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PRACTICAL OBSERVATIONS
ON
AGRICULTURAL GRASSES
AND
OTHER PASTURE PLANTS.

BY
WILLIAM WILSON, JUNIOR.

SECOND EDITION.

LONDON: SIMPKIN, MARSHALL, & CO.
EDINBURGH AND GLASGOW: JOHN MENZIES & CO.
ABERDEEN: JOHN RAE SMITH.

1889.

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AGRICULTURAL GRASSES.

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ON
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AND
OTHER PASTURE PLANTS.

BY
WILLIAM WILSON, JUNIOR,

HILLOCK, TERPESHE, ALFORD, ABERDEEN, N.B.

AUTHOR OF

- "Food Plants," Read before British Association, 1885;
- "Growth and Germination of Grasses and Botany of Alford;"
- "Transactions of Northern Scientific Societies";
- "Notes on Botany of Alford, Past and Present;"
- "Transactions of East of Scotland Union of Naturalist Societies;"
- &c., &c.

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P R E F A C E.

CONSIDERABLE discussion has arisen from time to time as to the desirability of extending our knowledge of the principles of pasture cultivation. During the last few years the system of laying out land in grass has in a great measure been departed from, whether under the method of alternate husbandry or that of permanent pasture, and a more general activity prevails in the matter. The difficulty experienced in making sound observations on the subject is getting to be more widely recognised, and a much greater interest is being taken by agriculturists in securing reliable information on the point. The importance of practical investigation is now all but universally admitted, and in the eyes of agriculturists it is held indispensable that any investigator shall possess a practical knowledge of agriculture and the habits of agricultural animals, as well as a scientific knowledge of the plants most likely to be useful.

Since the publication of the first edition, I have been engaged investigating, experimenting, and in every conceivable way trying to add further information to that already acquired. The success of the work has surpassed my expectations, and, in issuing a second edition, I beg humbly and respectfully to thank all who have aided me. I would wish specially to mention

the kind attention of the Agricultural Department of the Privy Council from which I received valuable suggestions; the candid opinion of the great pioneer of scientific agriculture, Sir J. B. Lawes, as regards the care bestowed on my enquiries; the attention of Professor C. C. Babington, of Cambridge, who has so long held the highest reputation in field botany. I also thank all reviewers, subscribers, and all others who have in any way aided me.

On the grounds indicated, I have every confidence that this issue, containing, as it does as much material in as few words as possible, will not only be read and appreciated by at least a representation of the great body of Agriculturists, but will be utilised in the promotion of the—to them, and we may also say to the nation—very important points involved in the subject of agricultural pasture.

W. WILSON.

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ERRATA

Page 63, 12 lines from top, for Woodward read *Woodford*.

" 75, 10 " " Golden " *Yellow*.

" 78, 16 " " *Roa* " *Poa*.

Illustrated sheet, for Great Plantain read *Greater Plantain*.

WOOD MEADOW GRASS.

SMOOTH-STALKED MEADOW GRASS.

CREeping BENT or FIORIN.

SWEET-SCENTED VERNAL.

VICIA SEPIUM. (Bush Vetch.)

CRESTED DOG-TAIL.

COCKSFOOT.

MEADOW FOX-TAIL.

CAT-TAIL or TIMOTHY.

EYEBRIGHT.

BURNET SAXIFRAGE.
(A fair sample of the Umbelliferous)

GRASSES:

THEIR PLACE IN THE VEGETABLE KINGDOM.

THE natural order of Grasses (*Graminææ*) comprises the great majority of plants which afford food to the animal kingdom. They are mentioned as grasses in the very earliest records of history, but in the broad sense I have no hesitation in saying that grasses meant all plants which formed staple food, while the term herb applies to that part which becomes economic as condiment does to ordinary food. They are placed in the natural arrangement of the vegetable kingdom at the foot of the higher order of it, or, in other words, they are the lowest form of flowering plants. They are considered by botanists a very difficult study, and may be said to form an almost distinct branch of pure botanical investigation—many who are considered pretty well up in the botany of the other flowering plants being comparatively ignorant of grasses; while, so far as pure botanical investigation as applied to agriculture is concerned, there has been, comparatively speaking, very little written on the subject.

The *graminææ* consist not only of the grasses, our principal subject, but also the whole of our cereals—the term cereal being derived from Ceres, the goddess of corn—which comprise wheat, barley, oats, rye, rice, and maize, and what is known as grasses or pasture plants; and as in practical agriculture there is a difference between the cereal and the grass, there

are other plants which are mixed along with the grass proper, which are in the eyes of agriculturists grasses—the carex or sedge, and juncus or rush being examples, although they belong to a higher botanic order. Thus it is evident that in the very earliest times the term “Grass” meant all plants that were useful as food for animals.

IS THE PRESENT CONDITION OF OUR PASTURE SATISFACTORY?

This is a question which is deriving very great importance in the meantime; and there has been no period in the history of our country when there was so great need for some light on the matter. While the question is settled that botany should be more attended to in matters agricultural, and that in the department of pasture cultivation there has been a shameful neglect and indifference, the matter has been, it may be said, fairly set on foot, and there is little doubt, or no reason to the contrary, but the subject will receive greater attention in the future, and the various grasses and other plants which are useful shall be attended to, and in time shall become utilised as best suited for the various conditions of British agriculture. The science of chemistry has brought into the field many articles which not only, applied to the soil, augmented the produce of it, but has introduced into successful use many articles which are of very great value to the industry of agriculture, such as cakes and oils, which are applied directly as food for animals.

In still giving a negative answer to the question, I shall give as a reason a fact which is now generally al-

lowed by practical men—that too much attention has been given to the results of chemical investigation, which has thrown the older and, to the agriculturist, the equally important science of botany into the shade. Had botany, as well as other sciences, received equality of attention in proportion to their relation to agriculture for the last number of years, I question very much if the same difficulty which has been experienced in raising certain crops for some time would have existed.

The fact has been pretty well borne out that a great fault has been to look at cultivation too much in the light of a matter which has been thoroughly investigated, when in reality it has little more than reached its infancy. While what is known as unfavourable seasons have, no doubt, a good deal to do with failure or partial failure of crop, it opens up a field of enquiry whether crops ought to be more attended to that depend less on being frustrated by a peculiar season, and, consequently, running less risk of pecuniary loss to the cultivator. But it is becoming very evident that too much inadvertent chemical application has to a very considerable extent enfeebled a very considerable proportion of the soil. A proof of this has frequently been found in the fact that in many cases most difficulty has been experienced in raising turnips where the heaviest consignments of manure had been in the habit of being used, while there is a marked deficiency in the succeeding oat crop on such fields. These injudicious or over-doses seem to have the effect of enfeebling the soil, and it is rendered unfit to sustain plants robust enough to withstand the opposing influences they have to come in contact with during their life history.

Agriculturists have allowed themselves to run too much after a channel of indoor investigation. There is probably no industry or profession where so many employed in advancing it are *not* practically acquainted with the duties of the farm, having thus, by non-practical suggestions and maintaining—on the grounds of indoor inquiry—conclusions opposed to the results of practice. This has been the means of raising a most undesirable indifference on the part of the general body of agriculturists. This also shows the value of practical men taking up any branch connected with agriculture, which fact is becoming to be properly recognised by agriculturists, as well as recognising the great neglect which, as a rule, has occurred in the matter of personal enquiry, and the consequent loss as regards condition of soil, value of properly-selected grasses and other plants, and the loss resulting from it of manure which the roots and other decayed parts form, which may be described as the manure received by natural causes.

A few years, over the greater part of the United Kingdom, out of the grasses proper there was only one species used under the ordinary conditions of alternate husbandry ; while in the case of oats, turnips, potatoes, &c., there were many varieties used, and considerable method applied as to which of these varieties were best suited for the conditions under which they were designed to develop.

The result was, and as yet in too many cases is, as regards our fields under grass, that instead of a close sward over the whole period under which the fields are under grass—an improvement which would have brought grass cultivation to the point which

should ere now have been general throughout the greater part of the kingdom had the subject received anything like the attention it deserved. We find that the first season generally, but very far from universally, there will be a considerable if not a satisfactory return. Soil, climate, and an unsatisfactory season even at this early stage are the means of producing many exceptions. The second season's crop falls behind; the third in some cases will outstrip the second on soil where Rye-grass develops best; it is, however, exceptional, and might lead to discussion on the peculiarities of Rye-grass. One of the reasons unquestionably is that of seeds dropping and rooting the previous season, another may be the power of a plant, or the plant in question, of maintaining its existence and reaching maturity under conditions unfavourable for its proper development, and goes on the side of showing that, under favourable circumstances, the plant is perennial—a fact all but decided in our own island by observers in a part or two quite exceptionally favourable to it as compared with the usual physical condition of the British Empire.

The result of the Rye-grass dying in a season or two is that in the majority of cases the surface of the fields are covered with plants of questionable utility, which find their way into the unoccupied soil, such as Self-heal (*Prunella Vulgaris*), Field Daisy (*Bellis Perennis*), Field Groundsell (*Senecio Jacobee*), and so on.

Now this at once shows that we are most inexcusably behind in this direction, as we long ere now ought to have made more of this subject, and the question is why we have not made more of it? I am

much of the same opinion on this point as the Right Hon. Sir Lyon Playfair with air—it has been under the notice of mankind ever since the first man drew breath; it surrounds him in every way, and still it is but very imperfectly understood at the present time; and the result of my investigations has led me to conclude that it has a wider function to perform in agriculture than is generally credited to it. One of the reasons is that there is, comparatively speaking, very little encouragement given in Great Britain for such research, which, I think, is not altogether satisfactory, because there is no doubt a staff of qualified investigators would have a material effect in advancing that industry.

We find examples in this direction of great activity, worthy of imitation, in younger and smaller countries, in encouraging enquiry into our and kindred subjects. Among those countries which have set us an example we may mention the United States, with its Department of Agriculture; Germany, with the seed-testing stations of some of its States of nearly the standing of half a century; Denmark, with its agricultural schools, and its seed-testing station subsidised by Government; Switzerland, with its seed-testing station, the celebrated director of which was considered by the Government worthy of assistance in the publication of his work known as the "Best Forage Plants," by Dr. Stebler, of the Swiss Seed-Testing Station. We must not omit to note that as we stand at the present time rapid strides have already been made in this direction in our country, and as a commencement has been made to pay more attention to the pasture question, it is to be hoped that the matter will in time arrive at a

satisfactory footing, by receiving from the proper quarters the encouragement and attention which the importance of the subject deserves.

While the turnip, which is an artificial production, and the potato, which was introduced by Sir Walter Raleigh from South America, have undergone many ordeals by way of improvement, we shall hope that similar transformations shall take place in due time in the selection of grasses and other plants, so that those best suited for particular purposes shall be there used.

The only reason I can think of for grasses being so overlooked is that the grasses that would form a close sward are to be found in many cases under the very eyes of the agriculturist, by the margins of his fields, the unreclaimed hillsides, sides of streams, and so on.

Besides the reasons above mentioned, we have been visited with a series of peculiarly trying seasons. These have a disastrous effect upon the soil. An unusual amount of cold draws an unusual amount of heat out of the soil ; thus after a severe winter it requires more heat to produce a fully matured crop than after a mild winter ; by severe winter I mean either a protracted snowstorm or long continuance of what is known as open frost, that is, long continuance of frost without snow. A certain amount of frost or snow is beneficial to the soil, but when either go to extremes it has the opposite effect. These circumstances have a disastrous effect on the tender Rye-grass, and combined with the altered conditions of British agriculture, from the energy displayed by foreign Powers, which, by lowering the value of produce, tends to make much of the land even in its best form an unremunerative operation to cultivate in the same form which, a few years ago

was fairly remunerative, it no longer continues to be so, and calls for more attention to more permanent varieties.

OPINION OF AUTHORITIES ON SOWING RYE-GRASS.

It appears that it was first introduced into Britain from the Continent about the middle of the seventeenth century, first cultivated in Norfolk, where it spread over the whole kingdom, as the chief cultivated pasture grass. Professor Martyn, in his *Flora Rustica*, writes (1792):—"How long this Rye-grass may have been in cultivation I am unable to ascertain; none of the writers of the last century say a word in its commendation, or insinuate that any particular grass was sown in laying down land; how it came to be selected we cannot say. Probably accident, or because it is common, and the seeds easily collected. That the Rye-grass is the only grass whose seed is to be had in any quantities in country shops is a disgrace to this age and nation." Sinclair, in his *Hortus Gramineus*, remarks, that "much difference of opinion exists as to the comparative value of Rye-grass, eagerly liked by cattle, has little aftermath, and dwindles away in a few years—impoverishes the soil." Dr. Parnell, F.R.S.E., Edinburgh, quotes the above in his work on Grasses around Edinburgh.

Sowerby, in his *Grasses of Great Britain*, gives a most interesting account of it, some parts of which I quote—"One of the most common British grasses, growing everywhere." This, of course, applies to the milder parts of Britain, in the greater part of which, without the care of the agriculturists, it dies out in a few years. "Varieties almost unlimited": This

answers, to some extent, the wideness of its artificial distribution. Although there is only one species of Rye-grass the same species can convert itself into many varieties, to suit the different soils, climates, and other circumstances it may come in contact with. "No species has attracted so much interest among agriculturists, and especially in more recent times, when it has become one of the more important factors of the 'convertible system of husbandry'" (that is, sowing introduced plants in rotation). Mentions that one, Dr. Plott, as the author having earliest mention of it, who says, "They have lately sown Rye-grass to improve cold, sour, clayey, weeping ground, unfit for Sainfoin." First sown in the Chiltern district by one Eustace: that has reference to Oxford and Staffordshires in England. "Having been the first pasture grass grown artificially by Europeans, its value, as compared with other grasses is, in all probability, exaggerated, and doubts are entertained by farmers as to whether it is worth the high encomiums lavished upon it by agricultural writers. I believe that a careful investigation of the subject would tend to invalidate much of the abuse bestowed upon this Grass, and remove the doubt as to its relative value in farming, both of which are due to mistaken application, and the absence of method in adapting practice to circumstances." Stillingfleet—"Well known and cultivated in England; hopes that the success that has attended this grass ought to be the means of inducing agriculturists to give the attention to other grasses which are no less valuable." Mr. Sowerby also quotes from Swayne as to Rye-grass degenerating, and mentions that an enlightened agriculturist, Mr. Pacey, intro-

duced a superior variety from seed selected from old pastures, still considered a superior grass in some respects and used in considerable quantities, which was a grand move in the advance of agriculture, and sums up with explaining what was at one time a mystery—liability to degenerate—systematic inquiry and observation having shown that no grass so rapidly impoverishes the soil, or takes from it what is necessary for its own support to an extent which is prejudicial to its future growth ; and when the nutriment is exhausted, it dwindles and dies off. In treating on this remark, when I come to touch upon my own views of Rye-grass, I shall give some idea of the reason why Rye-grass so impoverishes the soil.

The above is sufficient for the purpose of showing that the opinion of those best able to judge is uniform as to there being too much Rye-grass used in pastoral husbandry ; and while touching on the views of others as to agreement on the Rye-grass, I shall show how very conflicting the views of these are upon other grasses, which in some cases ought to take the place of Rye-grass.

VIEWS OF WRITERS ON NATURAL GRASSES.

Early-Spring Grass.—Sowerby says—"Contributes little to hay crop." Some of his observations showed that in Kent and Sussex it was almost untouched by animals, or only cropped when food becomes scarce ; condemns the views of Stillingfleet, who gives it credit for improving the quality of mutton, and touching more upon its useless than useful properties, recommends it to be taken into consideration. E. J. Lowe, F.L.S., &c.—"Valuable agricultural grass." Sinclair—

"Does not appear to be particularly liked by cattle ; agrees that it should be in all permanent pastures, and seems to entertain the view of it improving the flavour of mutton, where it exists."

Cock's-Foot Grass.—Sir W. J. Hooker—"Said to be advantageously cultivated for cattle." Mr. Sinclair—"Deserves particular notice ; more value for pasture than hay." Loudon—"Coarse grass ; valuable as an early grass ; useless for hay ; neither cattle nor horses eat it."

Crested Dog's-tail.—Professor Lindley mentions it as one of the most important. Professor M'Gillivray recommends it for straw-plait ; "cattle or sheep hardly ever eat it" ; quotes, however, from Professor Babington, who calls it "an excellent pasture grass." Thus far it is sufficient to show the conflicting opinions of well-known authorities on the subject, and which formed to me a problem puzzling and perplexing in the extreme, from the fact that the parties, such as mentioned above, could only have attained their position by an indescribable amount of work, perseverance, and care, which at once, from the different opinions expressed, showed that there was still a weighty problem to be solved upon this point.

Having now touched upon a number of points connected with my subject in a way to show that at least others as well as myself are at one on the main point, viz., the urgent need in the meantime for some enlightenment and advancement on the subject, I shall now touch on some points which must be taken into consideration in the selection of the most suitable pasture plants.

THE SOIL.

Soil may be described as earthy matter on the surface of the globe, and the raw material from which mankind not only manufacture material for food and clothing but from which the vegetable kingdom finds a base for its existence and the support, directly or indirectly, of the whole of the animal kingdom. As to the origin of the formation of soil we must touch upon a period when our country endured a climate similar to the polar regions of the present time, known as the glacial epoch of the geologist, from which it by degrees emerged, and in the direction to which it is *still moving to warmer epochs*. The whole land had been covered with ice, similar to Greenland at the present time, while glaciers, such as are on the Alps, had occurred on our mountains, and all the accompaniments of similar climates. As the climate altered the ice melted away, and the loose material left might be called soil. Immediately vegetation had commenced in a natural way, that is, plants suited to the soil and climate had found their way on to it and commenced to grow, and in many cases the decayed remains of certain kinds fattened the soil so as to produce plants requiring stronger soil to subsist in, and as the climate continued to improve plants requiring more heat had found their way, and so on.

