{8}$ of an inch long are formed; these, when cut crosswise, show minute tubes containing an aromatic oil much like that in the seeds of the common Parsnip; the seeds in these fruits are small, nearly cylindrical in shape, and have a slightly hollowed face.

In studying the plant it will be found that the *root bulb is the most distinctive part and will aid most in identification*. Special attention is called to Plate II in which the bulbs are well illustrated. A comparison of this plate with the other plates shows very strikingly the difference between the underground parts of plants of the Parsnip family, and makes obvious the great value of the roots as a means of identifying *Cicuta*. Taking the bulbous roots alone, as a means of identification, one could hardly make a mistake in naming *Cicuta*. The subterranean

part of *Cicuta*, properly speaking, is a close jointed, underground stem. It is bulb like in appearance, 2 to 4 inches long and 1 to 2 inches thick. In color the exterior is a dark purplish green, the interior a yellowish white, the flesh firm and bearing an abundance of reddish, aromatic oil—the odor of Parsnip being most decided; the root bulb is only partly underground and emits long fibrous roots from beneath. The poisonous property of the plant, cicutoxine, is found in the oil of the bulb.

Habits.

The flowering and fruiting part of *Cicuta* is sustained by food stored away during one or more years of immature existence. The reservoir for this supply is the bulb-like underground stem. After flowering, plant and root die, but while the flower is developing, the crown of the root, or underground stem, sends out one or more large buds, which, before the flowering stalk is dead, have formed roots of their own and are ready to produce a new plant. These buds sometimes require one, and sometimes two seasons for full growth. From the above it will be seen that the life limit of the species is intermediate between that of a biennial and a perennial.

In growth, as the plant reaches maturity, it becomes stout and scraggly, very often covering an area of five or six feet. Before reaching the fruiting season, the underground stem and roots become exhausted and begin to decay, the plant at this time being sustained and supported by tough, fibrous roots springing from a point where the leaves break from the underground stem. These roots are called accessory roots. At this period the young offsets are being formed.

Distribution.

Cicuta is found, in Oregon, in marshy or wet places both on the seashore and in the mountains. It is of most frequent occurrence along the banks of coast rivers and inlets, but is reported as being quite common about the lakes of Southern and South-Eastern Oregon. It is so plentiful throughout all of Western Oregon, that it is dangerous to cattle, during the spring, in uncultivated, marshy, pasture land. *Cicuta* is also found in abundance in Northern California, in Washington, and in British Columbia.

Other semi-aquatic plants of the Parsnip family, are often

found growing with the *Cicuta*, which adds to the difficulty of recognizing it and gives the others, most of which are harmless, a bad reputation. It is safe to say that no other plant in this family need be feared in Oregon pastures at the time when *Cicuta* is dangerous, viz. from January to May.

Damage Done by *Cicuta*.

It is hard to estimate the number of cattle killed yearly in Oregon by eating *Cicuta*. One hundred would be a low estimate in my judgment. Animals eat the underground portion of *Cicuta* in getting the tops which form about the first green herbage in early spring; as they browse the foliage, the roots, being only partly subterranean, and growing in a soft soil, are pulled up and eaten. A piece the size of a walnut, it was found by experiment, is sufficient to kill a cow. It is probable that the poisonous constituent is found only in the underground stem and the roots.

While the victims of the plant are chiefly cattle, yet they are not exclusively so. The poisonous parts are often mistaken for Parsnips, Artichokes and Horse-radish, and thus human victims are not infrequent. A number of cases of poisoning from *Cicuta* are annually reported in the United States. A writer in a local paper a few months ago, reported the case of two cattlemen in Southern Oregon, who, after eating "Wild Parsnip," presumably *Cicuta*, died in a few hours. Falk reports, that in Europe, in thirty-one cases of poisoning from *Cicuta*, 45 per cent died.

Symptoms of Poisoning, and Remedies.

Soon after receiving a quantity of the *Cicuta* bulbs from Mr. Harrison of Waldport, as before mentioned, it was decided to try their effects upon a cow, in order that a more direct knowledge of the action of the poison might be obtained. The following is the description of the behavior of two animals to which was fed the *Cicuta*,—the notes having been taken by Professor H. T. French, the Station Agriculturist.

"A bulb was cut into small pieces, mixed with a carrot cut up in the same way, and fed to a two-year old grade heifer. The material was fed at 8 o'clock, a. m., and at 9:30 the animal was dead. The poison performed its work so quickly, that we were unable to be present at the moment death occurred. The animal

evidently died in a spasm, froth and foam having escaped from its mouth in considerable quantities.

