SOY BEANS

And Secrets of

Legume Inoculation

Published By

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SOY BEANS

During the past fourteen years, practical experience and observation has convinced me that the Soy bean is probably the best plant known at present to grow protein for domestic animals in what is known as the corn belt, and second only to clover as an agent to supply nitrogen to the soil--even this latter point may be contested, if we consider the comparative time each crop occupies the land, and are satisfied to remove and sell off the land as small a per cent. of the crop as we do of the clover.

As compared with the cow pea, it is hardier, may be planted earlier in the season, and makes its full plant growth more quickly.

One summer I planted a field with Early Brown Soy beans and New Era cow peas, mixing the seed together in the planter, expecting the cow peas to continue growing and making succulence after the beans were ripe. But instead, by the time they were six weeks old, the cow peas were nearly covered, and never made much showing. It grows more erect, matures its seed more evenly, and the seed is not subject to attacks of the bean weevil, while cow peas are sometimes entirely destroyed by this pest. It is far more productive of seed, and this seed contains about 50 per cent. more protein than cow peas.

Its many varieties, ranging from very early to very late, makes its climatic range very great.

Soil and Rotation

It will thrive in any soil in which corn will grow. It can be made to enter nicely into rotation with various other crops. When harvested early it gives a fine opportunity to seed with rye, wheat or vetch. If this is not desirable a fine seed bed is easily prepared for a spring crop and may be followed by oats, barley, timothy, clover, sugar beets etc.

Special Uses and Methods

The Soy bean looks like a good proposition in orchards either to turn the whole crop into the soil, or if conditions are such as to demand immediate returns from the crop, it could be pastured with hogs, giving a good profit and still adding much to the nitrogen and humus of the soil. Further benefits could be derived by planting seed of the winter vetch mixed in the planter, and planted with the Soy beans. The beans will develop much more quickly than the vetch, and after they have fulfilled their mission the vetch will develop rapidly during the late fall months, at a time when the land would otherwise be lying idle.

All domestic animals become very fond of the Soy bean and some wild animals, notably the rabbit and marmot manifest a decided liking for it. Being extremely rich in protein, it is of especial value as a part ration for young and breeding stock, to be fed in connection with corn, timothy, millet, fodder, straws of various kind and other carbonaceous feeds. Brood sows that have had a small regular daily allowance seldom eat their pigs.

I find it makes a fine pasture during the latter part of July and August, especially good for growing hogs and milk cows. I turn in about the time the pods begin to form. The best results with hogs are obtained by turning in when the pods begin to turn yellow, and feeding about half as much corn as the hogs will eat if they are young and growing, and more if the hogs are approaching maturity, thus supplying the protein according to the needs of the animal. August 29, 1910, I weighed two old sows, ten small pigs and 126 March and April pigs and turned them into six and one-half acres of Early Brown Soy beans that were just beginning to ripen. These beans were about an

average crop for mixed clay and loam soil, ranging from heavy white clay to a deep black loam. In addition I fed them dry corn twice each day and kept water before them all the time. They had the beans about cleaned off in thirty-one days. When I again weighed and took account of the operation I found that in addition to the beans, I had fed them 179 bushels of corn. Four of the shotes had died from various causes, but I still had a net gain of 5350 pounds. Deducting the usual ten pounds gain for each bushel of corn fed straight with water, I still had a net gain of 3560 pounds or 547 pounds for each acre of beans, the value of which I leave for each reader to estimate in his own market. The hogs harvested the crop, prepared it for market, and returned the waste to the soil.

I am often asked which will produce the most feed for hogs, an acre of beans or an acre of corn. The probability is that for a single season, corn would, but a two-thirds acre of corn and a third acre of beans fed together will produce more pounds of pork than either alone, and this advantage would constantly increase through a series of years, by rotating the crops, if the same land is to be continuously used for this purpose.

If to be used for hogs only, I prefer to plant one half the field with an early variety and the rest with later ones, cultivate all until the early ones commence to bloom, then sow Dwarf Essex rape on the part growing the early variety. The hogs will clean up the early beans first, and the rape will grow while the hogs are pasturing off the late ones, and add considerable value to the crop.