Then we have other agencies to take into consideration in the formation of soil before it has come into a state fit for agriculture and which still assist in the fertilisation of the land. Rain-water falls upon the earth and it soaks into rocks and earth, and as it falls to the ground it draws from the atmosphere certain gases which have a powerful effect in breaking-

up rock and deposits valuable material in the shape of loose earth; and yet another powerful agent, frost, which is produced when the atmosphere is cooled to a certain extent, water swells as it freezes, and when it has crept into porous rock the consequence is that the particles of rock are pushed apart, and when the thaw comes it crumbles down and adds to the soil. Thus we have the atmosphere, its changes; rainfall; plants themselves; and, I may add, the operations of animals as well; all employed in the formation of soil.

It will be convenient to give a short account of the different kinds of soil, as we will have to touch upon this when we come to the kinds of grasses which should be used. They are divided into two leading ones, clay and sand; the former is the finer portions of the mineral matter of the soil. The particles are reduced in size as to become soft to the touch; when pressed in the hand it retains the form in which it is moulded or pressed; when water is placed in any hollow of the surface it does not readily soak into it. The latter is the reverse; it consists of minute stones; when pressed in the hand, hard and gritty to the touch. It will not mould into any particular shape nor keep the form given it, and if water be poured upon it it quickly passes through it.

It is upon these two kinds that a regular classification is formed, which consists in the following: 80 to 100 parts sand, forms sand soil; 40 to 60, of either kind, loam; 80 to 100 parts clay, forms clay soil. The subdivision is distinguished by placing, when sand predominates, sandy loam; when clay predominates, clay loam. There is another kind of soil—organic, formed by decayed vegetable matter, such as

peaty soil or moss; while there are many chemical ingredients in soil and parts of decayed matter, stones, and so on, which it is unnecessary for our purpose to do more than merely mention, and also sometimes mineral matter generally prejudicial to plant life.

CLIMATE.

Climate has been described as a very complex matter, depending on a great variety of conditions. It is the general resultant of all atmospheric phenomena, and must always be taken into consideration in determining what plants ought to be grown in any locality; in fact, it is of more importance than soil, because the soil can be to a greater extent altered than climate, but soil and climate are the most vital points as far as cultivation is concerned.

Climate includes the temperature of the air at various times and seasons, range and variations of temperature, the direction and force of the winds that prevail, liability to storm, amount of humidity in the air at various seasons, quantity of mist, rain, and dew; distribution of rain, cloud, and electric conditions—these all depend to some extent on each other and may be traced to certain causes, the principal being latitude, a term given to denote the distance, north or south, of the middle of the earth (equator), the size of the tract of land, elevation above the sea; nature, magnitude, and direction of the nearest marine current, and some others.

If it were not for what may be called secondary causes, latitude alone would decide climate, but we have the example of our own island this way, which is so influenced by the Gulf Stream that we enjoy

a climate far milder than that of America in the same latitude westward, and Continental Europe eastward, so that regularly-kept records of climate must be taken into account in judging of the propriety of introducing plants from one country to another.

Elevation is another important consideration. For example, a farm situated, we shall say, in a British county at an elevation of upwards of 800 feet above the sea level. This affects the value of it as compared with one of equal quality situated at a considerably lower sea level. The same appearance of a grain crop above that height will not yield the same return as one below it, and from nine hundred to eleven hundred limits the height of successful oat cultivation within most counties. Exposure to certain winds has a very marked effect upon farm crop. Thus, from the situation of the country, the farm exposed to the south and west is superior to the one exposed to the north and east. All these facts must be taken into consideration, as well as shelter and artificial causes, such as planting wood and so on, in choosing the most suitable grasses and plants, and in judging the value of a farm.

THE PRESENT POSITION OF AGRICULTURISTS, &c., ON SUCH MATTERS AS SOIL, CLIMATE, AND AGRICULTURAL PLANTS.

Farmers, as a rule, have a pretty accurate idea of the soil of the district in which they farm, as well as gain a knowledge from experience of winds and frost, and other factors which produce the comparative mildness or severity of their climate; and, as previously mentioned, devote a good deal of study as to what

varieties of cereals, turnips, or mangels, and potatoes best suit the various circumstances and conditions of their farm. While it must be allowed that a commencement has been made to devote more attention to the most important part, from the fact that more than one half of the arable land of Britain is occupied with pasture, and that improvement has been made in selecting grasses, and other plants better suited for the conditions of agriculture.

The advancement may be defined by being sufficient throughout the kingdom to show the value of the improvement, and at the same time give practical proof of the desirability and importance of the subject being thoroughly investigated, and although all those who have taken any consideration from a practical point of view always recognise the value of cattle being pastured on mixed pastures, still it remains a fact that so much of the sown-out land of England only receives a quantity of broad clover (*Trifolium Pratense*), and a great proportion in all parts of the Empire is sown out with, of the grasses proper, Rye-grass alone, with a mixture of Red or Broad Clover and White Clover (*Trifolium Repens*).

There is no place like an exhibition for getting at the facts as to general knowledge or enterprise of any class. And I shall now take notice of this matter as far as I could observe at the show of the Highland and Agricultural Society of Scotland, held on the Links, Aberdeen, July, 1885. The leading agricultural seedsmen of that city had exhibited general collections of the principal grasses, which thus afforded agriculturists an opportunity of examining and discussing, in their judgment, the merits of the

different species. One striking feature of this department was the ignorance of at least eighty per cent. of agriculturists as to the grasses best suited to meet their circumstances, or any general knowledge of the properties of individual grasses; and the knowledge possessed by any was as perplexing as the results of book investigation, and as such knowledge was of a practical character, that is, the result of personal observation, it at once shows that different grasses ought to be used in different localities. An example of the remarks passed may be thus quoted. "The fescues are the most valuable"; "meadow grasses are the best"; "cock's-foot ought to be more used"; "cattle would derive a great deal of more food from it than any of the others"; while another party would maintain that none of them could supersede the Rye-grass for utility.

Haying hitherto been perplexed to know how so much difference existed between authors, the above observations were the means of enlightening me by practical illustration on the point, viz., that different soils and climates ought to have different kinds of grasses, as, for example, a grass might grow near the seaside and be eaten with avidity, while a few miles inland animals would scarcely touch it. The records of parties hailing from different parts, and that of botanical writers, being both so conflicting, gives rise to a great question—What steps ought to be taken to overcome the difficulty?

In the first place, of the two parties connected with seeds, the seedsman and the farmer, it appears to me that the time has arrived for those engaged in the seed trade to be personally able to identify the seeds of the varieties

in the seed market, so that they can, without hesitation, guarantee every seed purchased from them to be the kind wanted. No doubt it is convenient to have the opportunity of getting seeds examined as arranged by the Royal Agricultural Society, the Highland and Agricultural, and the Agricultural Society of Ireland (Royal Dublin), by these having an engaged consulting botanist, who, for a small charge, will examine seeds forwarded to them. Still, there is no doubt but a great impediment to the progress of pasture culture is the large quantities of impure seeds which have been supplied to agriculturists, not in most cases intentionally to defraud their customers, but through inability to recognise the kinds of seeds.

Too much traffic is carried on in the line by country grocers, and so on, who retail seeds much in the manner of their groceries. It is desirable that the apprentice seedsman shall soon be required to be qualified to examine seeds, and thus become acquainted with the scientific as well as the commercial aspects of his business. On the part of farmers it is evident there is an equal need of improvement in a similar direction, so far as the industry of agriculture and those connected with it are concerned. It has now been finally settled that a considerable advantage would be derived by promotion of technical education among the agricultural masses; there is no doubt but this will lead to very satisfactory results. And it is equally evident that the present unsatisfactory condition of British agriculture can be, to a considerable extent, traced to the omission on our part of this point, and the very considerable amount of attention and encouragement in other leading nations.

A similar example is found in the part of our commercial circles where the superior commercial education of those intending to follow such pursuits in such countries as Germany and France, is the means of natives of such countries pushing aside our English youths from situations which are theirs by inheritance. The education of the future, if we want to keep our high place among nations, must partake of a more practical character, which means that in rural districts, where, at a moderate estimate, ninety per cent. of the children are engaged in agriculture as soon as their school days are over, a necessity has arisen, which the sooner it is brought into practice the better, of having arranged a text book on agriculture to be taught in agricultural districts, so that the seed may be sown in proper season, which is wanted for future life.

It is the want of knowledge of the various grasses on the part of agriculturists that forms so great an impediment to the progress of the subject, and it forms a great barrier to the progress of pasture cultivation. There is sufficient unanimity of opinion, besides a considerable practical proof among agriculturists as to the wide field open for investigation in this important matter.

In taking up the subject, I have endeavoured to lay the matter out in a way that any agriculturist may commence and experiment on a very limited scale and test the advantage and extend. The fault, in my judgment, of some of our writers on the subject is that they condemn too far existing forms and make proposed mixtures too wide apart from those in use, which tends to make agriculturists ignore the whole matter. The most likely way to success is to lay a practical

foundation, and when that is laid time will bring this part of agriculture to what it can be brought to.

In basing my conclusions as to the best grasses for different conditions of agriculture, I have studied their habits and form of development in their natural and artificial form, and have not confined myself to those in the seed market, but noticed all that were occupying a prominent part as pasture plants. Although it is undesirable to have too many forms, which leads to confusion, still there are some grasses not in the seed trade that ought to have a place. It has been my endeavour to lay them out in a way which can be as easily understood as the varieties of cereals and turnips. While there is room for a few more kinds being sold in this country, it is doubtful if there is any body in the kingdom that will take up the matter in a way that shall bring these plants into use. The next point we shall touch upon is what should be observed by farmers purchasing seeds. The principal point is to deal only with those seedsmen who will give a guarantee that the seeds are the kind asked, also as to their germinating properties. It is evident that impure and seeds that contain a large percentage that will not germinate have of late years been the means of considerably deteriorating pasture crops.

It is impossible for farmers to secure good seeds and cheap. Those that buy very cheap seeds will find that they are the dearest in the end. Good, strong, and properly-cleaned seeds, although costing a little more, are certainly much cheaper in the end than inferior seeds. No better proof of the desirability of due attention to securing pure seeds can be found than

consulting the reports of the Consulting Botanist to the Royal Agricultural Society, a few notes of which I quote. In report for 1883 only 29 per cent. of the whole grasses were free from Rye-grass seeds, 12 per cent. contained Rye-grass to the extent of one-half, 22 per cent. over one-fourth but under one-half, and 37 per cent. contained Rye-grass less than one-fourth. In some cases 25, 26, and as high as 41 per cent. of *Holcus lanatus*, Meadow Soft-Grass, or Yorkshire Fog for pure Meadow Fox-Tail; for pure Golden Oat Grass 27 per cent. Wavy Hair Grass (*Aira flexuosa*); for Crested Dog's-Tail seeds containing 50 per cent. of *Molinia coerulia*. For the Vernal Grass a continental variety is frequently supplied. It is only of annual or biennial duration. Its name is *Anthoxanthum Puelii*. Seeds of it which I tried alongside a plot of Vernal Grass flourished and died the first season. Meadow Fescue, from its seeds being, to the casual observer, similar to Rye-grass, a great amount of adulteration went on.

Quoting from the report already touched upon, only 29 per cent. were free from Rye-grass, 12 per cent. contained Rye-grass to the extent of one-half, 22 per cent. over one-fourth but under one-half, and 37 per cent. contained Rye-grass to the extent of less than one-fourth.

Having shown thus far the very questionable way which farmers were supplied with seeds, a position fitted to paralyse any attempts to promote pasture culture, it is desirable to give Mr. Carruthers' views on the situation—"I have no reason for supposing it is done by any one connected with the trade in Britain, and I have little doubt that the worthless

seeds are introduced before the goods reach England. It is greatly to be desired, then, that the buyers employed by the trade should be able to detect the presence of adulteration in samples offered to them."

To show that this part of the pasture question is on a more satisfactory footing as well as the progress being made in this matter too long neglected, I shall also quote from the Report for 1887 :—Meadow Fescue was remarkably free from Rye-grass, only 8 per cent. containing from a quarter to one-half of Rye-grass. Tall Fescue generally true ; smaller Fescues generally true ; Cock's-foot generally pure. Meadow Fox-tail contained small quantities of Tufted-hair grass and germination poor. Yellow-oat grass had a high percentage of germination, considerably mixed with other grasses. Timothy as a rule clean, but some mixed with weeds. Rough-stalked Meadow Grass was generally free from other grasses. Smooth-stalked Meadow Grass was also free from adulteration ; Vernal seeds were free from seeds of *Anthoxanthum Puelii* ; Crested Dog's-tail was free from mixtures. These notes show a very considerable improvement since 1883, and considerably more favourable than any previous year. It must be confessed that there is still room for improvement, but there is all round a sufficient amount of purity to allow farmers with confidence to invest in these seeds, and at the same time these notes show how land, through oversight of this important point, has, in many cases, been spoiled by impure seeds introducing noxious weeds, which are useless as food and difficult to eradicate.

Although Mr. Carruthers and I differ on some points on the grasses, we are evidently of the same

opinion as regards the desirability of a higher grade of knowledge being desirable for those connected with the seed trade. The absence of the ability to examine their own seeds as a rule makes it desirable that all well-conducted seed businesses should have their seeds examined by some one qualified to do so. Having the seeds in a satisfactory way, a very desirable point on the part of seedsmen is to have beside them average specimens of the various grasses, the seeds of which they supply farmers with. A considerable advantage may be derived from this, as many agriculturists are in the habit of observing grasses which grow well and afford foliage, which is relished by their stock on their farms. Or, as is often the case, when a farmer meditates purchasing any new plant—of course, I mean new to him—it is of considerable advantage to him to see the plant, the seed of which he means to use, and should the seed germinate properly, he can among his other grasses identify his new investment.

It may be here noticed that provision is made by the Royal Agricultural, Highland and Agricultural Society, and Royal Dublin Society of Ireland, by which, for a small charge, any plant sent for recognition will be examined and named by them, so that an opportunity is thus afforded to persons desirous of becoming acquainted with the name of a plant.

Whatever may in time be the result and the fate of the various grasses used in agriculture, should the subject continue to receive proper attention, in my judgment, the proper way is to look at the situation as it is and try to improve in a practical way from it. Thus, the course is clear, particularly in the case of alternate husbandry. Rye-grass in a

great measure holds sway, farmers have their quantities of it in stock, their animals are accustomed to it, and so on, so that any attempt to condemn it altogether is, as it appears to me, absurd and useless. Many of our most intelligent agriculturists of those who quite see the open field for improvement in the pasture question maintain that no grass on a well-cultivated farm will give in part more satisfaction than Rye-grass; and we may say this has been seen by some of its greatest opponents in some of the principal seed-testing grounds. This phrase, "in part," is a very important one, and the result of my observations has been to make out that different grasses have different parts to perform in their functions as food to a large section of the animal kingdom. Some may give good general results alone in agriculture, others will perform important exceptional functions, while some only act in a very small fractional proportion, although it is to be understood that acting as a stimulant or condiment among others they have a very important function to perform in the great design of creation.

The practical way to lay the grasses before agriculturists is to select the ones best suited to take the place of the Rye-grass in the different conditions of agriculture. These conditions may be briefly summed up by climate, soil, and artificial form of agriculture. The two former, although they can be somewhat altered by artificial means, are the natural conditions, and the latter condition is generally based on them, and is, as everything else, brought to a different stage in different parts. Which does not come further in the way at this part than merely to be touched upon, and we shall now enter into the

PROPERTIES REQUIRED BEFORE THEY CAN BE SUCCESSFULLY USED IN ALTERNATE HUSBANDRY.

Chief among these is the bulk yielded ; qualities of growth, both as regards coming early in spring and coming seasonably to maturity ; as well as aftermath if the crop is cut, or as to pasture properties of standing out in the autumn. When required for cutting, quantity of foliage ; and reproductive properties, both as regards quantity of seed yielded and growth of leaves for a certain number of years ; capability of standing extremes of weather, whether of heat or cold, drought or rain-fall, frost or snow ; all of which affect some grasses, some being adapted to stand the one, others to stand the other.

The roots must be of such a character as to die when the land is ploughed, as it is prejudicial to subsequent crops if the grass continue to grow after these crops are sown. Those with fibrous roots are in a general way those only suited for alternate husbandry, as the fibres die when they are turned over, while those with creeping roots will grow after the soil is ploughed, and, consequently, are considered unfit for alternate husbandry.

Adaptability to soil and climate, nutritive qualities, and, perhaps, the most perplexing, the avidity with which cattle of all kinds eat certain grasses under certain circumstances. This, I hold, to be a very important point. No doubt, in some cases, agricultural animals will refuse food they are unacquainted with, and in time come to eat such food with avidity, but in open pastures where variety of plants are to be found it is reasonable to suppose that animals possess instinct sufficient to enable them to use that best suited for them.

It does, in my judgment, touch upon a point too much neglected in modern enquiry—too much is laid on chemical composition as grown in some particular part, and then recommended to be grown over the general conditions of soil and climate. A grass may, and many do grow only useful as producing nourishment under exceptional conditions, and often they struggle for existence and grow with little or no nourishment for animals in them, while the nourishment adapted for animals is that which suits their physiological structure; thus the science of physiology should receive a share of the attention given to chemistry in matters agricultural.