“On post-mortem examination, pieces of the root were found in the rumen, and in the reticulum or second stomach. None was found beyond the second stomach. It was somewhat surprising to find not more than two drams of the root in the stomach. A very small portion might have passed beyond recognition by mastication, but a careful examination was made resulting in the finding of the above amount. From the amount left in the feed-box it was evident that only a very small portion had been eaten.

“The lungs were highly congested, otherwise there were no abnormal conditions noticed in the abdominal or thoracic cavities.

“The following day another animal was fed the poisonous roots in order that an attempt might be made to counteract the effect of the poison with an antidote.

“A calf one year old was selected for the experiment. The temperature of the animal was taken in the evening and morning preceding the experiment. The normal was found to be $102\frac{1}{2}$ degrees.

“Two bulbs the size of an egg were cut and mixed with carrots, and a little grain sprinkled over the roots. The material was eaten under protest in order to get the grain and carrots.

“The roots were fed at 9:15, a. m.: at 9:40 the temperature was 103, and the muscles about the nose began to twitch. At 10 o'clock the temperature had risen to $103\frac{1}{2}$, and the animal was a little uneasy. At 10:25 the temperature was 104, and there was a trembling about the flanks. The eyes watered very freely: at 10:35 the animal was somewhat excited, and the temperature was $104\frac{1}{4}$. At this time urination began and continued very freely until death ensued. At 10:45 the animal fell over on its side in a spasm. The eyes were drawn and the muscles were rigid and contracted violently. The animal fell backward rather than sideways, and when part way down rolled on its side.

“As soon as possible it was given an ounce of spirits of turpentine in a quart of milk, and immediately the calf recovered its feet and began to walk about, though with difficulty: its limbs were stiff and it walked with a straddling gait. At

PLATE III. WILD CELERY. *Oenanthe sarnenlosa* Nutt.

10:55 the temperature stood at $104\frac{1}{4}$ and perspiration was flowing very freely. The respirations were hurried being about double the usual number per minute; soon there were indications of severe spasms. The dose of turpentine and milk was repeated and the animal stood up till 11:30, when it went down as before. A full dose of tincture of aconite with a quart of milk was given, but no results were noticed; immediately after a hypodermic injection of nitro-glycerin was made, but with no results. The spasms were almost continuous from the time the animal fell over until death took place at 11:45, just two and one-half hours from the time the poison was administered. The highest temperature reached was $106\frac{1}{4}$ degrees."

The cattle were fed, as above described, in March. During the next few weeks a number of "sure" remedies were recommended. The most common of these are lard, bacon grease, milk, and flour. The milk had proved to be worthless in the first experiments, but to satisfy ourselves regarding the other named remedies, and to try some of a more medicinal nature, another animal, early in May, was fed several of the poisonous bulbs. The bulbs were of the same lot used in the first experiments, but had been growing for a month in a green house. It was expected that growth would remove some of the dangerous properties of the bulbs, but it was a surprise to find that an animal eating many times as much of them as had killed the cows in the previous experiment suffered no ill effects whatever. The conclusion is obvious; the bulbs are only dangerously poison when in the dormant state, or for a short time after growth begins in the spring. Cattle are likely, then, to be poisoned only from the first of January to the middle of May.

It is probable that the simple remedies, as lard, bacon grease, flour, and milk, so highly recommended by stockmen, in the milder cases, are of value, as they are substances which would tend to retard the absorption of the poison in the stomach, and, given in sufficient quantities, would act as a purgative to expel it from the intestines. But it is my opinion that none of these would be of avail with an animal that had swallowed even a small quantity, a few drams, of the bulb when the poison is most virulent. Further investigation may develop some agent more potent as a remedy but until then, farmers must depend upon

prevention—keeping their cattle from pasture lands containing Cicuta.

Eradication.

An effort should be made to eradicate Cicuta completely from all enclosed pastures. Cultivation will soon exterminate it from fields that can be tilled. In other pasture lands, the plant once recognized, can be eradicated during spring and summer by going over the field with a sharp hoe, spade, or shovel, and chopping out the roots, a thing easily done; or, better still, while the ground is soft in the early spring, just after the plants begin to grow, they may be pulled out by hand thus securing complete extirpation. In most pastures Cicuta occurs but sparingly and to detect it will require close observation. The bulbs can be readily destroyed by exposing them to the direct action of the elements—sun, frost, and wind, so that an occasional plowing is effective in getting rid of the plant.