In pasturing it is always better if water and a portable shelter is supplied on the field, and stock kept there during the pasturing period, as this prevents waste of fertility, not allowing it to be scat-

tered along the lanes and in barn yards, and wasted as is the common practice.

As a soiling feed for milk cows they are excellent. By planting both early and late varieties as early as the season will permit, and begin cutting as soon as they become well developed, a good supply of very rich succulent feed may be supplied in succession, and at a season when it is badly needed. A considerable feed value and fertility may be secured by planting a half bushel or more seed of an early variety, per acre, between the corn rows, at the last cultivation, without apparent damage to the corn.

A valuable hay may be made if cut about the time the pods are forming, before the stems get hard and woody, and cured as other hay is cured, allowing a day or two more time. This must be done as early as the middle of August, in this climate or there is danger of insufficient heat to properly cure the product.

As a silage plant it is highly recommended by some and is a plant worthy of trial, to be mixed with corn to give the balanced ration, but never alone. The larger growing medium late varieties are better for this purpose than the early dwarf ones. They may be grown in the row together with the corn, or planted separately and mixed in the cutting box. I have had no personal experience with the silo, but I am of the opinion that in practice, it will be more satisfactory for most farmers to rely on corn silage for succulence, and store the cured beans in some convenient place and give the stock their allowance of these regularly as a dry feed.

I do not advise anyone to raise beans to be sold on the market for seed, until he has grown them a year or two and learned their peculiarities, and the requirements of the market. The main point in

the proposition is, will it pay? For the novice it will be a risky proposition. The Soy bean as such is not yet a staple article of commerce like beef, pork, butter and eggs and he may have considerable difficulty in finding a customer who understands the full value of his product, hence it will be safer for him to transform his beans into an article whose value is generally prized, and market them in that form. For the year 1910, I found I received more clear money per acre from the field of beans I hogged off than for another one that I thought better, which I cut, threshed and sold for seed, besides the hog money came in three or four months earlier, and the hogging off process returned to the soil about 60 per cent. of the bean fertility to boost the next crop of corn---dairy farming would have returned a still larger per cent. of fertility. In 1911 I cleared more cash money from the land harvested and seed sold, but to offset this, I waited longer for the returns and sold fertility which if it had been fed to stock, would have made the land better.

The necessity of selling available fertility from the farm is a difficult problem to understand and adjust, and its practical application and ultimate analysis is but vaguely comprehended by a great many tillers of the soil. The popular thought and practice have leaned too strongly toward getting the largest and quickest returns out of the great store house of past ages, and "blow in" the same in keeping up with the luxurious and expensive customs of the day. It is plainly evident that this manner of living has already drawn heavily on nature's stores, and unless this process is changed will surely produce trouble in future years. Should I advise you, I would say, sell as little fertility as you can from the farm and return as much as you can to your soil, it will draw for you a big inter-

est. Your soil is your individual bank, the stock and the dividends are yours, and if you persist in drawing on your capital for current expenses, sooner or later you must go to the wall.

Planting.

Before planting, the land should be finely prepared about the same as in making a first class seed bed for planting corn. More care is necessary in planting and starting beans, than is usually given to corn, especially in clay lands that are liable to form a surface crust after heavy rains. A crusted surface interferes more with beans in coming up, than it does with corn, although corn is often seriously injured by the formation of a crust which prevents the young plants from coming through. This is the only difficulty I have experienced in getting a good stand of beans. Several methods of planting have been tried, each with a degree of satisfaction. Many use the common grain drill, drilling solid or with all holes open if for pasture or hay, and covering part of the feed holes if beans are to be cultivated and grown for seed. The one horse grain drill I find very useful to plant them in corn at the last cultivation.

The method by which I get most satisfactory results on my own land, is to plant the rows from twenty to forty inches apart according to soil and variety of bean and the available tools for cultivation, and cultivate. The thinner the soil and the smaller the growth of the variety, the closer the rows should be, and the richer the soil, and the more robust the variety, the wider apart. For most soils and varieties about twenty eight or thirty inches is best, but remember it is always better to plant them wide enough apart to cultivate them with your available tools.