It may also not be amiss here to touch on what has unquestionably retarded the progress of grass culture considerably. Where grasses of considerable nutritive properties on low-lying plains are used on high-lying and exposed situations they are often comparatively useless, and even become noxious weeds, and those best suited one way become the opposite in the other. Thus the field is wider than most are aware of; the geographical conditions and artificial forms make the field so complicated, and form incidents in this important subject as regards the value of the various plants, which can only be arrived at by personal observations. It is differences on this point that have a good deal to do with regard to so many conflicting opinions upon the different qualifications of different grasses, and which have created so much perplexity among authors on this subject. What is looked after in one quarter may be rejected in another, and such is sometimes the case. I have been astonished at the recommendation which cock's-foot grass received from

writers on the subject, and on which point I shall touch when I come to treat upon it, because, in my locality, neither cattle, horses, nor sheep will—where it has become naturalised among other grasses on pastures—as a rule taste it. The late Dr. Farquharson, F.R.S., Alford Parish, wrote a paper on *Natural Grasses* about half a century ago, and mentioned the same circumstances. Thus, it is impossible that the grass in question can, under any conditions, become in practice, in all-round British agriculture either in alternate or permanent pastures, what some would or did assign to it.

RYE-GRASS AS A CULTIVATED GRASS.

In touching on the properties of the various grasses, I shall first take the Rye-grass. Being used to a much greater extent than any of the others, it is expedient that it should be first noticed. It is a grass that has a fibrous root, will yield from one to three hundred stones of 28 lbs. each of cured hay, but over the greater part where it is in use it fails to produce a full crop for three successive seasons; in many cases where it is sown there is only one crop—the first one—and it is used in many exposed, poor, and high-lying soils, where one crop of hay cannot be procured, but there will be fair pasture for one season; and, subsequently, until the land is again ploughed, the ground fills up with anything that comes in the way. Where I am situated, about 56 or 57 degrees of north latitude, with cultivated land ranging from 500 to upwards of 1000 feet above the sea level, with a representation of all the soils enumerated in an earlier part of this work—clay, loam, and sand—and the conditions of agriculture similar to

what is carried on over a very considerable part of the kingdom, the result of my observations has been as above mentioned, with the exception of one kind of soil—very rich open loam soil,—which, if not high-lying or exposed, will produce, in ordinary seasons, three satisfactory crops, one of which, as a rule, grows a full cutting crop, the other two being pasture. On clay land, not so much as one good or full crop can in many cases be reaped, while on sandy soil, on the slopes of the hills the results of its use are equally unsatisfactory. The soil is too open for its roots, while on clay it is the reverse. The land being improved on these hillsides, which, with the severity of the climate, is the means of forming a great loss, as compared with having along with it a grass or grasses which would continue luxuriant all the seasons the land is lying in grass.

Now, the reason of all this is, that the Rye-grass is not suited for the climate. It has been all but settled that the Rye-grass is in reality, when soil and climate suit, a perennial grass. It is many years since I came to this conclusion, observing in the cold climate of Aberdeenshire. This point is corroborated by that leading authority in scientific agriculture—Sir J. Lawes,—who states that he visited the famous ox pastures of Leicestershire, which pastures are mostly composed of Rye-grass which must have grown for more than forty years and never been allowed to seed, thus forming conclusive evidence that it must, when under these favourable conditions, be a perennial grass. Professor Fream, consulting botanist to the British Dairy Farmers' Association, in corroborating Mr. J. Sutton's opinion in his work, states, as one of other instances, the occurrence of Rye-grass in the natural herbage of

the water meadows bordering the Hampshire Avon, which are invariably cut before the Rye-grass has time to ripen, much less to shed its seed, so that if it were not perennial it would not exist there.

These two examples quoted refer to favoured spots of the kingdom, and the luxuriance of the pasture is such as to maintain a quantity of stock, which, by droppings, add a great quantity of manure to the soil. These are exceptional cases in Britain, although, I may state, I have seen it on old pasture as far north as the neighbourhood of Glasgow—its natural *habitat*, that is, the place where it would exist naturally, being in a much warmer region. Supposing it would subsist naturally in the north of Italy, that is about the forty-fifth degree of north latitude, we attempt to naturalise it much farther north; while in clay and open stony soils we attempt to succeed with it, where it is doubtful whether it would subsist in any climate any number of years on such soils, the structure and form of the plant being not at all adapted for these soils.

The probability of the whole matter is, that when cultivation began to take a real hold of our island, which may be dated at a period subsequent to the rebellion of 1745, giving the north country a few years to recruit, agriculture would have commenced about one hundred years subsequent to the time we have record of Rye-grass cultivation in the county of Norfolk. It would have gradually worn its way through the island, spreading in all directions; and while only the finest patches of the country would have been reclaimed and the Rye-grass would have grown moderately well. While time and agriculture advanced, the grass had just continued to be sown without

any consideration being taken as to its properties; and while other parts advanced, pasture had degenerated, as the whole of the country which is worth reclamation, with an exceptional case, had been reclaimed, and the mixture of natural grasses, which would have formed an excellent mixture before so much of the land was reclaimed, has now vanished, agriculturists have neglected the point of retaining a judicious mixture of grasses.

As to the cause of the comparative failure of this grass as a whole, I shall take an illustration of another grass, the Cultivated Oat (*Avena Sativa*). This is universally allowed to be a production from the wild oat, but history does not clearly explain to us the origin of it; suffice it to say, that it was cultivated by the Romans. Now, it is a quick growing plant, coming to maturity and dying in a few months. We can observe the power of man in assisting nature to perhaps as good purpose as any plant in cultivation; the matter of from fifty to one hundred feet of additional height above the sea level has a material effect upon it, both as to earliness and productability—that is, counting from a climate where at or about sea level is the most suitable part for its coming properly to maturity. At the present time when the cultivation of oats is being extended into parts where wheat used to be grown, and the climate does not so well suit it from being too mild, and inferior quality is produced, of course elevation would promote better quality of oats; thus we see that both sides must in the study of plant production be looked at. All the care of humanity is bestowed upon it; it has only to be exposed during the warmest part of the year; and

we compete with climate thus far, that it is cultivated in localities where, in perhaps only one case out of three, it comes to proper maturity, in the first-mentioned conditions, and, to say the least of it, some parts where only the half of the crops, say, over six or eight years, are sufficiently matured as being suitable for seed, or not self-sustaining, always requiring seed from a warmer clime.

While on this plant, I shall take a familiar example which we see sometimes, as to the practicability of a variety of grasses to suit different soils, and the great importance of the study of geological relationship. A person will sometimes observe a field of clay land with part oats and part barley ; it will be observed in some seasons that the barley will grow a heavy crop while the oat crop is a comparative failure, the barley being better adapted for this kind of land than the oats. Now, the attempt with the Rye-grass is to suit all soils, and over too wide a range of climate, which is impracticable, and it is attempted to grow in the same way as the oats ; with the additional disadvantage of having to attempt the enduring of the winter season or seasons, which in many, it may be said the majority of cases, kills it out, and immediately plants which subsist naturally, in the usual sense, take its place, while it has been clearly shown that it impoverishes the soil, or, in other words, it subsists in soil which has the proper temper, that is, neither too close nor too open for the roots, and the soil must be in a fairly good state of cultivation.

Now, the only reason I can see for this is that, as already touched, it requires a higher mean temperature than that of this country ; and as plants generally

have a two-fold power of drawing food from the atmosphere and the soil, by the leaves from the former and the roots from the latter, when there is abundance of heat and a suitable atmosphere the leaves derive sufficient nourishment from it, but immediately when this fails, it has recourse to the soil, and thus draws matter from the soil, when a natural grass would be rather adding matter to it, and the leaves naturally enfeebled when the supply comes from the roots, it being a well-known fact than when it is allowed to wither before it is cut when left for hay, when one would think it would require little to sustain it, it is very trying upon the soil ; this shows the great attraction the leaves have, that by drawing matter from the atmosphere it sustains itself, but when the leaves wither it falls back upon the soil for nourishment. I am of opinion that when the ground falls below a certain temperature the grass dies, heat being necessary to sustain life. Rye-grass being delicate dies easily. Every subsequent crop falls off so much from its predecessor, because the natural heat of the climate is insufficient for it ; while natural grasses are so constituted as to be adapted for the climate, while other plants are to be found which suit a colder climate—take, for example, the Reindeer Moss, a kind of lichen, which forms the staple food of the reindeer through the winter, which is to be found on our hills, but would not subsist on our cultivated ground for the opposite reason that the Rye-grass does not continue to subsist.

Having now shown how the Rye-grass is not in a general way suited for the average climate and soil of Britain—in fact, one good crop even of pasture, let alone a crop of hay, is not to be had, as there are

many parts where it does not come to maturity at all, and difficulty is experienced on many farms of our country to grow as much as is sufficient for seed for each farm.

Both the climatic and geological conditions are of a too diversified character for allowing it to answer the general purpose which it is used for. Even where the soil suits, it is alone of a too watery character in early spring. It is late of coming over a considerable area, particularly in a cold spring. Is seasonable for about two months, then it dries up, stops growth, and is comparatively useless for the rest of the season.

Where the grass is cut there is, under most usual circumstances, scarcely any aftermath; we ought to have something along with it in spring of a binding nature, something having a later foliage for the later part of the summer, and which would not die out, but would spread and occupy the soil as the Rye-grass dies out, which it does, speaking in a general way, over the kingdom (authorities in all parts complaining of its short-lived peculiarities), when it is a season or two old. The quality degenerates as the quantity diminishes, not only so, but the quality of the seed of a few successive crops, in cold districts, suffers a similar degeneration, so that recourse is had to the produce of warmer parts every few years to keep up the quality of the grass. It is very much at the mercy of the weather, because it is naturally too weak for the climate, combined with its partiality to certain soils; although its many varieties assist somewhat, the greatest uncertainty exists as to what kind of a crop we will have.

This uncertainty is diminished by using hardier grasses, and grasses better suited for the various

soils, as they produce an average crop with far greater extremes of weather, and, instead of exhausting, fertilise the soil. As to the avidity with which both cattle and horses eat it, my observations lead me to make the same remark as Professor (now Sir Andrew) Ramsay, of the Geological Survey on the building stones of Aberdeen, that is—"Granite used because there is no better in the locality." Animals are very fond of it, because in most cases they can get no other; but for many years I have observed that they were fully as fond of some other grasses as the Rye-grass. It unquestionably has its time as far as stage of growth and average dryness, but it is not worth more than the third part of the day where an opportunity is got for natural pasture.

I have observed cattle, when left to their own choice in the dewy mornings, move off the Rye-grass on to a mixture of Bent Grass (*Agrostis*), and Sheep's Fescue (*Festuca ovina*), with a mixture of some others; as the day wears on, if a dry one, so as to dry the grass, the Rye-grass will be the favourite when it is nearly dry, and when it gets very dry the Meadow grasses, Crested Dog's-tail (*Cynosurus cristatus*) and similar grasses will be most prized. Horses are somewhat similar this way, but I think they suffer more from want of grass in the autumn even than cattle. The native White Trefoil, which fills up a great part of the arable land in some parts which is vacated by the Rye-grass, and which cattle are fond of, and on which indeed in some seasons they almost subsist, is not so much relished by horses.

Having now gone into the properties and deficiencies of the Rye-grass, in summing up upon it, in-

stead of it being qualified for what is laid upon it in the agriculture of the world, I question very much if it should at all be sown alone in any part or on any soil where the design is to form the most valuable pasture. This, of course, does not refer to what is sown to produce seed to supply the seed trade. It may be judiciously sown in part, in various quantities owing to various conditions, on all soils except extremes, that is, heavy clay, sand, or moorland soil, where it is doubtful if it should be used, or in severe climates where it seldom grows a single crop. Judicious mixtures with other grasses are commendable, as a mixture makes superior pasture and fodder, and when the Rye dies out the others fill the soil, so that a full crop is got as long as the land lies out in grass. I have no hesitation in adding that in a few years, if the present move in this direction be skilfully and carefully carried out, as suited for the various conditions of agriculture, Rye-grass shall have to give place to other grasses which modern enquiry shall show to be superior for producing food on our cultivated land under grass, while a great deal will be done by judicious mixtures; and the next to be considered will be the properties of the principal

VARIETIES OF RYE-GRASS.

The most popular of these may only be noticed. It does not come within the bounds of this work to touch upon the varieties which of late many seed firms claim to have promoted from the original forms, but it is expedient to notice the leading sports as first noticed by the earlier pioneers—the later improvements being forms promoted—having, doubtless, certain claims or

certain purposes under certain conditions which deserve to be considered.

The first form noticed, which has gained popularity, is the Pacey Rye-grass, discovered by Mr. Pacey, a Staffordshire agriculturist, who discovered it on natural pastures in that county, cultivated it, and showed that it was in many respects superior to the normal type of perennial Rye-grass, although, in the majority of cases, not so bulky as a hay crop. Where observations of it have been taken it has generally been allowed to be superior for pasture, not being so liable to be frosted out of the soil; and at the present time, when a good deal of the land cannot be profitably cultivated in usual alternate husbandry, more attention to its properties should be given. But even in alternate husbandry I have no doubt that, in many cases where geological and climatical conditions are unfavourable for the true Rye-grass giving proper results, this form will be both superior to it as a pasture and hay crop. I have little doubt but that this form, from its appearance, form, and habits, and where discovered, is a hybrid between Rye-grass and Meadow Fescue.

The other important form is Italian Rye-grass, which was introduced into Britain from Italy by the late Mr. Lawson, of Edinburgh, in 1833. Its properties are that, on good or well-cultivated soils, it yields earlier and heavier returns than Rye-grass. It grows with great vigour, and is both superior in bulk and nutritious properties to it. It is, however, more delicate and more partial to good soils, and of a less permanent character, acting the counterpart of the Pacey variety; is most valuable where good land is sown out for three and less than three years, to be used in such

quantities as may be considered suited for the different conditions. Where sown in large quantities, along with oats, there is a danger of the grass growing too vigorous, and deteriorating the oats.

Difference of opinion exists whether this grass should be used in laying down permanent pasture, many maintaining that, it being so short-lived, it should not be used. As it comes early to maturity, there is no doubt, on land well suited for it, but a small quantity could be used with propriety; because many of the more permanent species do not at first grow so vigorous, and these spread as years advance, while the grass we are touching upon dies. Thus, a prudent mixture of a permanent form must be on the thin side the first seasons, which, by using a short-lived form, enables the agriculturist to have a full crop; whereas by using as many seeds of the permanent grasses as form a full crop the first season, they would afterwards be too close, and retard the full development of each other. One point greatly in the favour of this grass is the great favour it receives from animals.

The only other form I shall notice is a form which is more prominent for the controversy it has raised as to the nature of the longevity of Rye-grass, having much to do with leading the users of Rye-grass to suppose it to be an annual or biennial plant. The form is the annual Rye-grass, which can be recognised by having the seeds broader and flatter. It grows for one season very rapidly, and yields on suitable soils a good return. But, take it all in all, it is very questionable, seeing that most of its properties are possessed by its relations and that there is a great risk of the perennial

forms being adulterated with it, whether it should not be expelled from the British seed trade. It can only be useful on lands in grass for one year.

SUMMARY ON RYE.

There are enumerated in all a good many varieties of Rye-grass besides these, but those noticed are sufficient to show the general scope of the Rye-grass varieties. From its being so extensively cultivated it has a wide range throughout the world, and in these days, when some leading authorities have attempted to condemn its use, a few closing remarks on it may be of interest.

The practical point is that it has possession, and it is improving from that point on the proper vein that is most likely to lead to the proper goal of pasture culture. When one considers the many methods of cultivation, points of progress, and neglect in a country so variable, they can at once see the importance of the question. There are two methods of sowing—that of spring, when it is generally sown along with cereals, and autumn sowing, when it is generally sown alone. It is plain, in the first-mentioned system, that it cannot be replaced by the quick, tall growing grasses, because they would destroy the cereal crop; the second way does not offer this obstacle. But by far the greater proportion is sown by the first-mentioned method, and thus, any grass or grasses that will supersede it must belong to the low growing forms—first, as regards the property of not deteriorating the cereal crop; and second, because over a great proportion of the Empire the exposure is such that the cold, withering winds extract the nourishment from the tall growing grasses: and thus these

on many pastures may be seen both destroying the pastures by interfering with the low growing ones and untouched by the animals grazing. Another important point is the different soils, and it must be borne in mind that Rye-grass is particularly suited where land is in a good state of cultivation for coming the first season to be productive, and although exhaustive to the soil, it dies out as other grasses which expand for some years, spread and occupy the whole surface; and thus it appears to me that it is suited for this purpose, and it would be difficult to show, unless under exceptional circumstances, that the Rye-grass should be condemned as an agricultural grass.

SOILS OF THE EMPIRE.

As to the varieties of soils in the Empire, which we may briefly notice, we can see how diversified these are by turning to a geological map of the Kingdom where variety in one leads to variety in the other. Of course, art has the effect of altering, but that and others are only secondary causes. The clay formations of Eocene beds around London—although through the influence of the great population much otherwise useless soil, some of which is in the meantime falling out, has been brought to a high state of cultivation—these beds form many bare parts, and similar is Hampshire in the south. North, west, and south of this are the chalk formations. As an example of the soils and pasture of some parts we may notice the celebrated pastures of the Plain of Salisbury. Much of the clay, though stiff, can be improved by tillage, while a good deal is steep and the ground covered with short turf and shrubs. In Kent, Surrey, and Sussex, the weald clay forms naturally a

damp, stiff soil, but when drained, it is susceptible to be brought to a high state of cultivation. While the chalk strata stretch far into the centre and west of England and northward into Yorkshire. Being bare over many parts with thin soil and broken by the alluvial drift of the Wash and Humber on the east coast. Such a variety of country forms soils of all forms.

The Oolitic strata—composed in great part of limestone interspersed with clays which form good agricultural soil and the thin high-lying forming good pasture—stretch from the Humber in an unbroken line through the centre of England to the seaboard in the south. While west of this we find the Liassic strata stretching from the Tees to the same sea coast; the soil is principally clay and marl. Much of this is under meadow, being considered suited for this. Of course, there being the usual variety of soil, other crops are grown, a considerable part being cereals.