Related Plants Likely to be Mistaken for Cicuta.

Two plants closely related to Cicuta are often mistaken for it, and, since both are more plentiful than the Cicuta, cause those upon whose premises they grow, much uneasiness. A careful comparison of the description of the plants here given aided by the plates, will enable farmers to easily distinguish these more common and harmless plants from the Cicuta. The first of these plants is:—

WILD CELERY. (*Oenanthe sarmentosa* Nutt.)—Wild Celery is well shown in Plate III. A comparison of the parts of the plant in the plate with those of Cicuta on Plates I and II, shows that the leaves and leaflets are much smaller, the stems weaker and *ridged*, that there are bracts or leaflets, called involucre, under the flowers; and that the root stocks or bulbs, are very much different, in being smaller, less closely attached to the plant, and of a different shape. The plant is more aquatic in habit than the Cicuta; growing nearly always in water, often in running water. Wild Celery is smaller than the Cicuta, growing only from 2 to 3 feet high. Its thick, aromatic roots have the smell of Celery, instead of the Parsnip as has Cicuta, and the base of the leaf stems much resemble those of small Celery stems. The plant is edible and is much relished by the Indians, and is not unacceptable to a hungry White Man.

PLATE IV. SWEET CICELY. *Glycyrrhiza ambigua* Gray.

SWEET CICELY. (*Glycosma ambiguum* Gray.)—Sweet Cicely, the second plant that farmers commonly mistake for Cicuta, is shown in Plate IV, and a comparison of this plate with the preceding ones will make plain the differences. It may be easily distinguished from Cicuta by the root, its smaller size, its smell of Cicely or Anise instead of Parsnip, and the fact that it is common in dry lands as well as in marsh lands. Sweet Cicely is harmless.

There are other plants which as closely resemble the Cicuta as the two described above, but they are not common in pastures and are not to my knowledge suspected of being poisonous. Wild Celery and Sweet Cicely have been frequently brought to the Station as "the plants that poison cattle."

POISON HEMLOCK. (*Conium maculatum* Linn) has been sparingly introduced in waste places in the neighborhood of the older settlements, but it is not dangerous in pastures as its herbage comes at a time when good pasturage is plentiful and, moreover, its leaves exhale a sickly, disagreeable odor which repels all animals. Its smaller size, white fusiform root, foliage spotted with purple, and later appearance, easily distinguish it from Cicuta.

REVIEW.

1. Cicuta, a plant of the Parsnip family, growing in the low, pasture lands of Oregon, in late winter and early spring, poisons cattle.

2. The following plants, reported poisonous, were fed to cattle without ill effects: Larkspur, Camass, Sanicle, degenerated cultivated Parsnip, and Cow Parsnip.

3. Common names are inaccurate, and the plant in question should be called Cicuta, to avoid confusion. Locally, Cicuta is often known as, Wild Parsnip, Water Hemlock, Musquash Root, Cow Bane, Water Parsnip, Muskrat Weed, and Snake Root.

4. Cicuta is a tall, smooth, coarse, marsh perennial; the stems come from a bulb-like, underground stem; the leaves are from 2 to 3 feet long and have from 4 to 6 pairs of lance-shaped, coarsely-toothed leaflets; the plant blooms in midsummer and bears an umbel of white flowers which form small kidney-shaped,

ribbed, aromatic fruits. *The underground root-stock is the most distinctive part of the plant and will aid most in identification.*

5 Cicuta is found throughout Oregon, Washington, Northern California, and British Columbia. It is of most frequent occurrence along banks of coast rivers and inlets.

6. It is estimated that about 100 cattle are killed annually in Oregon by eating Cicuta. Human victims of Cicuta are not infrequent in the United States.

7. After eating the Cicuta roots death takes place, commonly, in a few hours. The symptoms of poisoning are uneasiness, twitching about nose and mouth, trembling of the flanks, watery eyes, much perspiration, high temperature, continued urination, and finally violent spasms which end in death.

8. As a remedy, stockmen recommend, lard, bacon grease, milk, and flour; these, by absorbing the poison, and acting as a purgative may be of avail in mild cases.

9. Cicuta should be eradicated from enclosed pastures by cultivation, cutting out, or pulling up.

10. Two common plants of the same family, Wild Celery and Sweet Cicely, are often mistaken for Cicuta.

BULLETIN NO. 47.