The implement with which I prefer to do this

planting is a good corn planter with furrow openers set so as to shove the dry soil aside, and allow the beans to be covered nicely at an even depth in the moist soil at the bottom of the shallow furrow. Do not cover deeper than is necessary to keep the beans moist until they sprout. This, I think is also the best plan for planting corn. If your planter will not space the rows the desired width, you may be able to get a new set of holes drilled in the frame bars, so as to move the boxes and shoes closer together. I set the feed so as to drop about six to eight beans in each foot of row. This will require about thirty pounds of seed of the larger seeded varieties to the acre in rows forty inches apart and forty pounds seed if rows are thirty inches apart. Of the smaller seeded beans about two-thirds as much. If drilled solid for hay, or pasture, use from one bushel of small seeded to two bushels of the large seeded beans per acre, in closely drilled rows, and cultivate with harrow. If for hay plant as early in the season as convenient.

Cultivation

In cultivating I use the harrow soon after planting if it rains and a crust is threatened, or if weeds are liable to appear. This assists the young plants in coming through the ground and destroys many weeds before they get a hold on the soil. This harrowing is made possible by planting in furrows. I also use the harrow once or twice after plants are up, always harrowing in the heat of the day while plants are tough. They some times break badly early in the morning. Keep harrow teeth sharp, set at an angle, and keep them clean. Later cultivation is done with ordinary corn cultivators, keeping the land level if beans are to be cut with machine.

One of my customers who raises sugar beets, used his beet cultivator last season for his beans, and expressed himself well pleased with the result. It looks to me like a two horse beet cultivator set to cultivate two rows, about thirty inches apart, at one passage, would be a very convenient and satisfactory way of doing the work. The horses could be jockeyed or checked apart so as to straddle both rows very nicely.

Harvesting

I have already stated all I have to say about the handling of green beans under the head of Special Uses and Methods. When allowed to ripen fully before harvesting the foliage will drop off and add considerable fertility to the soil and improve its mechanical condition, adding materially to the next crop.

The ripened beans should be cut after the pods have turned yellow and before they have become dry enough to shatter badly. This may be done with a mower, just as you mow grass for hay, letting the beans cure in the swath and raking them in wind rows in the morning while they are damp, or a side delivery attachment may be used as in cutting clover seed. A cleaner job may be accomplished with a bean harvester, especially where stalks are short with pods low on the plant. The taller growing varieties may be cut very nicely with a wheat binder, and set in small shocks to dry. Small fields may be cut with a mowing scythe, or chopped off with a heavy sharp hoe.

As soon as the beans become well cured they should be stored under shelter, either with or without threshing. They can be threshed and fed, either whole or mixed with other grain and ground, or they may be fed in the straw just as they are hauled in from the field. This latter is the best

way to feed them to poultry in the winter, and will furnish them with needed exercise. I esteem the straw from these threshed beans as being of as much value as shredded fodder. In harvesting it is difficult to secure all the beans, especially with the dwarf varieties. Many pods will be set near the ground and will be either missed entirely or clipped off and cannot be gathered with the straw, or if the beans have become a little dry many will shatter out and be left on the land. But these need not be lost, as they make the finest of pasture for growing pigs and brood sows during the late fall and early winter.

Threshing

Any machine that will handle wheat and oats properly can be made to thresh the beans for feed by taking out the concave teeth, or most of them, but if the beans are dry enough to thresh properly many will be split, and many more will have the skin jarred loose rendering them unfit for seed. If they are damp and tough, the beans will heat and mold in the sack or bin. For home planting the split beans may be screened out by using a sieve made of queen-excluding zinc such as is used by beekeepers, and used for feed. In a small way the seed may be flailed out; some corn shredders may be made to do a fair job. I have heard of a clover huller being rigged to thresh them. Where there are enough beans raised for seed to justify the expense, a regular bean huller should be used.

Yield of Grain

The yield of grain by test plats taken in different parts of the fields have ranged from 13.4 bushels per acre on thin white clay to 40.8 bushels on rich grayish black land averaging about 26.5 bushels on my mixed clay loam where cultivated, and

considerably less when planted close and not cultivated. Machine measure however, has usually fallen three to five bushels short of these figures when dealing with the dwarf varieties, on account of shattering and other losses.