Next we come to a considerable tract of soil resting on sandstone which forms a good deal of fertile loam, although a considerable tract is even here ferruginous and barren. It stretches from the Tees in a strip to the 51 degree latitude, then forms a considerable tract, a point running south to the Bristol Channel and extending to the south seaboard.

We now come to the older formations which extend in the shape of the Permian Coal-measures, Old Red Sandstone, Silurian, Cambrian, Laurentian, Sedimentary, and Igneous rocks, on the east from the Tees north through all Scotland and west through the whole north of England, and south about the half of the land, a line of magnesian limestone (*permian*) dividing the newer formations in the east side from

the primary in the west, intersected in one part with marl and sandstone and some alluvial drift which here stretch to the west coast, the great proportion of Wales and the whole of the south-west end of England, comprising more than one-half of the island.

Speaking in a general way, the highest form of cultivation is on the sandstone, and is of an advanced character, the natural rock forming many fertile valleys. The limestone where highlying is bare, but the lowlying is pretty fertile. While over this wide area, where in some parts crops and animals are raised superior to any, the general character of the whole is, as regards pasture, bare and rugged, and exposed to cold, withering winds, the strongholds of such cereals as oats and barley. While a very large proportion of land known as agricultural is used for sheep farming, the general form of the whole is such as prevails in favour of such grasses as those low-growing grasses—as the Rye-grass—more than the taller, and in the lower-lying parts more luxuriant forms, although it must be allowed that there are usually exceptional conditions.

In Ireland the same general form may be expected from the physical features of that island. In the north and round all the sea coast, presenting, as it does, variety of hill and dale, when, from the peculiar form of the island in the centre, with bogs and morasses, a peculiar form of grasses may in the meantime be suited for it that are not suited for the general forms of Britain.

GRASSES WITH HABITS THAT COULD SUPERSEDE RYE.

In commenting on other grasses, we shall first

touch on those which can, from their habits, supersede the Rye-grass, if it can ever be made out that there are grasses under all conditions superior in cultivation to it. The most likely substitute I can pitch upon is the Meadow Fescue (*Festuca Pratensis*).

This grass grows much the same as Rye-grass, is in all senses a perennial grass ; it spreads out its foliage much in the same way ; has long borne a very high character as a highly nutritious grass, and it abounds on the best natural meadows in the kingdom. Meadow Fescue is favourably commented upon by all authorities, from the oldest to the present time. In my experimental plots containing it it grew much in the manner of Rye-grass. The leaves did not grow so rapid as Italian Rye-grass leaves, but taller than Rye-grass. In the autumn it even became taller than the Italian, but I do not think that where, as is the case in so much of the kingdom, the grass is sown along with a cereal crop, this grass would grow so tall as to deteriorate the grain crop, and the grass after the oats would be of more value. That the grass would yield a heavier crop, even the first season, I can testify from the result on my plots, and yield more aftermath.

A popular idea exists of many grasses that they are years before they come to maturity. All the grasses on soils and climate and artificial conditions suited for them will come to maturity, in the strict sense, the second season, that is, they will yield seed ; but there are several, of which Meadow Fescue is one, that require some seasons to reach that point known as their greatest perfection. Meadow Fescue grass has a wide natural range, adapts itself to all soils, and, as the usual form is in agriculture to enrich soils,

this grass, although predominating on good soil and luxuriant pastures, is suited to follow cultivation on poor soil and the roots will enrich it.

Although the natural altitudinal range is about 600 feet above sea level, it must be remembered that it has not been artificially spread to any extent like the Rye-grass, whose height above the sea level is about 1,000 feet. The Meadow Fescue would, if it had received the same attention, have been by this time as high. There is no doubt it will prosper in higher and colder parts. This grass may with propriety be used under all the general conditions of agriculture and in quantities ranging from one pound per acre upwards. It is better for the beginner to use only a small proportion, as I have received hints that, under certain conditions, the seeds will not grow so well as Rye-grass when the cereals are very close. This might be another of the results of bad or impure seeds, as it is certainly exceptional.

YELLOW OAT GRASS.

The next likely to suit all conditions is the Yellow Oat Grass (*Avena Flavescens*). This grass, which bears the characteristics of the Meadow Fescue in as far as it is of a perennial character, and can develop properly on any soil, is relished by animals. It received great recommendation as a pasture grass upwards of a hundred years ago. This was about the time pasture was receiving considerable attention. This period was superseded by the more general use of cruciferous plants, such as the turnip, and more attention to the cultivation of grain, which was the means of throwing the pasture question too much in the shade.

In all probability, because the pure seeds of this grass are difficult to procure, it fell almost into disuse. I have no doubt, from the fact alone that it is very highly suited for calcareous soil, measures should be taken to secure a quantity of good seed. This point, as regards seed, puts it in the meantime without the pale of superseding Rye-grass, and we can only speak of it as of its habits. It seemed to me to grow in the proper form for the most critical form of grass-sowing, although the tendency of the stalks was to grow somewhat tall too early. There is no doubt but it would be permanent over the general conditions of British agriculture. Rev. John Minto, Schoolhouse, Clatt—a cold, high-lying parish of Aberdeenshire—botanising from a quarter to half-a-century ago, used to find it naturalised in that locality, being introduced by agricultural seeds. Having grown it in his green a part of the time mentioned, it is still luxuriant. Along with the Meadow Fescue it seems to me to be inferior to it here, although on the calcareous soils, and probably on high-lying open soils, it might be, if not superior, of equal importance as well as on flooded meadows.

As very conclusive proof of its valuable properties, I shall quote from that great pasture pioneer, Curtis,—“Its excellence comes near to Meadow Foxtail—a grass best suited for rich meadows—for which it may prove no bad substitute.” It is valuable for after-math, and ought to be generally introduced into the agriculture of Britain to test its qualities. Though probably it can be used as a substitute, my opinion of it is that its proper place all round is as an assistant among most grasses under most conditions of pasture culture.

Besides the difficulty of pure seeds, there is also in the meantime complaints made of many of the samples germinating badly. I cannot give this account of it. The seeds I used of the true Yellow Oat-grass germinated as vigorously and purely as any of the kinds used. It has an extensive natural range on all soils, and is found at the height of about 1,000 feet above sea level. Unlike Meadow Fescue, its normal height is rather higher than Rye-grass. These two, all round, might make a better grass mixture than Rye-grass with its varieties, but, combine these three species, and the situation is very much altered. These grasses are the only two which, in my estimation, can show properties which could lead any practical man to conclude that, in the general forms of British agriculture, the Rye-grass ought to be superseded. Many other grasses possess important properties, but while admirably suited for one form are the opposite for the other.

In the form of both an alternate husbandry and permanent pasture grass.

We shall now touch upon one suitable for clay soil,

ROUGH-STALKED MEADOW GRASS.

Our clay soils have as a rule been drained or reclaimed from wet places where plants grew, not at all suited for alternate husbandry, but we will observe by the side of such fields a number of grasses which are eaten with avidity even during the first season's grass, when there will be a comparatively good return of Rye-grass. The one I have pitched upon as best suited for this kind of soil, where alternate husbandry is prosecuted and a grass which, sown along with cereals,

will be found a good grass, whether combined with Rye-grass or sown alone—it is the Rough-stalked Meadow Grass (*Poa Trivialis*) which is suited for such soils. It has all the necessary qualifications—root fibrous, continues longer in foliage than the Rye-grass, yields a fair return in a very indifferent season, forms excellent pasture; animals are equally as fond of it as pasture or cured as hay as the Rye-grass.

The late Rev. J. Farquharson, F.R.S., mentions in his paper, which I have previously spoken of, as having cultivated it successfully on such soil, testifies as to the fondness of animals, both cattle and horses, for it both as pasture and hay. In a cold district of Scotland I have observed that these animals were fond of it as natural pasture. Any actual experience of the cultivation of this grass which I have had has given a favourable result. It has minute seeds, a bushel contains about eight times as many seeds as the Rye-grass, so that a bushel will sow eight times as much as the same bulk of Rye-grass or perhaps more, as it, being a native grass, will of itself increase.

It belongs to a genus or family of grasses, having a great many representatives, being different in this respect from the Rye-grass, and different also in the way of running into varieties, as the Rye-grass is very liable to this. The Rough-stalked Meadow Grass does not run into varieties, retaining the same form from the coast of the Mediterranean Sea to that of the Arctic Ocean. It may with confidence be cultivated over a very large part of the globe on clay moist soil, but ought not to be used on any other kind.

Now, this accounts in some manner for Rye-grass

being used on such a variety of soils, as it can turn itself, as it were, by constituting a variety, that is, the Italian Rye-grass is a variety of the Perennial Rye-grass, and many of these so-called varieties, by repeated sowings on similar soils, will run into the same form. A familiar illustration of this being the introduction into Scotland of Swiss Oats, which, after a few years' sowing, ran into the same form as our Scotch Oats.

A species is a wider division between two forms ; but I am of opinion that many who are by some so looked upon have not the necessary difference to form a species, that is to say, if they grow in different localities and under different climatic and geological conditions, will, if taken and repeatedly sown under the same conditions, turn into the same form. The only variety of this grass is one noticed by Dr. Parnell called *Parviflora*, which grows in shady woods, sometimes mistaken for Wood Meadow Grass. While touching on the latter it may be useful to show how they run into each other, by stating that the nearest form to it is Parnell's Meadow Grass (*Poa Parnelli*), first noticed by Professor C. C. Babington in Upper Teesdale, who doubts if it should rank as a distinct species ; the next, Balfour's Meadow Grass (*Poa Balfourii*), first found by Professor Balfour, of Edinburgh, growing on Ben Voirlich, near the head of Loch Lomond. Now, this grass occurs on or about the tops of mountains, and Dr. Sowbery questions if it should take rank as a distinct species as well as the last-mentioned grass, while Dr. Parnell and Professor Babington make a species of it. The latter mentions that the difference is more marked on specimens grown in England than in Scotland.

Now, I am of opinion that all the three we have taken into account, if sown from seed a few times alongside of each other on similar soil, would all turn into one form, and, if so, we may expect that, if a seedsman had sold a quantity of similar seed to different parts of the country, some of the grass would probably take a form somewhat different from the others, so that some allowance must be made in this way.

This does not apply to our grass recommended for moist and clay soil. As already stated, it does not run into variety, excepting the one which led us to diverge. I have been very careful in observing it, and have no hesitation in saying that cattle and horses are fond of it. It delights in the sides of streams, growing among the mud and upon moist banks and sheltered parts where there is moisture. It appears to be a tender grass, and while it has all the appearance of growing well alone, and from the fact that it has a better chance by being sown on loose ground—that is, ground under cultivation—than taking root of itself on such as the above-mentioned places, there is little fear but that it would give a fair yield any season; but in exposed places a small mixture of hardier grass would be safer.

It ought not to be cut until the seeds are about ripe, because if it were cut when in flower, being in a soft, watery state about that time, a considerable loss would be sustained. It would be ready for cutting about the same time as the Rye-grass. I mean the same time of the season; and perhaps as the best time for getting the most of the Rye-grass is between flowering and the time the seed is ripe, it is probable that the same stage would be the best for the Rough-stalked Meadow Grass. I have also no doubt but these two grasses would make an ex-

cellent hay mixed together, as it is evident we have too little of that in our usual system of husbandry. Another peculiar feature of this grass is that all writers agree on the useful properties of it on the kind of soil above mentioned, which is more than can be said of any other grass, no criticisms being passed upon it, I mean as far as to any doubts as to its being relished by animals.

Although this grass is well spoken of by all, considerable misapprehension exists at the present time about it, no doubt from the different forms of cultivation prosecuted in Britain. Sinclair, while speaking well of it, states that it is only suited for permanent pasture. This statement is used by many commercial men; it is quite a mistake. No doubt Sinclair had come to this conclusion because his observations were made on some of the celebrated plains of England where much of the land was at that time laid out in one and two years' ley, and the climate admits of the growth unmolested of the tall growing forms of grasses. On clay soils a mixture of this grass is no doubt of value in all conditions of agriculture, but smaller quantities probably should be used in the milder parts of Britain.

GRASS FOR DRY SOILS—HARD FESCUE.

We shall now notice a grass suited for the opposite side of the last one, from which family we have already made one very important selection—the species called Fescue Grasses (*Festuca*) as their name indicated, which is supposed in the first to be derived from the Latin *festum*, and the Celtic *fest*, which signify food. They are of very great value as pasture grasses (the

name *poa* also signifies pasture or herbage, being derived from the Greek *poe*). It is evident that these two species, from their names, had early drawn mankind to observe their properties. The Fescues are a very extensive class, and, unlike the Rough-stalked Meadow Grass, have a great tendency to variety. They are so constituted as to have a species for any soil or climate.

After touching upon the one, and only after very careful observance and consideration, best suited for the kind of soil in question, I shall touch on one or two of the ones suited to form a mixture in alternate husbandry, as well as permanent pasture, where it forms a very close sole in connection even with some of the taller luxuriant grasses in climes suited for them. The one I have selected is the Hard Fescue (*Festuca Duriuscula*), which, on dry soils, grows to about the size of Rye-grass. It commences earlier than that grass in the spring, and stands out until late in autumn on poor dry land which does not produce a full hay crop, I mean Rye-grass crop, none of which, on such soil, should be without at least a mixture of this grass, as it not only makes good hay itself, but shelters the favourite Rye-grass, so that the farmer can have a very fair crop off even this land, and when the Rye-grass falls out it spreads, and thus retains a close surface alone.

It ought to be cut when in full flower or soon after—being rather later than the Rye-grass in flowering, they come very near the same time to the mower. It will also grow on rich soil, if wanted, but it appears to be the one suited for light soils, where many others would fall victims to the drought. In a

bushel of seed there is supposed to be about the same quantity as in that of Rye-grass.

It has an extensive native range from Italy in the south to Lapland and the Scandinavian Archipelago. It occurs in Scotland, England, and Ireland, also North America; the limit of its occurrence, in altitude, is about 3,000 feet above the sea level. Some authors, among whom are Lowe, who, in his *British Grasses*, gives it as a variety of Sheep's Fescue (*Festuca Ovina*), which occurs 4,000 feet above the sea level, but only a short plant a few inches high, and becomes what is known as *viviparous*, that is, instead of bearing flowers and seed, it bears small leafy buds which drop off, and falling on the ground produce new plants. This occurs when the plant is situated in a climate too cold for flowers and seed, and shows a great adaptability in this grass to retain life.

This small one, known as Sheep's Fescue, makes an excellent sole grass, but being only a few inches high it will not produce hay. If a number of these, which authorities differ upon as to being species or only varieties, were taken and sown under the same conditions for a few times, in all probability many would go into the same form; and I am inclined to suppose that the different soil and climate is the only real difference between them. From their great tendency to variety, if a person were commencing with one kind of seed and sowing in different directions, by constant repetition he would produce a large number of varieties; indeed, the *Festuca* genus are adapted to all soils and many climates, having their representatives alike in the morass as on the dry moor, on the

rich soil and on the dry roadside. It is true the meadow grasses are represented on dry moors, but only short stunted varieties, and fall behind the Fescue.

It is evident that this grass is of considerable pastoral value on dry soils throughout the world, British, Continental, and American authorities all testifying to its properties, but it should not be used on moist soils.

A form known as Red Fescue but deficient in foliage, with creeping roots, grows naturally on moist soils. Combined with Hard Fescue on soil suited for it Smooth-stalked Meadow Grass should be used.

SMOOTH-STALKED MEADOW GRASS.

Although possessing roots with a tendency to creep, they are not of such a character as would produce much difficulty in exterminating it when the land is broken up, that is, in alternate husbandry, but I do not think it should be used on loam soils.

The tendency of authorities on grasses has evidently been to err on laying their views from too favourable situations, and thus some of the grasses best suited for exposed parts are somewhat cast in the shade. The result of my observations has been to come to this conclusion as regards this grass. In my plots, although it did not grow fast as a mere briard, probably on account of its form of growth, when the season when it comes to be useful came round, it showed vigorous growth, with a rich crop of succulent leaves and a full return of healthy flower stalks. The leaves resemble very much those of the Rye-grass. Some say that it has not much foliage, but as it has both a wide range and occurs to the height of 3,000 feet above sea level, there is no doubt but it should be used both in

alternate husbandry and permanent pasture in high-lying or exposed situations on dry open soils.

We have now come to what I shall call a distinct stage in our division of the grasses. We have commenced by laying what may be termed a practical foundation by touching on the properties of the most extensively used grass, and, with all due respect to the most advanced authorities, first noticed those grasses which, in my judgment, can take the place of it should it be discovered that it should be excluded. The first two combined would, no doubt, form pasture of value and without spoiling other crops on all soils cultivated. Probably the second may not come to be looked upon of value but for a small mixture among the others, while the third mentioned, would, along with these, or along with Rye-grass improve the soil it is naturally adapted for; while the remaining two show the same result on the soils suited for them also under all conditions of agriculture, and the remaining grasses which we will speak of can only be used under more exceptional circumstances, in many cases only in small quantities.

THE TALLER GRASSES.

There is no doubt but these can be taken to much better account than is the case at the present time. A very considerable amount of the land should be under them in the form of permanent meadows, but to be used in the greatest part as alternate husbandry grasses they cannot act the same part as the ones we have previously mentioned.

TALL FESCUE GRASS (*FESTUCA ELATIOR*.)

A grass which grows to from three to five feet, suited for stiff, clayey soil, although it is coarse and harsh

to appearance, cattle are fond of it, and on the above-mentioned soil it ought to be sown, as the strong roots loosen the soil, and would tend to fertilise it, and would produce a full crop on some of these on which even the Rough-stalked Meadow Grass would not grow. A mixture of the two would make excellent fodder. Mr. Bentham and some others consider Meadow Fescue to be a variety of this grass.