SEPTEMBER, 1897.

OREGON AGRICULTURAL EXPERIMENT STATION.

CHEMICAL-AGRICULTURAL DEPARTMENTS.

THE RELATIVE DIGESTIBILITY
OF
CHEAT AND CLOVER.

BY

G. W. SHAW, Chemist, and H. T. FRENCH, Agriculturist.

The Bulletins of this Station are sent free to all residents of
Oregon who request them.

AGRICULTURAL COLLEGE PRINTING OFFICE

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RELATIVE DIGESTIBILITY OF CHEAT AND CLOVER HAY.

Much controversy has arisen over the comparative value of Cheat hay. Cheat has long been considered a valuable hay-producing plant throughout the Willamette valley. That it grows well there is little doubt. Many farmers report a yield of three to four tons per acre, and even greater yields are often mentioned. The average yield is about $2\frac{1}{2}$ tons per acre. This portion of the State seems to be the natural habitat for several wild species of *Bromus*; and owing to the certainty with which Cheat may be grown, and the uncertainty which attends the efforts of the farmer in growing other varieties of grasses, it is not strange that Cheat should be retained so tenaciously.

Cheat is a very hardy plant, easily withstanding such vicissitudes of climate as are likely to prevail throughout a large portion of Western Oregon. On low, flat, heavy soil, where water is too abundant during the winter months for other grasses to thrive, Cheat will make a very good growth. It would not be easy to find a grass that can surpass Cheat under these conditions. On the higher portions of the land, or on land which is fairly well drained, there are other varieties of grasses and clovers which may be grown successfully, and which will give much better results when fed to stock.

The question upon which this report is intended to throw more light is not a question of *growing* Cheat, but rather its value as compared with Clover, when fed to cattle.

It is a common practice at present to feed Cheat to dairy cows as well as to all other kinds of stock; and it is with a view of discouraging its growth for dairy stock especially that these facts are presented.

The question of profit is determined more largely if possible, in dairying, than in any other branch of farming, by a proper knowledge of the food supply. It is not a question of quantity altogether, but of quality, and a proper combination of food constituents to produce the best results. The dairy cow is a delicately wrought machine which must not be over worked in consuming a large amount of material that is not needed, in order to get a sufficient supply of that which is essential in the production of milk.

When Cheat is fed to dairy cows the creamery man complains of a lack of milk supply, and this fact implies that the farmer is simply *keeping* his cows without getting proper returns from them. Much is said in these days regarding the yield of butter fat as an indicator of the value of a cow in the dairy; but it is not altogether just to the cow to apply the test before we have learned how to feed her properly. While the food, under normal conditions, will not materially change the per cent. of butter fat in milk, it will materially change the total yield by increasing the flow of milk.

It would not be right to discourage the growth of Cheat unless there is something better with which to replace it. Over a large portion of the

Willamette valley, where Cheat is now grown, Clover can be grown successfully. This has been thoroughly demonstrated on the Experiment Station farm, and we have seen the same results obtained on other farms in this portion of the State.

The two factors entering into the value of a foodstuff are its composition and its digestibility. The first factor is determined by chemical analysis alone. The second is determined either by actual trials with animals, or with artificial digestion fluids made to correspond closely with the digestive fluids of the body. The digestible matter for most of the common cattle foods has been determined by feeding animals for a stated period upon food whose composition has been previously determined by analysis. The material so used is weighed and the excreta of the animal carefully collected, weighed and analyzed.

The solid excrement is simply that material which has escaped the action of the digestive fluids, or the indigestible matter. From its analysis, and that of the food eaten, can be calculated the amount of the food digested.

The per cents of the various nutrients that can be digested by an animal are called the *digestion co-efficients*.

Thus it is seen that chemical analysis is the first and last step in rendering intelligible the results of feeding experiments. It is absolutely essential to a proper understanding of the material used in rations, if we desire to feed economically. It is the foundation upon which the whole system of rational feeding rests. The object of the following experiment; from the chemical standpoint, was to determine the digestion co-efficients of Cheat (*Bromus secalinus*) hay, and to compare its digestibility with that of Red Clover (*Trifolium pratense*) when fed to the same animal.