The Seed

In buying seed for northern latitudes never accept that grown in the south. If you do you will surely be disappointed. Several persons have reported their dissatisfaction with these seeds. I tried them once myself; I got a bushel from a big seed firm in Chicago. They cost me \$4.65. They were full of foul seed and trash. As it was planting time when I received them, I concluded to hand-pick and plant them. I picked out a large handful of cockle burs, and 1,284 morning glory seeds. I had ordered an early variety, but not a single bean got ripe before they were killed by frost. A customer in west Tennessee wrote me that the Mammoth Yellow, the common Soy bean of the south, and which he had grown for several years never got ripe for him until in October even if he planted it in March, and he was seeking an earlier bean for his locality.

Never accept seed that contains noxious weed seeds. The seeds of some of our worst weed pests are contained in Soy beans and cow peas, notably the wild morning glory, Bull or Horse nettle and Butter print, any one of which it is very difficult and expensive to eradicate when once established. I am utterly unable to comprehend why our government is so lax in permitting our soil to be filled with pests through the marketing of seeds both native and imported, grown on land that should be quarantined against its use as a seed producer. In addition to our native pests, we Americans are importing and scattering foreign selections, that

A stalk of Soy Beans that had a chance
and made good.

Select samples of roots with nodules 14 weeks after planting. Concentrated Inoculate used with seed.

are vastly more pernicious than any with which we have hitherto had to deal. They belong to various species, that represent the survival of the fittest of all the thorns and thistles with which the ground was cursed, having their persistency intensified by ages of warfare which has been waged against them in the old world without eradication. The American farmer seems to be calmly sleeping while the enemy, unmolested, is quietly seeding our fair fields with his choicest selections. The result is a rapidly increasing cost to the American tiller of the soil, each year making more labor or smaller returns. This certainly affects the cost of living, and is an item in which every person who buys a mouthful of feed is interested, especially will this apply to those who come after us, and for whom this influence will be compounded at a fearful rate.

Varieties

In the matter of choosing varieties much depends on how and when you want to use your crop. The early varieties do not grow as tall, especially on thin soil as the later ones. They bear many of their pods near the ground, and are difficult to harvest without leaving a good many beans on the land, but they are of especial value for early use and for late seeding.

The late varieties are best used where seeding can be done early, about corn planting time, especially on thin land. They produce more roughage and about as much seed as the earlier ones. They set their pods higher up on the stalk and cleaner work can be done in harvesting. They give satisfaction for late pasture, soiling, and storing for winter in the dry form. They will make more humus in the soil, when filling the office of a fertilizer. The Early Brown, Ito San and Early

Yellow are the best among the well known early varieties, there being but little choice between them.

THE EARLY BROWN

is a rather large brown seed without other special markings than its color, which is characteristic. It grows about twenty-eight inches tall in good soil, shorter in thin soil, somewhat branching, and ripens in about 90 to 105 days according to soil and season. It is a heavy yielder.

THE ITO SAN

is very similar in all respects to the Early Brown except in color of the seed, which is a dingy white with a small brown spot at one end of the hilum on each bean, by which it may be identified.

THE EARLY YELLOW

is very similar to the above except in color, which is more yellow than Ito San, without any definite individual marking by which it can be identified from the other yellow and later beans, and in buying seed it is best to avoid this variety unless you are sure of its identity.

The above three varieties are the best ones for early hogging off or late sowing as a catch crop. When planted between corn rows after the last cultivation in July, they will develop a smaller plant, and ripen seed in seventy or seventy-five days, emulating the common reputation of the cockle bur which is said to always ripen its seed before hard frosts, no matter when it starts to grow.

THE HOLLYBROOK

is a midseason variety, at least two weeks later than the three above mentioned. It grows erect, with a rather large stiff woody trunk with but few branches, and about thirty-three inches tall in

good soil. It bears its pods in clusters about main stem and is a good yielder. It is a good second early for pasture, for hogging off and for putting up for winter use.