SPIKED FESCUE GRASS (*FESTUCA LOLIACEA*).

This is a grass for deep, rich soil, is thought to be superior to Rye-grass, but some doubt is entertained about it, as to the production of it. Sowberry mentions in his work that the Rev. G. Swayne fancied it, cultivated a plot in his garden, but got no seed from it. Others have tried the same with similar results, only a seed or two being produced, supposed to be a hybrid between the Rye-grass and the Meadow Fescue. It resembles Rye-grass.

I have touched upon it to show what might be accomplished by experiment: I mean by producing hybrids between different plants. The want of seed is the drawback with this one, or else it has the properties of the Rye-grass, taller, and would stand much better on certain soils. These two are of a perennial character.

OTHER GRASSES THAT MIGHT BE PROFITABLY CULTIVATED—MEADOW FOXTAIL.

As our style of classification partakes of a peculiar character, we may say that, instead of speaking of the species of the different genera together, we are touching on them first as regards their geological relationship,

then what they are adapted for when the forms of art are taken into account. Thus, we may say, that we have instituted a combined form of botanical and geological classification along with a supplement of art as stimulated in the various conditions of agriculture.

First, we shall touch upon a grass universally allowed to be in its proper place—on rich loam and clay soil—a most valuable one, Meadow Foxtail (*Alopecurus Pratensis*). Attention was paid to its value in England previous to 1766, for in that year the London Society for the Encouragement of Arts, &c., awarded a prize of £5 to Mr. W. Judge, Woodward, Essex, for collecting its seed by the hand.

It does not come to full maturity for three or four years, and thus on fields for one or two years ley it is not so well suited, but may be used in small proportion. It forms one of the most productive of grasses for permanent meadows on suitable soils, and from early spring to late autumn throws up excellent foliage. There is no doubt but it is a safe grass for using in small quantity, on soils suited for it in alternate husbandry. Where the climate admits of autumn sowing, it might be more liberally used. It does not form tufts as some of the large grasses do on pastures. It extends naturally to 1,500 feet above sea level.

TIMOTHY OR CATS-TAIL (*PHLEUM PRATENSE*).

This and the next we shall notice are what are known as Artificial Grasses, both, though native to Britain, were introduced into British agriculture by being brought from America; by being noticed as being of economic value on the pastures there. The name Timothy was given it from one Timothy Hanson taking it to the

State of Carolina, from whence one Wyche brought it to England, when, at his suggestion, Mr. Rocque, of Wollhamgreen, cultivated it about 1760.

This grass, unlike the last, will adapt itself to any soil, but although called fibrous-rooted it has the property of developing on soils not naturally suited for it, by forming bulbs at the roots, and thus on exhausted high-lying, gravelly soils by being so laid out for a few years, these bulbs, along with the other parts of the roots, will soon restore the soil to a state suitable for alternate cultivation. Its naturally adapted soil is rich loam and clay.

As a Meadow Grass, it should be included. Good results have been experienced by the use of a small quantity of it on such soils in the alternate husbandry system. Still, it is on such soils inferior to Meadow Foxtail, and in many parts there is difficulty of getting rid of it when the land is ploughed over, both from the roots and seeds falling and germinating. English authorities speak of it coming early to maturity, but my plot of it kept well in the background and did not come up with what some term the finer grasses in this respect. There is no doubt, partly from the conspicuous part this grass plays in the American pasture lands, and the facility with which seed is procured, that undue prominence is given to it in the meantime.

As a rule, in alternate husbandry or even permanent pasture, it should not be used in exposed, very dry, or gravelly soil, and on rich loam or clay soil where it should form a mixture there are so many that also deserve a place there, that only a small portion of it is required. It is one of those, however, that should always

be included in permanent meadows. It is inferior to the Meadow Foxtail but of more certain growth, the seeds showing a high percentage of germination. Its natural limit is about 1,500 feet above sea level.

COCK'S-FOOT (*DACTYLIS GLOMERATA*).

No grass has for the last few years received so much recommendation. This has now been considerably mitigated, as there is no doubt, like the last mentioned, it has had somewhat to do with keeping back the progress of grass culture, when recommended to parts naturally unsuited for its development. Like the last mentioned it was introduced to England from America under the name of Orchard Grass and cultivated by the same agriculturist about 1764.

Many who read the first edition of my work were astonished at the remarks on it as a natural grass in the North of Scotland. In many parts it is untouched by agricultural animals. The reason for this grass being so much recommended in the seed trade in some respects has arisen from the high encomiums lavished on it by F. De Laune, Sharsted Court, Kent, and supported by the consulting botanist of the Royal Agricultural Society.

When we touched upon the geological surface of Britain we may notice that in the part where De Laune is situated we find the weald clay damp and stiff, but when drained, susceptible to a high state of cultivation. Now, this accounts for the great return from this grass there, but it is a very limited part of Britain, and we find English as well as Continental authorities very much modifying the properties of it. Its best natural development is on rich loam soil and good climate.

Now, I have observed, where it has become naturalised, agricultural animals seldom touch it. This applies to a considerable part of Britain.

It does not form a bulbous root, but becomes hard and wiry and thus devoid of nourishment in many localities. In many cases it will both grow from roots and seeds after the land is ploughed over. It will also grow too tall among the cereals if used in large quantity where the land is sown out in grass along with a cereal crop.

If kept down in pasture, there is no doubt but it will give a large yield in a season. To show that I am not alone in criticising the properties by some ascribed to it, I shall touch on the views of Mr. M. Sutton, whose farm I have visited and satisfied myself of the soundness of his views in this case. It does not withstand drought so well as Fox-Tail, and is entirely out of place in upland meadows. When a fine hay crop is the chief desideratum, Cock's-Foot should be omitted altogether, and its place be filled by Meadow Fescue.

This speaks for a large proportion of the cultivated area of Britain. Systematic enquiry has shown that when cured into hay much of the nourishment is drawn out of it. It has a disposition to form tufts which make it only suitable in small quantities, and in some situations it is not well suited for one or two years' ley, being best for from three to five—when older it is recorded in many cases as becoming tufty. Two great authorities give this account of it—Dr. J. A. Voelcker and Dr. F. G. Stebler, of the Swiss Seed Control Station.

In my first edition I spoke of it only from observation as it occurred on natural pastures. I shall now

give my views from what I have seen of it as used in cultivation. There is no doubt but it has a good yield, but care must be taken to keep the stalks from shooting, as when the seeds ripen they fall down, and will germinate; when allowed to get the better of farm stock, it is expedient to run the mower over the field. Ben. Reid & Co.—a well-known agricultural firm in Aberdeen—sowed a small field of it, and, through the kindness of Mr. Hay of that firm, under whose superintendence the experiment was made, I was made acquainted with the results.

The field supported a heavy cover of stock which thrived remarkably, and a very remarkable crop of swedes grew after the field was broken up. It was necessary when in grass to run the mower over it when it got the better of the stock. This probably caused little inconvenience under these circumstances, but in the general conditions of agriculturists this would cause considerable inconvenience, and seriously interfere with the propriety of using it, especially when others are to be had of equal usefulness.

Near the old royal residence of Kildrummy Castle, in the course of my researches, I came across a specimen of a farmer—to use the phrase used by Hugh Miller when he came across R. Dick, of Thurso—who adds stamina to the rest, Mr. G. Watt, Honeybarrel, who from childhood had studied the natural history of objects surrounding him. Cultivating a small farm, he was troubled with want of grass, and has for some seasons used a selection of these grasses. There was a small quantity of Cock's-Foot, and on the third year's grass when examined by me it was not in tufts—the land had been previously infested with soft grass (*Holcus Mollis*), and then there was not a single seed of it left.

Although Cock's-Foot did not appear to me to be the most suitable of those used, still I could not see anything very objectionable to it here. In several parts brought under my notice where it has been used, the seeds have grown among the oats when the land is broken up, so it is one of those that ought to be used with caution. The most suitable parts for it in alternate husbandry being in good loam soil, where the greatest number of grasses are suitable, thus limiting its proportional usefulness.

Like Dr. Stebler, I am of opinion that in alternate husbandry the quantity should seldom, if ever, exceed two pounds per acre. In most permanent meadows it should be used. In such meadows where I have observed it, it does not grow into tufts, but this might be on account of its being only used in small quantities. Large quantities of seed are easily procured, and it has a wide natural range both in the Old and New World.

Instead of having a tendency to run into variety, while it is best suited for rich, porous, calcareous, or loam soil with porous sub-soil, when under conditions not so well suited for it, the stems, leaves, and roots become hard and wiry. Its natural limit of altitude is about 1,000 feet above sea level.

BENT GRASSES.

I shall now treat on a few which belong to a different genera from those already selected, Marsh Bent Grass (*Agrostis Stolonifera alba*), belongs to a very large, complex, and, in a natural way, useful family of grasses, the term *agrostis* being derived from a Greek word signifying grass.

They cover a considerable part of the area of natural pastures. Their green leaves grow early in spring, and one kind or another will have green foliage late in the autumn. From my observations of them, they have been but imperfectly wrought up, from a botanical point of view. There is a great tendency to run into variety, and the most perplexing forms are to be met with. They have considerable power of adapting themselves to a variety of soils; and the one I have selected is, if I mistake not, no exception to the general rule.

A good deal of diversity of opinion exists as to the value of it. Dr. Richardson, an Irish gentleman, recommended this grass under the name of *Fiorin*, a name which it is generally known by. Mr. George Don, a Forfarshire nurseryman and botanist, condemned Dr. Richardson's views on this grass most strongly, as far as it concerned Forfarshire; and we may notice here what at the present time opens up a wide field of enquiry, the reason of so wide difference of opinion existing between different people. We quote the views of the two mentioned gentlemen on this grass. Dr. Richardson of Clonfecla states—"Fiorin Grass produces hay preferred by cattle to all others, and near treble the quantity afforded by any other grass. This enormous produce is not the exhausting effect of a single year, but the regular crop to be expected. This succulent grass is equally serviceable for winter green food. It is in a great degree indifferent to the extremes of wet and drought, particularly suitable to unproductive tracts." Mr. G. Don—"What is this celebrated Fiorin Grass of Dr. Richardson? It seems to be a mixture of all the tribe of couchy grasses

held equally in detestation by the farmers and their cattle, and we in Angus-shire are apt to judge of the industry of the farmer in proportion as he has eradicated these grasses." He also states that in the West of England this grass is held in equal detestation.

Mr. Sinclair again considered it worthy of attention, but probably on account of its early and late growth affording food earlier and later than almost any of the other grasses. I believe the reason of the difference arising between these gentlemen, all accurate observers, was on account of the difference of locality and the different modes of cultivation, Dr. Richardson being on permanent meadow and Mr. Don in alternate husbandry.

The results of my observations have led me to the same conclusion as Mr. Sinclair—am of opinion that a mixture of it on dry soil would prove satisfactory, but should not be sown on clay moist soil, unless under permanent meadow, as difficulty would be experienced in killing it when the land was ploughed. A *stoloniferous* plant is one that creeps along the soil, sends down roots at joints, and, at the same time, throws up leaves into the atmosphere. Cattle are very fond of this grass under certain conditions, and I am convinced that a mixture either among hard fescue or Rye-grass would make excellent hay. I am also of opinion that when properly investigated this genus of grasses will receive favourable consideration, in some districts at least.

In plots sown by me I was struck with the appearance of the leaves of common bent grass, and have no doubt but on dry gravelly soils it should be used both in alternate husbandry and permanent pasture.

There are many forms of Fiorin Grass. I have no

doubt but the different forms of Bent Grass have the property of forming these stolons on soils where they cannot develop with the fibrous roots, and thus it is for the farmer to avoid, in alternate husbandry, allowing it into clay, moist, or rich loam soil. While in a permanent marsh it is very valuable.

While touching on gravelly soil requirements, I shall notice the properties of a grass often accidentally introduced among seed, as Yellow Oat Grass, and by some writers on agricultural plants termed a weed—I consider the term a vulgar one in some respects. I am always of the same opinion as when I expressed my views before the British Association that all plants are of use, in their own sphere, out of that some die, others have certain powers of maintaining themselves, but are useless under these conditions for food to animals. Wavy Hair Grass (*Aira Flexuosa*), named probably from the beautiful glittering appearance it has in the summer time on our Caledonian moors, the stalk and flower of it having a peculiar power of attracting the fancy of the tourist, and, perhaps, larger quantities find their way to the city in bouquet form than any other grass. I have often admired the beautiful green foliage of it, and have observed that it was eaten with avidity. A small mixture on very poor high-lying soil, particularly where sheep are kept, would give satisfactory results. It grows about the height of the Rye-grass.

THE SWORD OR SOLE GRASS—CRESTED DOG'S TAIL.

The Crested Dog's Tail (*Cynosorus Cristatus*) is one of the most important of all our natural grasses. It performs an almost separate function from other

grasses, and if added to Rye-grass alone, provided others did not come into use, would be one of very material value to the agriculturist. As a single grass it ought not to be sown because the stalks are few and wiry, but the use of it is in forming a close sole; and as a pasture grass it has few if any equals, not only for the richness of its foliage, but its nutritive properties.

The crowns of it are formed under the ground, and it shoots up fresh and green in the very driest season. I have often admired it this way after the 22nd of June, when, to use a popular phrase, the night is on the turn, how quickly it made its appearance, that is, as being fit for pasture. Although eaten very close down, twenty-four hours afterwards it would have recovered and been again ready for pasturing, and continues this way until late over in the autumn. It will continue to grow, less or more, as long as severe frost keeps away, and although not particularly early in a backward spring, it commences and will in that case be before the Rye-grass. I have observed it a fortnight in advance.

Being a natural grass, it would not be so easily affected by the cold as the Rye-grass, and forming the crowns under ground, it would also be less at the mercy of the elements. It is a grass that may be sown among the other grasses on any soil, and when any of them dies out, it will spread and form a close sward. Although it makes excellent pasture alone, it is not suited for being sown alone because it has few stalks and is unsuited for a hay crop. Animals do not eat the stalks readily, and they form a rather awkward appearance. They will eat them up to the time they are in flower; and as they are later than the Rye-grass,

they are caught when cut along with it, when the juice is in them. I have tried horses with a dried stalk found among hay, and it was eaten as the hay itself. They show great partiality for it, and, if possible, they should be represented on fields where this grass is used, because they will, to some degree, keep down the flower stalks.

It also appears that these stalks among hay improve the quality, as Sinclair mentions that the finest hay in the London market was that known as Fendon Bent, being Rye-grass mixed with stems of Crested Dog's Tail. An erroneous idea prevails that it does not come to maturity for a few years after being sown. In my plots the Crested Dog's Tail grew as vigorous as any of them, and produced both stems, and with seed the normal size, both on the plot and where sown as a mixture the second season.

It may be remarked that when Rye-Grass itself is allowed to get so far advanced, animals do not care for the stalk of it. It (Crested Dog's Tail) got into bad repute at one time from ergot growing upon it and causing abortion in cows, but it has now turned out that ergot has the same effect when growing on any other of the grasses. A bushel of seed of Crested Dog's Tail Grass contains about four times as many seeds as a bushel of Rye-grass. It will grow on any soil suitable for cultivation, and even a few seeds along with any of the other grasses will be found of considerable advantage. I know of no grass so well meriting attention as this grass for pasture. It forms the staple grass along the beautiful banks of our streams and roadsides, and affords a juicy and nourishing bite in severe drought when almost all the rest are

either too dry or withered; and it is equally acceptable in dew or rain.

The Crested Dog's Tail Grass does not run into varieties. The only one is one which I have discovered, which, as far as I know, was not previously known, which is of no value to agriculture. It (Crested Dog's Tail) occurs about 2,000 feet above sea level.

SWEET-SCENTED VERNAL GRASS.

Sweet-scented Vernal Grass (*Anthoxanthum Odoratum*) is one which most writers on grasses give a place as a useful grass, but not very definite as to what place it belongs, as it is not very readily eaten in some parts when there is a considerable quantity of it. I have observed it growing under more conditions than any other grass, but nowhere very numerous. It is a grass that ought to be sown in small quantities among all the other grasses, as it acts as a condiment or stimulant among them. It does not require moist nor rich soil to grow, as I found as fleshy leaves on the north side of the Coreen hills, on a barren spot about 1200 feet above sea level, as I have met with anywhere or in any season. It comes early, remains green late in the season, and a small quantity would be found very valuable among all the other grasses. From the many different conditions I have found it growing—from a wet morass to such places as previously noticed—I am of opinion that it takes a very great part of its nourishment from the atmosphere. Nature seems to have adapted it to act the part of a condiment or stimulant among other grasses. There is only one British species; it extends through most countries of Europe, part of North America, and has been found at the height of 3,500 feet above the sea level.

PERMANENT PASTURE.

The whole of the natural grasses mentioned as suited for alternate husbandry ought to be sown on the same kind of soil for permanent pasture. It is questionable if Rye-grass should at all be sown under this head. There is room for systematic enquiry on this point. Most probably Rye-grass coming early to maturity would ensure a full crop earlier, and die out as the others spread. If Rye-grass should not be used the Meadow Fescue and Golden Oat Grass ought to take its place. I am taking as permanent pasture all that is intended to be out upwards of five years. In addition to these, there are a few others worthy of notice this way, and in some localities, perhaps some that I have mentioned, may be considered only fit for being added to permanent pasture—I mean mentioned as being best suited for alternate husbandry; and, on the other hand, one or two I may mention, which ought to be added to permanent pasture, may be thought by some worthy of a place among those used in alternate husbandry, the farmer being the judge himself, as he sees with what relish animals eat the different ones in his locality.

GENERAL SUMMARY OF USEFUL GRASSES.