It seemed the more essential to set forth the results thus contrasted since after the publication of Bulletin 39 numerous persons—some evidently not having read the bulletin—made extravagant statements as to what the author claimed. Now the fact is that the writer never did assert that the hay in question was "worthless," for such a statement would be far from the truth. What he *did intentionally* imply was that Cheat did not favorably compare with several other grasses there named, either from the standpoint of a food or in economy of production. Cheat, and even straw, can be made the basis of a ration, but it is certainly poor economy to feed a hay of low food value when there are others much better which can be had; and it is still more wasteful, as well as crude and unscientific, to feed either this or any other coarse food alone, when the advantages to be gained by properly balanced rations are so clearly set forth in the literature of the day, and are so well recognized by the most eminent feeders of the country.

The details of the feeding were as follows: A three year old Short Horn grade steer was selected for the experiment. The animal was placed in a stall arranged in such a manner that the excreta could be collected without loss. The apparatus used was that recommended by Professor Armsby, of Pennsylvania. It is shown in the accompanying illustration. The apparatus was found well adapted to the work. The preliminary feeding began on February 17, 1896, and continued till March 2d, during which time

the animal was fed in the same manner as during the actual digestion period. During the last four days of this time the harness was adjusted to the steer, and the conditions made identical with those of the digestion period.

The hay was cut as for ordinary feeding, and after being thoroughly mixed, was weighed into rations, and a sample of each placed in an air tight bottle and brought to the laboratory for analysis. The first of the prepared rations was fed to the steer on March 2d, at 5 p. m., and the experiment ended at 5 p. m., March 8th. The water, as well as the food, given to the animal was carefully weighed. The amounts of each consumed, together with the weight of excreta, and the weight of the animal are given in Tables I and II. It is somewhat interesting to note the fact that the animal voided 58 per cent more urine during the Clover experiment than when fed on the Cheat. During the same time he drank 20 per cent. more water. The samples of dung were brought to the laboratory where they were reduced to an air-dried condition, and after being ground till the entire material would pass through a one-millimeter sieve, were preserved in air-tight bottles till analyzed.

TABLE I—CHEAT.

<i>Dates.</i>	<i>Food eaten.....</i>	<i>Water drunk.....</i>	<i>Weight of urine</i>	<i>Weight of solid excreta.....</i>	<i>Weight of animal.....</i>
	Pounds	Pounds	Pounds	Pounds	Pounds
March 3.....	16	37	11¾	29½	1006
March 4.....	16	40½	7	35	1012
March 5.....	16	28¼	3¼	30¾	1002
March 6.....	16	44	8	34	1007
March 7.....	16	32½	8¾	37¼	1008
March 8.....	16	33	9	32½	1006
Total.....	96	215¼	47¾	199½	.....

TABLE II—CLOVER.

<i>Dates.</i>	<i>Food eaten.....</i>	<i>Water drunk.....</i>	<i>Weight of urine</i>	<i>Weight of solid excreta.....</i>	<i>Weight of animal.....</i>
	Pounds	Pounds	Pounds	Pounds	Pounds
March 23.....	15	21	19	30	988
March 24.....	15	70	22¾	28	993
March 25.....	15	40	18½	33½	991
March 26.....	15	49½	16	36	992
March 27.....	15	42½	18½	32	991
March 28.....	15	47	18½	31	992
Total.....	90	270	113¼	190½	.....

The composition of the two hays was as follows :

TABLE III.

<i>Material.</i>	<i>Clover.</i>		<i>Cheat.</i>	
Water.....	4.27	Dry	7.00	Dry
Dry matter.....	95.73	matter.	93.00	matter.
Ether Extract.....	3.35	3.50	1.95	2.09
Protein.....	14.84	15.50	6.06	6.52
Crude Fibre.....	28.83	30.11	31.80	34.19
Nitrogen-free Extract.....	40.20	41.12	44.10	47.43
Ash.....	8.50	8.77	9.09	9.77
Total dry matter.....	95.73	100.00	93.00	100.00

For a full description of the terms above employed the reader is referred to Bulletin 39, but for the sake of reference the following resume is here inserted:

Protein, albumenoids, and nitrogenous matter mean the same thing, and are represented by the white of an egg, lean meat and the gummy part of wheat. Other things being equal, that food has the highest food value which is the richest in digestible protein. The function of this class of bodies is that of muscle forming. The term *Ether Extract* in the case of grains might well be expressed by the word fat, which is frequently used, but in the case of grasses and other coarse foods there is also included coloring matter and certain gums. *Crude fibre* is a term used to express the more woody parts of the plant, and is well represented by paper and cotton fibre. It is closely allied to starch, and with the next group belongs to the class of carbohydrates. The *Nitrogen-free Extract* is best represented by such bodies as sugar and starch, which together with the Ether Extract and Fibre serve to form animal fat and heat.