THE SABLE.

is a small jet black seed, grows about forty-two inches tall on good soil, but is not very firmly fixed in some of the characteristics of the growing plant. In this respect it is inclined to manifest a sporty disposition and varies in style of plant, color of bloom, etc., but is a heavy yielder of forage and a good one for soiling, hay or silage, and is also a good yielder of seed. It should not be planted late in the season as it is a late variety about ten days later than Hollybrook and requires a rather long season.

THE MAMMOTH YELLOW

is an excellent variety for use in the southern states, but worthless in the north because of its extreme lateness.

There are hosts of other varieties, some of them clamoring for a front place in the list, but none with which I am acquainted have established a reputation for superiority over those given above.

It is not likely that the list of early varieties given above will be greatly improved upon in the near future but for midseason and late varieties there is more chance for improvement along certain lines.

LEGUME INOCULATION

When you buy complete commercial fertilizers, the nitrogen in them is what you pay the big price for at the rate of from 15 to 17 cents per pound. Above every acre of land to which you apply this fertilizer, there is floating approximately seventy million pounds of this same element, as free as the rain that falls in a wet time, in fact so free that none of your farm plants can use it, without the help of a third factor stepping in and tying this nitrogen up in such a shape that your plants may feed on it.

If you possessed the magic wand whereby you could at will transform this exhaustless supply of nitrogen into nitrates, and pile them up ready for sale, you could soon possess a fortune that would make the barons of wealth look like the proverbial thirty cents. But this you can not do, and it is a fine thing for the rest of us, and you too, that you can not. However, there is a class of little organisms, invisible to the naked eye, that will help you to get a part of it at a big profit, if you will accept their services, and make their surroundings congenial. They will enable you to secure your legitimate share of this great wealth, without the interference of any trust, syndicate or other combine.

I thought I would tell you some of the nice things about this little organism before I told you that it is a bacterium, so when you found out, you would not be afraid of it, but would know that it is one of the good kind.

It existed and plied its trade secret, that of transforming free nitrogen into a commercial product, which it bartered only to its favored legume for a home and other necessities, long ages before its identity was discovered by man. In the year 1884

a German Scientist named Hellriegel, proved that the nodules on the roots of clover contained bacteria which had the power of gathering nitrogen from the air and transforming it into available food for clover. This then was the secret of why clover was a good fertilizer. The key having been discovered, it was soon found that all legumes possessing nodules containing bacteria, were collectors of nitrogen and added fertility when turned back into the soil. The family name of these nitrogen gathering bacteria is *Azotobacter Chroococcum* which name does not seem to have injured its health, or interfered with its activity in the least. In fact, since it has been thus honored it has become quite popular, and has multiplied and prospered more than before.

If these little helpers are already in your soil their surroundings is all you need to look after, and if you make these all favorable they will multiply at a rate almost beyond the comprehension of man, and collect this nitrogen for you. If they are not present, you will need to go where they are, and get some and put them in your soil where you have the right conditions supplied. To make the conditions right the soil must be drained of all surplus water. It must not be acid, if acid after draining use lime. To do their best, they must have plenty of potash and phosphoric acid in the soil. They must also have the roots of some legume plant to live on. They will not associate with any plant whose seed is not borne in pods. Furthermore they are divided into families and each family is so particular that it must have its own favorite legume as a host, or it will refuse to do business for you. One kind will associate with the clovers, red, white and alsyke, another with the Alfalfas, another with cow-peas, and still another with Soy beans. Some kinds are natives to your soil, having been

associated with wild legumes growing in the forest and prairie, and will be ready to co-operate with cultivated plants in the same family. Others will be absent altogether; this will usually be found to be true of those families of legumes that have never been grown in the locality. The only way to determine the presence of the specific bacteria you desire, is to examine the roots of the particular legume that you wish to grow, and if nodules are not found it is safe to be guided by the conclusion that the bacteria are absent. If not present you must supply the kind that thrives with the legume you want to grow. This may be accomplished by distributing soil from an inoculated field where the crop has been grown the year previous. This is a rather slow and laborous task because of the bulk and weight necessary to make a good job. If you can reduce this bulk and still keep the conditions for the preservation of these bacteria the same as we find them in nature, you will at once have a preparation that can be handled more easily and with less expense. The farther this concentrating process is carried, the more convenient and efficient will be the product.