On clay, damp soil, a quantity of the Floating Sweet Grass (*Poa Fluitans*) ought to be added. It is very much liked by cattle, and has very sweet juicy leaves, which remain green long through the season. If not on account of its creeping habit, this would have been a valuable grass for alternate husbandry. A small quantity of the Annual Meadow Grass (*Poa Annua*) may also be added, as animals are very fond of it.

While on dry, mountainous soils there is a kind of grass, the Silvery or Early Hair Grass (*Aira Caryophyllea* or *Præcox*) which forms a very fine bite in early spring, of which, where attention is paid to the wants of sheep or ground game, a small quantity might with prudence be used. The Turfy Hair Grass (*Aira Cæspitosa*) is, as a rule, looked upon as a noxious weed, while there is no doubt that on meadows where it is permitted to gain footing it forms disagreeable tufts, and is with difficulty eradicated. There is as little doubt but upon moors and mountain sheep runs where a few tufts exist that they will be found closely cropt down. Probably on account of the hardiness of this grass, coming early in spring and withstanding cold storms, that it often contains nourishment of a kind scarce in such parts, and, therefore, attention should be paid to have a small quantity of it in that and similar situations. It may be noticed that, from its habits, it can hold its own where few grasses will prosper. It is early green, and remains green the whole season, and although there is not much nourishment in it, there must be a use for it. It only occurs in small proportion to the whole area, but it commences at the sea-shore and ends about the top of our high mountains.

As we move upwards on our natural pastures, we may use Quaking Grass (*Briza Media*), another favourite bouquet grass. I have observed this grass very eagerly eaten on pasture, in the parish of Crathie, on the Abergeldie moors, near Balmoral Castle. The *Ovina Festuca* ought to be sown in uplying districts along with others, as also the Common and Dog Bent Grass (*Agrostis Vulgaris* or *Canina*).

In mountainous districts Purple Melic Grass (*Molinia Cærulea*) may, with confidence, be recommended as a grass for natural pasture, and on some uplying moorland ground, under alternate husbandry, it might be to some extent used, as it is said by Professor McGillivray to improve the butter of cows which feed upon it, making it rich and highly coloured. Decumbent Heath Grass (*Triodia Decumbens*) is also useful on natural pastures, both dry and high wet ones. It is late of flowering, and the foliage remains long green. Seeds of it are often imported among those of Crested Dog's Tail.

Red Fescue (*Festuca Rubra*) is recommended by some for dry soils. What is against it is the creeping nature of its roots. Some recommend the use of Various Leaved Fescue. It belongs to the south of Europe, and, probably, unless in the milder parts, would be of no advantage. Yorkshire Fog or Meadow Soft Grass (*Holcus Lanatus*) should not, in my judgment, be encouraged in many parts; still it receives so much notice among authorities that we cannot but suppose in some parts it is of importance. It grows on any soil; thus, on peat soil, where few grasses will hold, it is of value, but the seeds in many parts will spread, and on other soil it is difficult to eradicate. Curtis speaks well of it. Hon. Mr. Lewis, of Louisiana, says, from experience, that it is the best grass for some lands. Dr. Stebler gives no great name to it, but allows its value for peat or dry sandy soil. Care should be taken in introducing it. I have seen no part where safer grasses would not do as well.

The Brome (*Bromus*) Grasses are generally excluded, but some question the propriety of this. There

is no doubt there is good in them among hay, but when required for seed there is danger in getting Ryegrass seeds cleaned from them. Some recommend Schroeder's Brome Grass; there are several forms having different peculiarities. A form generally connected with the Fescues, Giant Wood Brome or Fescue, might be used in damp clay or mud marshes. Fibrous-rooted Oat-like Grass (*Arhenatherum Avenaceum*) is recommended for rich soils, but I am unable to say if there is any advantage in using it. Some make out that this form proper is very different from that noxious weed, the bulbous-rooted, but there is some reason for doubt that it is the property of the plant to sustain itself where unsuited for its natural development.

Wood Meadow Grass (*Poa Nemoralis*) is suited for growing under shade of trees, and in my experimental plot of it, the third season it was the first to be the length of being fit for pasture; it shows very considerable persistency in throwing up foliage the whole season. My attention was drawn to it the second season, which was corroborated the third. I should recommend it for trial on dry soils, even in alternate husbandry, as well as among mixtures for permanent pastures. A form has been introduced, Var. *Sempervirens*—Hudson's Bay or Evergreen Meadow Grass; the supply of seed is rather uncertain for its general use, but, besides having superior properties to the other form, it comes very early, remains long green, and yields a considerable bulk of foliage on any soil.

Reedy Meadow Grass (*Poa Aquatica*, or *Glyceria Aquatica*) forms in flat countries a great amount of herbage either to cut or for pasture, where the land

will not sufficiently drain to admit of general cultivation. It is known in some parts by the name of fodder. There are occasional spots to be met with, where good soil cannot be properly dried, and, where nothing is produced but rushes and sedges, such as the dried Loch of Spynie, in Morayshire. This grass is suited for being planted into it. It does not produce seed very well, but, having creeping roots, they can be parted and planted, and they will throw a crop of at least from six to eight feet high each season. At a dried pond near Breda House, Alford, Aberdeen, where it was introduced more than half-a-century ago, it not only produces an excellent crop, but cattle eat it with great avidity. It is also an excellent fodder for cattle when cured for winter use.

Wood or Spreading Millet Grass (*Millium Effusum*), although forming finer herbage than Reed Canary Grass (*Phalaris Arundinacea*), may both be said to be of the same use, namely, growing on the banks and shelves of rivers and streams; the former also grows in old woods and copses.

Sea Reed or Mat Grass (*Ammophila Arundinacea*) and Sand or Upright Sea-lyme Grass (*Elymus Arenarius*) are adapted, and are used for consolidating and fixing loose sand at the sea-shore, their strong creeping roots and elastic foliage being adapted for this purpose.

MIXTURES OF OTHER PLANTS THAT OUGHT TO BE SOWN AMONG OUR GRASSES.

This subject has as much need for attention as the grasses themselves, and this part is probably not the least perplexing. Two plants form the nucleus in this

way, viz., Red Clover (*Trifolium Pratense*) and White Clover (*Trifolium Repens*).

In my judgment there is no better proof to be found of the desirability of larger mixtures, both in land being put into permanent pasture and in alternate husbandry, especially as a good deal is at the present time being sown into permanent pasture, than what can be learned by observing the quantity and variety of plants used by animals, there being a great many besides those mentioned above on our natural pastures. In many cases the first mentioned is not present, and the other is often all but absent.

As, also, that there are a great many farms in the kingdom where cattle will not take on condition fit for the butcher. When they come to a certain stage on these farms they do nothing in the shape of improvement without artificial assistance, whereas on the finer farms they will develop properly, or, in most respects, as well as with artificial assistance. This, as far as I can see, shows that with more method being applied to this part of culture, a great economic profit would be the result, and thus the utilisation of plants suited to the various conditions of pastoral culture is a most important point.

RED CLOVER.

Red Clover (*Trifolium Pratense*) is supposed to have come under the notice of British agriculturists about 1645, when Sir Richard Weston, in a work published at that time, gave accounts of its properties in Flanders, having seen crops of it cut three times in one season in the vicinity of Antwerp. We find published instructions as to its culture in 1653.

Its natural habitat is rich, loam soil, but under cultivation it will, in not over-severe climates, develop almost on any soil. There is little doubt but the plant is, when conditions suit it, like the Rye-grass, a perennial plant.

With cultivation and the many different conditions under which it exists many strains have originated, and, consequently, an equal diversity in the results of its utilisation. There is no doubt but the plant had been too widely extended along with the extension of cultivation, or, to say the least, too freely used in that extension, to the neglect of certain other forms. The same point must be noticed with it and the other plants with regard to the importance of fertile and pure seed. There is no doubt but there has of late years been too little attention paid to this point, particularly as regards imported seeds. I do not in this work lay out seeds from different countries as different varieties, although it may be noticed that, commercially, they are looked upon in that light, and, in the agricultural sense, with some degree of propriety, as seeds from different parts characterise themselves by giving different results, differences being experienced in the durability of seeds from different countries.

As a rule English and Swiss are most durable ; still there are different accounts from different places and various agricultural conditions. Either as a plant for pasture, summer indoor food or cured for, or among other plants for hay, there is no plant in its own place more worthy of attention. Still, its use has been overdone.

Its properties are that it generally exists for a few seasons on loam, alluvial, or rich clay soil, when these

are in a good state of cultivation and a moderately temperate climate. On the other hand, in bog or marsh land, or gravelly, sandy, or chalky soil, it is only a plant of annual or biennial duration. In my opinion, it should be used in more or less quantities in all mixtures for alternate husbandry, and probably permanent pasture on the soils mentioned as best suited for it. But I have doubts if it should be used when the properties of all the other available plants are properly authenticated on the soils mentioned as not suited for it—a good deal, no doubt, depending on the state of cultivation of the different soils, climatical conditions, and form of husbandry prosecuted.

COW GRASS.

The next to be noticed was introduced into England about the beginning of the eighteenth century. Some confusion exists with regard to the name of it. Cow Grass is its English name. Sinclair terms it *Trifolium Medium*, while Lawson calls it *Trifolium Pratense Perenne*—same being generally used in commerce—Perennial Red Clover or Cow Grass. It has a stronger, less fibrous, and more penetrating root than the last mentioned, and is thus of a more durable character. It is adapted for developing on land too poor for sustaining Red Clover. It is also adapted for meeting the want in pasture between the times of productibility of Red Clover, and remains longer green, as well as withstanding better the effects of extreme drought. It is, as a rule, inferior in suitable localities to Red in after-math. More difficulty is experienced in getting seed, and care is required that the proper article is procured.

I am inclined to favour Dr. Stebler's view as to the

name being best served by Perennial Meadow Clover (*Trifolium Pratense Perenne*); still, if the next to be noticed should be introduced into cultivation, there is something in the idea of this being termed Middle Clover, as used by Sinclair, as the perennial of botany and the perennial of commerce do not correspond. I would favour the use of this clover in most clover mixtures.

ZIG-ZAG CLOVER.

The next to be noticed is the Perennial Clover of botany, Zig-zag Clover (*Trifolium Medium*), not in the meantime in commerce. Some believe Cow Grass to be a hybrid between this and Red Clover. The name Zig-zag has been given it from the form of the stem. Its properties have been noticed and touched upon by botanists and other investigators. It is spread over the kingdom, generally to be met with on dry pastures and banks by the wayside. I am convinced that it should be introduced into culture. It is almost independent of season, and forms a green bite on pastures in the severest of droughts. My observations on it confirm the views of Mr. J. Sutton, who makes interesting remarks on it, and finds it improves by being cultivated in his garden. Over the wide range of climate embraced by both observations, as well as that of others, and its recognised permanent pastoral value, there is no doubt but it is worthy of a place in cultivation. I have no doubt but it should take the place of Red Clover on dry pastures of long duration, and probably on other parts where the Red Clover is not so well adapted. In company with Cow Grass it would on many situations form an admirable mixture. The

roots of both these are more of a creeping character than those of Red Clover. In many cases all three ought to be used. The value of the short-lived being first, and the others coming afterwards. There are many severe climates where the Red does not come to maturity, and the kind in question would be found very valuable there. In concluding this notice of it, I shall state that it is most desirable that extended experiments and observations be made on it.

ANOTHER FORM OF CLOVER.

Having had the honour to be asked by the great seed firm, James Carter & Co., about this plant, and, securing some seed, which led me to take particular observation of it and other similar Trefoils during the summer of 1888, I find that there is yet another one to be disposed of.

On many of the permanent haughs I find this form; it neither corresponds with Cow Grass nor Zig-zag Trefoil. The name I would propose to it would be Perennial Meadow Clover; it throws persistently succulent leaves, some plants come very near in character to Cow Grass, others to Zig-zag Trefoil, a good deal depending on the features of the part where it grows. It is to be found at a level above where oats will ripen, even producing seeds in that cold season, and these better matured than the Zig-zag Trefoil, and much more prolific. It deserves to be paid attention to along with the other as regards introducing it into commerce.

ALSIKE CLOVER.

The next I shall notice is the Alsike Clover (*Trifolium hybridum*), which was introduced into culture

in Britain about 1834 by Mr. Stephens, of Edinburgh ; that gentleman taking it from Sweden. It is one that should be a good deal used along with the other clovers in alternate husbandry, but, as a rule, not in large quantities. It is one that is adapted for clover-sick soils. For clay soils of a retentive character, or damp or wet soil, the Alsike is the proper one to use. Also, it should be introduced into permanent meadows, it adds to the pasture value, and greatly to the hay from such parts. One or one-half pound may be used on an acre of any kind of soil. One drawback to its use is that in many parts cattle are not very fond of it as a pasture plant, but it generally stands out well in any season, and thus stock are often glad of it. On the other hand, when cured among hay it is generally relished, and is of advantage that way. Although it is stated by some, from the fact that it does not possess roots that will penetrate far into the soil, that it is not capable on dry soils of withstanding severe drought, still, from the form of the plant, in many cases it may be used successfully on this form of soil in alternate husbandry. But should the Zig-zag or the other form be got into use, one or other of these would be preferable on this kind of soil. Alsike is generally productive for about three years, although on soils suited for it it will continue to be productive for ever so long, and is, strictly speaking, a perennial plant.

WHITE CLOVER.

White Clover (*Trifolium repens*) is one that is justly popular. It has more claims to being natural to Britain than any of the previous-mentioned ones at present in the seed trade, it is both widely distributed this way

and in cultivation. With the aid of cultivation it may be brought to flourish in most soils and climates. It is best adapted for good loam and dry, kindly soil. It has held its own in British agriculture since the beginning of the eighteenth century.

In many parts in alternate husbandry this clover forms for a considerable part of the season the chief food. If it were not for it many of our arable fields, in Scotland at least, would present a bleak enough appearance. While Rye-grass and Red Clover die out, and often the seeds of this one which are sown do not germinate, the seeds of the natural form retain their germinating properties for years in the soil, and fill up when a vacancy occurs. On land suited for it, it springs early, and produces green leaves until winter sets in. It is not so well suited for heavy clay or moist soils, and high exposed dry ones. Like the Red Clover, commercial varieties are produced by seeds grown in different countries; there is but one recognised botanical form. Like the previous-mentioned ones, this clover is perennial where conditions suit it, but is annual or biennial where these do not suit it.

BIRD'S-FOOT TREFOILS.

To replace this plant on clay and moist soil, the Greater Bird's-foot Trefoil (*Lotus Major*) ought to be introduced. While on dry, thin soil the Common Bird's-foot Trefoil (*Lotus Corniculatus*) should be used. Both these are peculiarly adapted for the soils for which I recommend them. Although not adapted for giving a yield as hay, they are admirably suited for pasture, and are both perennial; animals are very

fond of them. The common one is indispensable on dry, natural pastures. They have, in my judgment, been very much overlooked ; as being permanent plants and suited to take the place of the White Clover, in both extremes—neither extremes so well suited for it. The next two I shall notice are not perennial, but will throw out seed, which grows up in many cases, and thus, in soils suited for them, are a sort of continuous.

YELLOW CLOVER AND SUCKLING.

Common Yellow Clover or Trefoil (*Medicago Lupulina*), also Black Medic or Nonsuch, was first recommended by Hartlib, 1659, under the name of Hop Trefoil, from having seen a chalky down in Kent with little else on it maintaining many sheep, so that they were “even fit for the butcher.” It grows on any soil, but is best suited for calcareous soil. It can be had cheap, comes very early in spring, and thus a small quantity may be judiciously used either in alternate or permanent pasture.

The other, Yellow Suckling (*Trifolium minus vel filiforme*), is best suited for dry soil, although it may grow on most soils. It has been long used, and affords a bite, on pastures suited for it, the most of the season. The nature of the foliage suits it admirably for lawns. It seeds the same as last-mentioned—both of which, in my judgment, ought in many cases to be replaced by the two Bird’s-foot Trefoils.

LUCERNE AND SAINFOIN.

Lucerne (*Medicago sativa*), a Greek and Roman forage plant, and Sainfoin (*Onobrychis sativa*), a native of England, and cultivated for over two hundred years ;

both are only suited for a limited part of the kingdom. The area under the first has diminished of late years in England. From the fact that it will remain for twenty-five years in the Continent and only five in England shows an inferior climate for it. The peculiarity of this plant is that the sub-soil is of more importance for its development than the soil; calcareous sub-soil suits it best. Is best adapted for cattle, and used as fodder off the scythe. Sainfoin is also useful for horses and sheep, best suited for low alluvial plains; develops best for one or two years, Norfolk being an example of a part suited for it. There is no doubt but better results would be got in such counties as Oxford, Wiltshire, Berkshire, and Hampshire by using a judicious mixture of grasses which would keep the land in good plants, instead of sowing this plant alone, to be left for a few years, the result being that, as this plant dies out, the land becomes filled up with anything that comes in the way.

COMMON PARSLEY.

We shall now go a small piece out of the way to notice a plant similar as regards being suited only for a limited area and being one of our introduced plants—Common Parsley (*Petroselinum Sativum*). It received recommendation from being reputed as a preventive of red water and liver rot in sheep. It is supposed to be a biennial or triennial plant, but the seeds fall down and root, and thus it maintains its ground. It is eaten by most agricultural animals; is best suited for light medium soils, and, in the milder parts of the kingdom, on such situations as suit it, there is no doubt that a

small quantity may be used with advantage, although, as regards the three last-mentioned plants, there is every probability that their bounds have been further extended than they would have been for the purpose they are used had the pasture question received the attention the importance of it merited.

THE VETCHES.

The next I shall notice, the Vetches, are a class closely connected with the Trefoils. They have undergone a good deal of notice as natural pasture, although few, if we may state so, have been cultivated, although the Pea of horticulture and agriculture has been formed from them. It is also recorded that the Everlasting Pea (*Lathyrus latifolius*) was cultivated by a gentleman in 1765, who sowed a rood of it, which yielded a great deal of food much relished by horses and cattle, both in a green and dried state.