As stated above the indigestible matter constitutes the dung. This was collected during the period of the experiment, weighed and analyzed.

TABLE IV—THE STEER VOIDED AS DUNG.

	<i>Dry Matter.</i>
Of the clover hay, 190.5 lbs.....	32.37 lbs.
Of the cheat hay, 199.7 lbs.....	49.10 lbs.

The *water-free dung* showed the following composition: *

TABLE V.

	<i>Clover.</i>	<i>Cheat.</i>
Ether Extract.....	4.51	2.56
Protein.....	15.40	6.89
Crude Fibre.....	33.32	33.24
Nitrogen-free Extract.....	32.24	13.47
Ash.....	14.53	43.84
Total.....	100.00	100.00

* The nitrogen was corrected for metabolic nitrogen according to the method suggested by Dr. Jordan in Annual Report of Maine Station, 1888.

From the above figures, computing the ingredients of the dung excreted during the experiment, we have:

TABLE VI.

	<i>Clover.</i>	<i>Cheat.</i>
Ether Extract.....	1.46	1.26
Protein.....	4.98	3.38
Crude fibre.....	1.78	16.22
Nitrogen-free Extract.....	10.52	21.58
Ash.....	4.70	6.66
Total.....	32.37	49.10

These figures represent the indigestible matter. It is evident, then, that if these be subtracted from the figures representing the ingredients eaten, we shall obtain the amounts digested.

TABLE VII—SHOWING DIGESTIBILITY OF CLOVER HAY.

<i>Material.</i>	<i>Dry Matter.</i>	<i>Ether Extract.</i>	<i>Protein.</i>	<i>Crude Fibre.</i>	<i>Nitrogen-free Extract.</i>	<i>Ash.</i>
In 90 lbs. clover hay.....	86.15	3.02	13.35	25.94	36.29	7.55
In 190.5 lbs. clover dung.....	32.37	1.46	4.98	10.78	10.52	4.70
Amounts digested, lbs.....	53.78	1.56	8.37	15.16	25.77	2.85

TABLE VIII—SHOWING DIGESTIBILITY OF CHEAT HAY.

<i>Material.</i>	<i>Dry Matter.</i>	<i>Ether Extract</i>	<i>Protein.</i>	<i>Crude Fibre.</i>	<i>Nitrogen-free Extract.</i>	<i>Ash.</i>
In 96 lbs. cheat hay.....	89.28	1.86	5.81	30.52	42.37	8.72
In 199.7 lbs. cheat dung.....	49.10	1.27	3.38	16.22	21.58	6.66
Amounts digested, lbs.....	40.18	.60	2.43	14.30	20.72	2.06

The following table shows the comparative digestibility of the constituents in each food stuff used in the experiment:

TABLE IX—DIGESTION CO-EFFICIENTS.

	<i>Clover.</i>	<i>Cheat.</i>
Dry Matter.....	62	45
Ether Extract.....	55	32
Protein.....	63	42
Crude Fibre.....	59	46
Nitrogen-free Extract.....	71	49
Ash.....	37	23

Computing the nutritive ratio* for each, as determined by the experiment, it is found to be:

For clover hay..... 1: 5.3
For cheat hay..... 1:15.0

The chemical analysis shows that Cheat contains a larger per cent. of indigestible woody fiber than Clover, and less than half as much protein or flesh formers. In carbohydrates, or those substances which go largely to keep up animal heat, the Cheat is better provided than the Clover. This to a certain extent explains why the Cheat gives such favorable results in keeping stock animals, or those which are being kept over winter. In the fat contained the Cheat is not nearly as well provided as the Clover.

The nutritive ratio is rather wide—that is there is a large proportion of carbohydrates to the protein, or flesh forming substances—there being 15 of the former to one of the latter. It is not economical to require the animal functions to take care of so much crude fiber in order to obtain a sufficient supply of nitrogenous material. It is cheaper to supply the deficiency by a better balanced ration. This might be done by feeding liberally with bran oil meal, pea meal, or cotton seed meal, but in feeding these concentrated foods the expense is materially increased. The best results will be obtained when we feed in the coarse food as nearly a complete, or balanced, ration as possible.

* Found by multiplying the Ether Extract by $2\frac{1}{2}$, adding to the product the Crude Fibre and Nitrogen-free Extract, and dividing by the Protein. It expresses the relation between the carbohydrates and the protein.

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