Bacteriologists tell us that these bacteria are about one twenty-five thousandths of an inch in diameter. If you will cube the number 25000, you will have fifteen thousand six hundred and twenty-five millions or about the number there would be in a single cubic inch of bacteria. Now if you can preserve these in a few pounds of soil, you will still have many millions of them in a single pound. You can obtain very good practical results in the following manner:

When plants are nearing maturity, collect of the same family of legumes which you desire to inoculate, roots with adhering nodules and pack these mingled with a small quantity of loam free from

sand, in a bed frame or box made of old weather-beaten or other lumber that is free from turpentine and tannin. Cover with a slatted covering sufficient to prevent heavy rains from washing out the bacteria, and still open enough to let sufficient water through to keep the mass moist. Leave this undisturbed in a protected place out of doors until planting time. Then sift through a fine screen and it will be ready for use. This should give you a preparation sufficiently concentrated that from two to four pounds will be ample to inoculate a bushel of seed pretty thoroughly.

Because of the small bulk, extremely rich in bacteria, this preparation may be mixed directly with the seed in the planter, just before planting, and distributed during the planting operation, with little trouble. This procedure is facilitated and made more efficient by slightly dampening the seed before mixing with a little water, especially if a little glue has been dissolved in it, then add the inoculate and thoroughly mix, when nearly every bean will have bacteria adhering to it, which as soon as the bean sprouts, will be on the spot ready for business.

I have never used the glue myself, but the reports I have received indicate the best results when used. Care should be exercised not to add enough to make the seed stick together in lumps. Anything that will make the inoculate stick to the beans, will prevent it from settling to the bottom of the seeder box, and guarantees a more perfect distribution. The seed should never be dampened until ready to plant, and the inoculating material should never be left exposed to the direct rays of the sun for any continued period of time. These are the principles which I follow when preparing the concentrated inoculate I use, improving their application as experience dictates. Out of a large

number of reports from customers, not a single failure was reported last year, the majority reporting from 75 to 100 per cent of the roots bearing nodules. The first year the nodules will not be as numerous, but will be larger than in succeeding years, after the soil becomes filled with an excess of bacteria. Do not expect first class results in wet or acid soil. It is better for the current crop if you get all the plants inoculated the first year, but this cannot be expected any more than you can expect a perfect stand of corn with an ear on every stalk. If as many as ten per cent. of the roots have nodules, that will place enough bacteria in the soil to insure a complete inoculation the following year.

Although these germs will retain their vitality in neutral and slightly alkaline soils for several years, they are not so long-lived under ordinary shipping and storage conditions, therefore they should not be prepared until a short time before they are to be used.

My experience has been chiefly with Soy beans but the same plan may be applied to other legume bacteria, always bearing in mind that in protection from destroying influences such as the sun's rays, chemicals of various character, excessive dryness etc., and from waste, as by washing out and scattering of the bacteria by excessive rains, lies the hope of practical success.

The locust tree and other legumes that are to be transplanted, can be started in nurseries where the soil is inoculated, after which the roots of the young seedlings will carry the bacteria to their permanent location.

It must be remembered at all times that your plants, like your animals, must have in their food all the elements entering into their physical structure, or they cannot develop.

If any element is eaten in excess by an animal, such excess cannot be assimilated and becomes a burden to the animal's system. It must be thrown off, not only being a waste of the substance itself, but a tax upon the animal's system in its effort to rid itself of this burden. If the same element should be furnished in too small a quantity, the assimilative powers of the animal appropriates all of this element within its reach, and as much of the other elements as it can combine with it, either for growth or maintenance, after which all the residue becomes a useless burden, and must be gotten rid of, and a waste of valuable food is the result. The minimum ingredient always determines the amount of nutriment assimilated by the normal animal economy.

Carrying this thought to the extreme, and supposing the young animal to be entirely deprived of one element, protein for instance, and all the other elements supplied freely, muscular development must cease because there is none of the essential material to make muscle out of. Then nature's processes recognizing the fact that there will be no further need of bone to support the muscles, refuses to assimilate the minerals which enter into the bone structure, growth ceases, and all the feed becomes waste. I think it is evident to the reader's mind, that to obtain the most rapid and economic gains in feeding an animal, that animal must be furnished in its feed all of the various elements of which its body is composed, in about the proportions and quantity of their ready and complete assimilation by the animal's system.