They are represented by many different forms in different natural situations, and I shall content myself by mentioning those that have come under my observation, along with the nature of the parts best suited for them, and it is very likely that some may be either added to or deducted from the list as our knowledge of the properties or deficiencies becomes more extended.

Geological relationship, again, may be taken under notice, as the Trefoils in many cases do not hold for years on certain soils, and at best are not in many cases of a permanent character. A characteristic of the Vetches is that they are mostly permanent, and this makes them of importance in permanent pasture, as well as in alternate husbandry. Although in some

cases the roots might not die when ploughed, the nature of these plants is such as, generally speaking, gives little trouble in subsequent crops.

MEADOW VETCHLING, EVERLASTING PEA, AND TUFTED VETCH.

The one best suited, as far as I have observed, for clay or clay loam soil, and is fitted to develop properly on damp sour clay also, is the Yellow Meadow Vetchling (*Lathyrus Pratensis*). It is not confined to these soils, although they are the ones best suited for it. It persists in throwing up foliage the whole season which is relished by animals. It is favourably noticed by Sinclair, although, in my opinion, he overlooked it in some respects, touching on the value of the fodder amount more than the pasture value of it, also its abilities to stand extremes of weather.

For some purposes the already touched upon Broad-leaved Everlasting Pea, from its yielding heavy bulk, might with propriety be noticed as worthy of attention. It is not a native of Britain. The Meadow Vetchling has attracted the notice of botanists as a pasture plant.

The next I shall touch upon has also attracted notice as valuable on natural pastures, the Tufted Vetch (*Vicia Cracca*). It has more foliage than the first mentioned. It has the same properties of persistent growth, although it is probably more subject to variation with the seasons. It will develop any season, and is less limited as regards soil, although open loam or medium soils are the proper place for it, and the

extremes of clay or gravelly exposed soil are not so well adapted for its proper development. It is an excellent plant among hay, either artificial or meadow, and there is no doubt but in the latter case it would be a great acquisition.

BUSH VETCH.

The next I shall notice is the Bush Vetch (*Vicia sepium*), a spreading Vetch, and is relished by animals. Although not growing so tall as the Tufted Vetch, I have no doubt but it yields an equal amount of foliage. It is suited for any kind of soil but clay—those best suited being sandy or gravelly loam soil, but not extremes in that direction.

An interesting sketch of the Bush Vetch is preserved in the Memoirs of the Bath Agricultural Society by the early observer, the Rev. G. Swayne, who states that it shoots earlier in spring than any other plant eaten by cattle, vegetates late in the autumn, and continues green all the winter. It is difficult to collect the seeds, owing to the pods bursting and the seeds being scattered about; the seeds were also subject to be attacked by an insect. Mentions a patch in a garden cut five times the second year—gave a yield equal to twenty-four tons of green food, or four and a-half dry food, per acre.

I have paid considerable attention to this plant, but I have not noticed it as being over-subject to be eaten by insects, nor the pods to burst so as to scatter its seeds, nor are the seeds subject to attacks of insects. It contains chemical matter, which is often deficient in grasses; and climate may have occasioned the defects mentioned by the Rev. G. Swayne.

WOOD VETCH AND HEATH PEA.

Wood Vetch (*Vicia sylvatica*), having the habits of Tufted and Bush Vetch, but suited for woods or copses, where it gives a good nutritious yield; but under exposure it is inferior to these two, being, as far as is yet investigated, suited for sheltered localities. Dr. Plott mentions this, and that the Tufted Vetch will advance starved or weak stock above anything yet known; it is of value for improving wood pasture. Agricultural animals are in such localities fond of it, and the plant is worthy of notice on this account.

The Bitter Vetch or Heath Pea (*Orobis tuberosus*), sometimes Butter Vetch, is adapted for sandy and gravelly soils and pasture runs, and is of great value on gravelly moorland soils.

KIDNEY VETCH.

Kidney Vetch or Ladies' Fingers (*Anthyllis vulneraria*) has of late been deservedly more prominently under notice. It is of value both on dry inland pastures, either in alternate husbandry or permanent pasture, and on the seaside it is successfully used. It is of importance that in Northern Germany Kidney Vetch is a good fodder plant; also, H. Pringle has successfully used it in this way in England, the yield of hay in his case being considerable. It is thus likely that most plants will increase in bulk in many cases by being cultivated in localities where the conditions suit them, where, growing as natural plants, they appear to be of value only as pasture.

Or, to say the least of it, the last two mentioned appear, as natural plants, useless as hay, but valuable as pasture in the situations mentioned as suitable for them, but are of value as hay when cultivated.

BROOM, WHIN, AND PETTY WHIN.

I may here diverge as far as notice three shrubs belonging to the same natural order of cultural value for certain purposes.

The Broom (*Spartium Scoparius*) is valuable, as being introduced in certain localities it improves the soil, and as in part a food for sheep, although when eaten alone it produces a sort of intoxication. Sometimes certain classes of cattle relish it also.

Whin or Furze (*Ulex Europæus*), a valuable shrub for sheep, and grows on worthless soil and more rocky situations than many plants. Is of more value for sheep than Broom, but does not improve the soil on which it grows to any marked extent. Needlegreen Weed or Petty Whin (*Genista Anglica*) also deserves attention on high-lying pastures.

In touching on the many plants connected with the Leguminosæ order, it is only right to notice that those plants touched upon are all worthy of consideration. At the same time, as regards the completeness of those worthy of notice, it may be that in such families as the Vetches there are other plants equally worthy, or that some of those noticed may be replaced if the matter comes to be properly investigated, probably some one plant may answer all the purposes of two or more, and thus there is only need for introduction of those into the seed market which perform some exceptional part of economic value.

It is a point requiring the greatest care and attention under the different conditions of agriculture. Thus, although the Bush Vetch had a tendency to throw off its seeds, as previously noticed, it may not do this in other parts, so as to raise difficulty in securing

seeds. Every plant has its natural habitat, which may be included agriculturally, where by nature or art it will develop properly; beyond this, whether as regards climate, soil, or other causes, it is, as a rule, bad policy to use it, and some other plant ought to take its place. Thus, it can be seen that we have too meagre a stock in cultivation, for it is a fact that many are cultivated under conditions where they do not come to or retain that maturity over the term that they are intended to cover. Next to the grasses, the Legumines hold the most important place in pasture.

OTHER PLANTS OF ECONOMIC PROPERTIES.

I shall now proceed to touch on some plants which contain noticeable economic properties. In many cases these plants hold the properties of astringents, stimulants, and so on, instead of purely nutritious properties, and are consequently equally worthy of attention.

Eyebright (*Euphrasia Officinalis*) is of considerable value on dry pastures, especially in the autumn, when many of the grasses become withered, and well deserves consideration on dry permanent pastures, if not on such soils under alternate husbandry. It is an annual plant, but the seeds drop, and it thus remains permanently in the soil, it being similar in this respect in its own haunts to the Lucerne or Trefoil in theirs. It will grow on very thin moorland soil, and on such situations is worth attention.

There are other plants of this order worthy of notice, for it may be that in some particular part they may act the same as this one where I have observed it; one of these is the Yellow Rattle (*Rhinanthus Crista-Galli*), which has some properties in it.

The Ribwort Plantain or Rib Grass (*Plantago Lanceolata*) and Greater Plantain (*Plantago Major*) deserve notice. The former is in the seed market at the present time, but it is doubtful which has the prior claim.

They are suited for growing on any soil. According to Swedish experiments on the latter, horses and cows refuse it, but it is eaten by goats, sheep, and swine. Of course it may, as most likely it would, be different in Britain. This plant was a great favourite of Dioscorides, a physician in the Roman army, he commending it for curing different diseases. They are both perennial and suited for alternate husbandry or permanent pasture. At one time Rib Grass was considered a preventative of hove in cattle on after-math.

Yarrow or Millfoil (*Achillea Millefolium*) has the properties of an astringent on pastures. I have observed that the leaves were eaten by animals in spring. They come early, when the leaves of the grasses are too watery, and it evidently prevents scour at this season; while, in the autumn, when the leaves of the grasses are withered, the leaves of the Yarrow are green and succulent, and at that season they have the opposite effect to the spring season. The leaves remain green the whole season. It is perennial and only adapted for dry soils in cases where it would require to be eradicated occasionally such as in alternate husbandry; as in wet or clay soils, although the leaves have the same properties, from the creeping nature of the roots, it becomes in such situations in alternate husbandry a pestilent weed, as it cannot be eradicated when wanted.

The one bearing most resemblance to this plant is

Sneezewort (*Achillea Ptarmica*), having in some respects the same properties, and it is probable on wet soils, the roots not being so creeping, that it is better suited than the other ; but, on the whole, not having so many leaves, it is doubtful if it is worth attention as a plant of pasture culture. They belong to a very extensive order of plants, the Compositæ, but it is doubtful if any more of them have very marked properties in this particular department of British pastoral culture. I made particular observations on Yarrow ; in the season of 1886 it was more eaten than in any season I ever observed. A cold spring had doubtless produced unwholesome grasses, and thus one saw the properties of Yarrow.

There is a plant, Common Bitter Cress or Cuckoo Flower (*Cardamine Pratensis*), which might be looked after for moist or clay soils. It belongs to the same class as the Bitter Cress, the latter being known as a salad. Probably this plant would take the part of Yarrow on clay or damp soils ; it is only suited for these soils. On meadows the foliage may be seen the whole season. The leaves have a rather bitter taste, but I have observed them cropped by animals. It is a perennial plant, and should it ever be introduced into agriculture there would be no difficulty in eradicating it when land came to be broken up. It is also to be understood that, in my judgment, this plant is of value in permanent meadows.

All the foregoing plants are, in my estimation, worthy of attention as to their economic properties, either as alternate husbandry or permanent pasture plants.

The subject is such a complicated one, as regards

the many various conditions of agriculture, that some plants that are useful in one part may be the opposite in others, this point varying with the various conditions, although it is evident that it has, like the whole subject, been too little attended to, and in suggesting a few of those plants not in the seed market which I have noticed as being used by animals on natural pastures, it is not to be supposed that the list is here complete, but sufficient to assist, at least, to raise a spirit of enquiry in all parts where this may be noticed among the body concerned, so that in time the pasture question may be brought to its proper standing. It is in the power of many to make use of a plant if they have grounds for thinking it of value, by collecting the seeds and using it.

PLANTS CONNECTED WITH PERMANENT PASTURE ON MOUNTAINS, &c.

I shall now touch on some plants connected with permanent pasture on mountains, moors, meadows, marshes, &c., which even, by a proper mixture of plants, may be considerably improved. There is no doubt but reasonable attempts should be made to introduce such plants as, guided by the geological and climatical conditions, are best suited for particular localities. In the conditions we are now touching upon, there are plants whose particular functions lie in such localities, the great majority of which have suffered diminution of territory by the advance of reclamation of land, but still retain a hold of a considerable proportion of the surface area of the land.

No class has suffered more than the Sedge (*Carex*), or, more properly speaking, the order (*Cyperaceæ*)

of which the Sedge is the most numerous of the family or genus. They are generally styled an order of little value; still, when the land was in its natural condition they had performed an important part in feeding the plant-eating animals of the time and age.

They, as well as their economic properties, are now driven to pastures of all extremes where reclamation has not penetrated, and even in these localities it is worth noticing that this and others are properly represented. The object is to select a plant or two, having a fair amount of foliage, and suited on one side for dry moors, and on the other for wet inland or seaside marshes. Probably in the first mentioned situation the Common Carex (*Carex Vulgaris*) or Green-ribbed Carex (*Carex Binervis*) may be best suited, but on this point I have come to no conclusion, but will content myself with throwing out the suggestion that they are in this respect worthy of attention.

Two plants belonging to the same order are worthy of some notice, Narrow-leaved and Hare's-tail Cotton Grass (*Eriophorum Augustifolium* and *Vaginatum*). Their value lies on wet moors and marshes, where they spring early, and the leaves are eaten readily by sheep or cattle before the leaves of the grasses appear. Their value at other times is not very marked, but they fill a place two ways, by coming very early in spring and growing under conditions where superior grasses will not exist. Sinclair notices these two plants, and his opinion, the result of observation, is the same as my own.

The next to be noticed have also suffered considerably by the inroads of reclamation—the Rush

(*Juncus*) family ; still, in similar situations as the two previously mentioned, they occupy a no inconsiderable part. The most important is probably the Sprot (*Juncus Lamprocarpus*), which occupies considerable tracts in wet, low-lying parts and sides of mountain streams. Coming early, animals will eat it readily.

When cured it makes excellent winter fodder, and has been recommended by some for ensilage. It is generally mixed in growing with certain grasses, and the creeping White Clover, so much to be met with on arable fields, is often found with it.

A corner of damp land may be very profitably utilised with this plant being grown on it, it makes the best of thatch for cereals and ropes for holding on the thatch, also good litter for animals and a good mixture for farm-yard manure.

The other ones, with the pith in the inside, such as the Common Rush (*Juncus Conglomeratus*), are not so valuable as fodder or manure. The Heath Rush (*Juncus Squarrosus*) may be noticed as of value on dry moors. It grows on very poor soil, and affords a green bite in such situations at almost all seasons.

Of the Wood Rushes, the Great Hairy and Broad-Leaved (*Luzula Sylvatica* and *Pilosa*) are of value where they grow as also affording a green bite at all seasons ; while the Field Wood Rush (*Luzula Campestris*) is a very early growing plant, and if the seeds could be properly collected it might with propriety be introduced into cultivation on dry exposed fields, even in alternate husbandry. It is eaten by stock readily in early spring. The first two are found adjoining rivulets and in woods more than in open pastures, although, if found to be an advantage, there is no doubt but they

could be introduced into any pastures having a moist tendency at least.

Next I shall touch upon a shrub which covers a considerable acreage of the kingdom, Ling of England, Dog Heather of Scotland (*Calluna Vulgaris*)—a plant which has suffered greatly by reclamation, and in the indigenous state of the country must have occupied a very important part in the food of the animals of the time. At the present time it assists as food for hardier breeds of sheep and cattle. It has peculiar habits, being in good condition for food in autumn and winter, when there is a scarcity of seasonable outdoor food; it has considerable nutritive properties for those animals physiologically adapted for it. In some parts in winter cattle in open weather do well when allowed out on to it a few hours daily, while the hardier breeds of sheep will subsist upon it in snow-storm a considerable time.

When this shrub is properly attended to it is one of very considerable value, taking also into consideration the amount of food, shelter, and so on, it affords wild, useful animals; and the agriculture of it also deserves consideration. Much depends on this point as to its value both as a food for agricultural or wild animals, on the moors, being under a sort of rotation, having parts with the plants in different stages of development. There is, also, no doubt but a good deal can be attained by diminishing the area of this plant where too much exists, and introducing others in part, and in some other parts there may be, and most probably is, a propriety of introducing some of it, for it must be always borne in mind that all our natural pastures are susceptible of considerable

improvement. The common native heaths, Cross and Fine-leaved (*Erica Tetralix* and *Cinerea*), fall behind for economic value, although deserving of notice.

Bilberry and Red Whortle or Cranberry (*Vaccinium Myrtillus* and *V. Vitis idea*), along with Red Bearberry (*Arctostaphylos Uva Ursi*) and Black Crowberry (*Empetrum Nigrum*), are all worthy of notice. For, as far as my experience has gone, plants that are left untouched in one part are eaten with avidity in another.

The plants known as Winter Greens, the botanical name being *Pyrola*, which, as the English name implies, are to be found green the whole season, also deserve notice.

I shall now touch upon a family, or genus of plants, from which we derive many of our useful vegetables.

UMBELLIFERS.

The *Umbelliferae*. They are of a large and complicated nature of plants; different plants of different forms of this family being found under many different conditions, so that it is impossible to touch on all having claims of attention. One, Common Parsley, has already been touched upon as being used in the seed market.

I have observed the following plants eaten, but should only be on pastures in small quantities:—Wild Beaked Parsley (*Anthriscus sylvestris*), noticed as being not unwholesome for cattle by M'Gillvray, but he states that it is seldom touched by them, which is not altogether my experience of it. He also states that Cow Parsnip (*Heracleum Sphondylium*), "which would

yield in cultivation a vast amount of herbage, one of the most important plants as food for our domestic animals, although utterly neglected, the stem being sometimes eaten in the Hebrides." I have not seen this plant eaten where I have observed, but should suppose that on rich soil, with a milder climate, it would be of value. The Wild Beaked Parsley is suited for dry soils.

Wild Angelica (*Angelica Sylvestris*) is occasionally cropped, and is suited for wet or damp places, by the sides of rivulets, and so on. These plants are worthy of every consideration, and some of them produce a great amount of seed, so that a person who has seen any good of any of them can, with a little care, easily supply his pastures with abundance of what suits his wants.

Of the many forms I have no doubt but, in the various conditions of agriculture, the plants are as various as will be required before that industry will reach the stage it might do. It only stands to reason, that those plants which show great variation and are suited for one particular condition must give place to another suited for some different condition. All I pretend to do in this genus is to mention some, with the hope that it will be the means of making agriculturists take observation for themselves, for some of these are in most cases to be met with in some way adjoining their premises.

PLANTS BEARING ENGLISH NAMES OF PASTURE PLANTS, &c.