The same specific laws hold good in plant life as with animals. The essential elements of plant life which are lacking in most worn lands, are nitrogen, phosphorus and potassium, and a deficiency of either one will limit the developement of the

plant and its power to assimilate the others. For instance available potash and phosphoric acid may be present in abundance in your soil, but the nitrogen compounds may be very deficient. Your plant will use all the nitrogen that is available within its reach, but will not use any more of the other substances than it can combine with its stock of nitrogen.

Now if your plant is a legume and properly stocked with its family bacteria, and not finding the proper amount of nitrogen in combination in the soil, it will reach out through these parasitic servants and draw on the free store of the atmosphere, which enables it to consume more largely of the other elements, and effect a more vigorous development, thus relieving you from the necessity of purchasing the nitrogen for its use. The same law of necessity holds good in the case if nitrogen is present in abundance, and either of the other essentials should be absent. Therefore if you want your legume with its helpful bacteria to bring you good returns see that these elements are not lacking.

Before paying out any large amount of money for fertilizers, it is wise to determine wherein your soil is deficient and buy only those elements that are lacking and which you cannot supply more cheaply in some other. Use the same tactics you would in buying for your own table, or food for your stock. You may be able to obtain much valuable information from your nearest Agricultural Experiment Station along this and other lines, if you are not too bashful to make your wants known. I find the managers of my own State Experiment Station at Lafayette very courteous, obliging and as helpful as the funds apportioned to their use will permit. They will even sometimes send out search warrants in the form of bulletins, special

cars, district short courses and institute worker to find and help farmers, but there is one thing they will not do, and that is to fill your pockets with gold, unless you will push the flap aside, open the pocket a little and display some willingness to carry the burden after it is thrust upon you.

Often there is a considerable quantity of phosphorus and potassium especially the latter in the soil, locked up in an insoluble form and no more available for plant food, than the free nitrogen of the air. These are liberated by chemical action brought about in the process of cultivation, more rapidly in the presence of humus, presumably the work of a specific bacteria acting upon the soil compounds, in a manner similar to that in which the legume bacteria gathers the nitrogen from the air. The power of these little organisms to change the form and composition of special substances, may be better understood when we remember that there is an insect that eats its way into solid iron, not by means of teeth but by means of a peculiar acid secreted in its own body. To the Doubting Thomas to whom this may seem incredible I will ask him to remember that his own existence depends upon similar arrangements within his anatomy, whereby the food he eats, utterly unfit to enter his blood circulation, is so changed by his own organic secretions, that it becomes the proper material to enter the life sustaining current--even small quantities of metallic iron may be thus manipulated.

For both plants and animals the food must be put in available form, in other words, digested; the chief difference being, that in plant life these preparatory changes are more nearly completed outside the organism of the consumer through interposition of external agents, while the animal carries within its own body the necessary arrange-

ment for much of this work. To encourage this form of disintegration, remove all excess of water by draining, of acid by liming, and the deficiency of humus by incorporating stable manure and other vegetable fibre into the soil. Then cultivate as freely as conditions will permit.

In our efforts to build up a prosperous and permanent agriculture, we must keep continuously before us the fact that all plant life depends upon a series of chemical changes, mutually dependent upon each other, forming as it were an endless chain, whose working strength is measured by its weakest link, working automatically when the raw material and the proper conditions are supplied. For instance the supply of raw material for the manufacture of protein is everywhere inexhaustable. Its manufacture is governed chiefly by activities of the Azotic bacteria, and these again depend upon the existence and thrift of their particular family legume, and its vigorous developement is possible only when abundantly supplied, in available form with the various elements entering into its make-up; these again depend on the disintegrated remains of former generations of plant life; and thus the round moves on with a vigor which rises and falls in direct ratio with the activities that strengthen each individual link in the chain and determine the sum of results. It is therefore evident that if we would draw largely on this store of unlimited wealth of nitrogen, we must have a chain that draws, and supply each and every link in that chain with the necessary strength to draw the load we want, and it rests with each individual husbandman to determine how heavy a load he will make it draw.

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