I shall now notice a plant, along with some others, which, although apart from the other plants belonging

to the most useful orders, bear in the English name the term of these orders. From observation, I have seen that these names have been given from their economic properties, and not, as some might suppose, from similarity in structure; one of sentimental fame as well, Scorpion Grass, or Forget-me-not (*Myosotis*). This plant, in wet parts, comes to be eagerly looked after by animals at a particular season in summer, and is of value to be represented in such parts. With the land in its natural state they had formed a very noticeable part, hence the name of Scorpion Grass. I have no doubt the scorpion or dragon fly appears in summer about the time, as far as I have seen, that this plant is most looked after by animals. —

There are several plants of the same order, having economic properties of one kind or another. The lately-introduced forage plant, Prickly Comfrey (*Symphytum Asperinum*), belongs to the same order, viz., Boraginaceae. Grass of Parnassus (*Parnassia palustris*), is similar, both in name and as being used as food by animals, as well as being suited for wet situations.

Buckbean, or Water-trefoil (*Menyanthes trifoliata*), I have observed as of value in similar localities; it has been long a noticed plant. Linnæus informs us that in some parts of Lapland, where it abounds, the people dig up the roots and give it to the cattle, who eat it as their usual food. In the "Flora Medica," by Barton and Castle (edition edited by Jackson), it is stated that it is eaten by goats and sometimes by sheep, and that it is asserted that sheep affected by the disease known as rot are quickly recovered by feeding in meadows where this plant abounds; so that it may be of value where such conditions exist on sheep runs. Cattle eat

it readily in marshes where I have seen it; but, doubtless, sheep-farmers should look after it for their runs. It belongs to the order Gentianaceæ. The Field Gentian (*Gentiana campestris*) represents this order on our dry pastures, and deserves attention.

The order Polygonacæ, from which the Buck Wheat is derived, has not shown much of economic properties where I have observed. Although there are several representatives, the only one which is readily looked after is the Common Knot Grass (*Polygonum Aviculare*), which grows in rather sheltered places, and agricultural animals are fond of it. Still, I have no doubt but in some parts they are worthy of attention.

FINISHING REMARKS ON THIS PART.

I have now touched upon all the plants I intend to do as being noticeable pasture plants, but before finishing this part, I wish to conclude with a few general remarks. A great point, which has hitherto been to some extent detrimental through the kingdom to progress, of this part of cultivation is the tendency, which has been too much followed, to adopt one routine over a wider area than the conditions are such as permit all the various plants to develop properly.

All my enquiry goes to show that the plants that develop fully in any climate under general conditions are the best adapted for food in that locality. But it does not follow that all plants require to develop fully naturally before they can be very suitable pasture plants in any locality.

We have to take into consideration the power which man can exercise on plants on one side, and soil, or even climate, on the other. The latter being changed some-

what by drainage, planting of wood, and so on, so that plants become successfully used in parts where, under natural conditions, they are of no value.

The most extensively used grass, Rye-grass, is an example of this, and most probably a sound reason for pasture being so uniform in large tracts is the fact that other grasses, from having given satisfactory results in one part, have been recommended to be tried in different conditions and found to be unsuited in some other part.

The great point I wish to propound is, that every agriculturist ought to examine around himself and study his own situation, and thus he can make for himself that enquiry which hitherto has been too much left to others, in some cases wholly ignorant, practically, of the agricultural profession.

For example, some of our leading authorities term Wavy Hair Grass or Purple Melic Grass weeds, while there is evidence, both by observation at the present time and by record of previous authorities of the highest standing, that each, in their own place, have their own particular function in the place assigned by Nature for them; and to use the term weed is only to show their own ignorance and too faint conception of the great design of Creation, if not showing a want of even what we receive too much of—book investigation.

For does not Loudon remark of the Sheep's Fescue, "there is apparently not much in it, but it is suited for the physiological structure of the sheep"; and that is the great point.

Now, in the North, Narrow-leaved Oat Grass (*Avena pratensis*) may be termed a weed, although there are grounds for supposing it to be of some value

on rich meadows in milder climates. But others of more general use being abundant, there awaken doubts if it is worth being included in the general list of cultivated grasses.

Timothy, as well as Cock's-Foot, may be termed weeds, but this is where circumstances are wholly unadapted for them, for the term weed has been designated as a plant misplaced. I, therefore, do not profess, in the latter part of my work, to have mentioned all the plants worthy of notice, nor that they may be all worth introduction into the seed trade ; but they have all their economic properties, and those who see the properties of a plant can endeavour to secure seed, and make an experiment for themselves.

I have looked carefully over the "Flora Medica" already referred to, and some plants are said to be eaten by animals, which I have not seen eaten, while others differ. For instance, I have observed cattle look greedily after the Elder, and Linnæus remarks that the leaves are refused by all animals save sheep, while others state that cows eat the leaves eagerly. Thus, the whole thing is, that different plants are used differently in different situations and other conditions. Of some of the plants numerously represented within the field of my observations, and which, as a rule, are untouched by animals, may be mentioned the Speedwells, though, doubtless, in certain parts this cannot be the case, for, in the work mentioned, it is stated that Common Speedwell is eaten by horses, cows, goats, and sheep.

Bed Straws, as a rule, are seldom touched, although in cases of severe drought, I have seen Yellow Bed Straw cropped.

I have not seen Common Lady's Mantle eaten at all, although quite common. This is something worthy of notice, as some have affirmed that it is relished by horses, goats, and sheep, and it has been recommended for cultivation.

Thus there is no doubt but much has yet to be learned as to what can be taken out of the soil, as well as how to apply the various plants so as to get the best value of their properties. The subject being doubtless one of the greatest possible importance, it behoves everyone to do his utmost to promote it, not only amidst the competition as applied to this country with others, but also as universally applied, for it appears that there is an ever-changing condition of things going on at the present time, as taught us by geological investigation, which has gone on from the earliest records of our globe.

INTRODUCED PLANTS.

It is not my intention under this head to enter into an elaborate description of the various plants which are at the present time, or have been, attempted to be brought under the notice of the British agriculturist. As it, however, occurred to me that they are as much under notice, and that it would leave a want of finish about this work if they were not touched upon, I resolved to add a little about them—although I disclaim the same practical inquiry as I claim for the general body of the work—and base my few remarks more on the so-called theoretical than practical enquiry, that is, what is available to be done or attempted, than what has already been accomplished in Britain in this way.

There is, in reality, no other course open, when I

mention that on enquiring for some information from the greatest pioneer of the present age of British scientific agriculture, Sir John B. Lawes, on this subject, his reply was as follows:—"Although I have farmed for more than fifty years, and am well acquainted with British agriculture, I could not point out one new plant introduced into this country which has stood its ground so as to be established as one of the crops of the country."

During past years introduced plants, as a rule, have tended to retard rather than promote advancement in pasture husbandry. The reason is obvious. Some traveller, for instance, observing the qualities of a plant in some other country, takes steps to have it introduced into our own, although the physical conditions of the climates are wide apart from each other.

Often these plants, no doubt, are fairly tried on certain experimental grounds; but these grounds are as often under exceptional care, with experts superintending their growth and development, that the results there are better than can be expected under the general conditions of husbandry, even in a similar climate. One great mistake being that when once such a result is gained the plant is too often advertised for general use, and tried under circumstances where both system of husbandry and climate are beyond its available range of utility, and hence a partial or general condemnation of the plant is the result. The inferior seed scourge, also, often leaves its footprints.

Apart from all this, we have to consider the general situation of our kingdom, its variations, its humid climate, as a whole peculiarly suited for the growth of pasture plants, and that all those growing

naturally form a field for selection and experiment, both nationally and provincially, which ought more particularly to engage the attention of the British agriculturist for some time. I very much question, when all these have been properly sifted, and each assigned its place as regards its physical range and the various conditions of husbandry for which it is suited, if much can remain for introduced plants eclipsing indigenous or natural ones in the pasture of this country. Although some of those mentioned as forage plants might have an exceptional point somewhere over the length and breadth of the various uses for which plants have in one shape or other been utilised in the service of mankind. Often plants whose produce or extracts are of value as condiments, medicines, &c., are attempted, but it will generally be of more advantage to import such, or the useful parts, than cultivate them here—we may quote Fenugreek (*Trigonella Foenum Græcum*) as an example.

The few plants I mean to touch on under this head as being in our seed market are taken from the issues of James Carter & Co., London, who have long occupied a leading position, as well as a moderate one as regards recommendation of plants to the British agriculturist. Personally, I believe that, with the view of forming ensilage or catch crops, some of the more recently introduced and bulky growing plants may obtain at least a provincial footing in our agriculture, but I doubt if any be found of much advantage in the matter of ordinary pasture.

One recently attempted in the latter way, as possessing properties that recommends it for attention, is Japan Clover (*Lispedeza Striata*). A native, it is

believed, of China and the adjoining parts, it found its way to Japan, where it covered many waste places. It was introduced into the United States, where it takes many forms to suit many varieties of situation, and is in that great country said to be much relished by stock. As it grows in any situation, it is as easily introduced, and can be sown in a variety of ways successfully, as ordinary clovers, or sprinkled among the existing herbage on any part where it is intended to be introduced. It is also said to be a fertiliser of the soil, as its long roots penetrate deep into the soil.

Crimson or Italian Clover (*Trifolium Incarnatum*) has been to a small extent in use as a sort of exceptional crop in certain parts of England, but unfitted for general introduction. In favoured parts it can be sown in the autumn and used as green food or hay in the month of June the succeeding year. Being available of being cleared off in time for late turnip sowing, or for allowing the land to be fallowed for sowing wheat or spring corn.

Maize or Indian Corn (*Tea Mays*) has been often, but unsuccessfully, tried for the grain of it. Attempts are being made to grow it for mowing as fodder or ensilage, for which, under a certain limited area and system of treatment, it may give satisfactory results.

Sugar Cane (*Sorghum Saccharatam*) also (*Sorghum Vulgare*) are also being tried. There is no doubt of its qualities as a forage plant, where the climate is not too cold for it. There is absolutely no evidence existing in Britain as to how wide the range is where it can be utilised, but sufficient evidence exists that it can be successfully used in one part. Experiments should be tried in others, so as to define the area over which it might be introduced.

Prickly Comfrey (*Symphytum Asperrium*) has been tried for several years with more or less success; although of late it has been in some measure characterised as being nowhere as a general agricultural plant, still it remains, in some measure, one of utility. Even a plant which can fill a useful place, in some corner otherwise producing weeds, should not be overlooked as being unworthy of notice in regard to raising the value of the produce of the soil.

Serradella (*Ornithopus sativa*), although an annual, is frequently cultivated in Northern Germany on good, light soils, its produce being larger, and its nutritive properties equal to Red Clover. When sown with Hard Fescue, or such grass, cattle like its produce, either as green food or hay. It is sown in the locality mentioned in spring. It can be profitably sown alone, or also along with a corn crop, either Oats or Rye, and furnishes, after the corn crop is removed, a good cutting, or pasturage.

Hungarian Forage Grass (*Bromus inermis*) has great repute on the Plains of Hungary, where, from the dry, sterile nature of the country, so many plants succumb. It is represented as having stood where such plants as Lucerne have been destroyed. It can be cultivated as an annual crop plant or perennial. Is useful for filling up gaps where clover crops have failed. Cattle are said to be fond of it, either in a green or dried state.

ENSILAGE.

During the time that has elapsed since I first published on pasture plants, what was then termed to be generally confined to the experimental farm, that is,

from the sense of amateur experimentalists, who are to be met with in various parts of the world (who, of their own enterprise, give any new, or rather, in this case, newly-introduced, means of utilising agricultural crop a trial), has now become established as a part of British husbandry. Various schemes have been tried to elucidate which is the best way to make ensilage, and various crops at various stages of their development have been tried, to ascertain which, and at what stage, they are best suited for the purpose. It may be said to be a system which will admit of all the various grass, grain, or forage plants cultivated being manufactured into. And what is of great importance, that sometimes crops may be taken to good account by being made into it, when, in a critical season, little use would be got of them.

The information gained from results up to the present time corroborates my views of it, as regards the utilisation of plants peculiarly adapted for it.

But beyond it being established as an advance in our agriculture, it cannot be said to be sufficiently tested to be possible to give anything of an estimate of its value to agriculture, or the various plants that may be judiciously cultivated exclusively for its manufacture, either to be introduced into cultivation for that purpose, or presently cultivated plants grown in a new form for it.

Of the forces at work to curtail the area of arable husbandry, the fall in prices of produce and the deterioration of the soil naturally leads to extension of permanent grass and curtailment of, among others, our most expensive to raise crops, viz., turnips. As regards ensilage, there is no doubt but a certain class

of the taller growing grasses can be grown and very profitably used for ensilage; while cereal, foreign forage, or such old-established plants in our own country as pease and tares, may be grown in part instead of turnips, and secured in summer for winter use.

There is one point I would here wish to point out, as regards both these plants mentioned and any new ones likely to be used, that attention should be paid as to what stage they should be put into the silo so as to give the best results.

I have often observed that plants which are not eaten when growing, nor when cured as hay is cured, but when cut for a day or two and commencing to fade, that cattle or horses have a relish for them at this particular stage.

Beyond the economic value of ensilage, it is also a great scientific discovery, as well as one, when properly elucidated, which will give very important results in our abilities to grapple with Nature, so as to derive the most valuable results in the utilisation and growth of plants of economic value. The fact that excluding the atmosphere from cut plants enables them to retain the most valuable part of their feeding properties, in my judgment goes a long way to show the value of the atmosphere in plant growth, and the study of the relation of the atmosphere, both to plant growth and crop preservation, to be a very essential point in husbandry.

Any additional information that has of late been brought out goes on to show that ensilage can be made of best value with a proper mixture; and what is the best mixture, or the best available, is yet to be discovered. While every division of the

country has its own system of husbandry and its own peculiar characteristics, it would be invidious to say what peculiar advantages would be gained from the general use of it.

Over large tracts too many turnips are cultivated, and it is generally allowed that they are not all grown to profit. The land has in a measure tired of growing them. In many parts there is not sufficient season to get them all properly sown, while it is as often the case that a considerable number are destroyed, or, to say the least, partially so, by unseasonable exposure, and, when required, are often pulled when the land is covered with snow or environed with severe frost.

Ensilage affords a remedy, or partially so, for this, by having part of what was once turnip area laid down in crop suitable for it, and having it secured so as to be in a measure independent of the weather in winter—thus both mitigating the danger of exposure to weather and forming what has been pronounced to be a beneficial mixture of food for farm stock. It now being admitted that in large turnip growing districts too much use has been made of them for deriving the best benefits, these two-fold considerations are sufficient to give ensilage a prominent place in British agriculture. On a hay-growing part, where the season often turns out such as it is impossible to secure it all in good season, it also forms a means of securing a part in valuable order, when in the uniform method of hay-making a considerable part is always in such unfavourable years more or less damaged.

There are many plants which might well be tried in this light as valuable to be manufactured into it. There is the crop of the Perennial Meadow, the Annual

Cereal, and the plants which could be grown in a shorter time than cereals require to ripen, so as to admit of sowing late and ensiling early, as not to interfere with harvest operations; or in some parts a crop may be reaped and an aftermath ensiled, every part as to its conditions yielding in best form the fruits of the earth.

HOW TO USE THE GRASSES.

Rye Grass used alone, - - - - - 36 to 48 lbs. per acre.

To be diminished in proportion as others are used.

Italian, loam soil and moderate climate, mixed with Rye,
4 to 12 lbs. per acre.

Pacey Rye on loam with above two, - 4 to 6 lbs. per acre
" on sandy or dry open soil, with Rye, 4 to 12 lbs.
per acre.

Meadow Fescue, equal weight as Rye if tried alone. As a
mixture on any soil, 1 lb. and upwards according to cir-
cumstances, 4 to 5 lb. an average per acre.

Yellow Oat Grass, any soil, - - - - 1 to 8 lbs. per acre.

Hard Fescue, dry soils, - - - - - 2 to 8 lbs. per acre.

Tall Fescue, stiff clay soil, - - - - 1 to 4 lbs. per acre.

Rough-stalked Meadow Grass, clay loam and clay, $\frac{1}{2}$ to
3 lbs. per acre.

Smooth-stalked Meadow Grass, for sandy and dry open
soil, $\frac{1}{2}$ to 2 lbs. per acre.

Crested Dog's-Tail, any soil, - - - - $\frac{1}{2}$ to 2 lbs. per acre.

Vernal Grass, - - - - - 1 oz. to $\frac{3}{4}$ lb. per acre.

Meadow Foxtail, loam and clay, - - 1 to 3 lbs. per acre.

Cock's-Foot, loam, clay, sandy loam, - 1 to 2 lbs. per acre.

Timothy, loam, - - - - - 1 to 2 lbs. per acre.

The last three when for permanent meadow in about
equal quantity.

Others, when used generally in small quantities. These
weights can only be approximated. In mildest parts the
tall ones more lavishly, and in the coldest parts more
sparingly, and so on according to circumstances.

MIXTURES OF THE CLOVERS.

Red Clover, - - - - - $2\frac{1}{2}$ to 4 lbs. per acre.

To be diminished as others are introduced.

Cow Grass, on any soil, - - - - - 1 to 2 lbs. per acre.

Alsike, on all soils where Red is not inclined to hold—clay on one side and sand on the other—and in many cases for a mixture, - - - - - from $\frac{1}{2}$ to 2 lbs. per acre.

White Clover, generally always along with Red, from 1 to 2 lbs. per acre.

On many soils the seed of the latter lie and germinate on the ground when it is put in grass, in which case little need be sown. On clay soil, Alsike should mostly take its place, and some of the others, such as—

Greater Bird's-Foot Trefoil on clay and moist soil, $\frac{1}{2}$ to 1 lb. per acre.

Common Bird's-Foot, dry soil, - - - $\frac{1}{2}$ to 1 lb. per acre.

Yellow Trefoils, either if used, - - - $\frac{1}{2}$ to 1 lb. per acre.

Other plants when used, such as Yarrow, Spear-leaved Plantain, &c., generally in small quantities, from $\frac{1}{2}$ oz. per acre upwards.

These clovers, &c., must be used in quantity in a measure according to existing circumstances.

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For Foot-rot in Sheep.
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