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TOOGOOD'S TREATISE

ON

PASTURES

AND

PASTURE PLANTS

WILLIAM TOOGOOD

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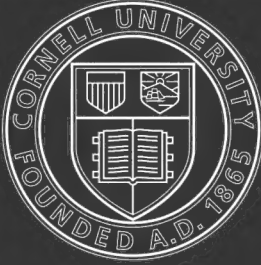
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PASTURES
AND
PASTURE PLANTS



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Directors { WILLIAM G. TOOGOOD,
E. KEMP TOOGOOD, F.R.H.S.

PASTURES
AND
PASTURE PLANTS

BY
WILLIAM TOOGOOD

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PREFACE

IN the compilation of a treatise on any craft, the recorded experience of great authorities must of necessity be consulted, if not, to some extent, form the basis of such treatise ; and though we have striven in the pages following to concisely summarise chiefly our own experiences in pasture-making from carefully kept records covering nearly 100 years' work, we have great pleasure in specially acknowledging our indebtedness to the following works :—

1. The scattered writings of Mr. William Carruthers, F.R.S., F.L.S., the accomplished consulting botanist to the Royal Agricultural Society, who unites to Sinclair's exact knowledge of pasture plants probably the most precise and extended acquaintance with English pastures ever yet attained, and to whose kindly and untiring courtesy is due much of what merit may lie in this manual.

2. The scattered writings of Sir John Bennett Lawes, F.R.S., LL.D., of Rothamsted, whose profound knowledge of the subjects he has made his own is equalled by his willingness to impart information, and to whom also we owe much special and invaluable help.

3. The works, especially *The Best Forage Plants*, a laborious and singularly accurate translation from the German by Mr. A. N. McAlpine, B.Sc., botanist to the Highland and Agricultural Society of Scotland, and *Les Mélanges de Graines Fourragères*, done into French by M. C. Denaiffe, of Dr. G. Stebler, whose long experience as Director of the Swiss Experiment and Seed Control Station enables him to speak with special authority on forage plants and their seeds, and whose esteemed and kind assistance we gratefully acknowledge.

4. G. Sinclair's *Hortus Gramineus Woburnensis*, still our standard work.

5. *Die Natiirlichen Pflanzenfamilien*, by M. Eduard Hackel, of which a translation has been made by Mr. F. Lamson-Scribner.

6. M. Gustave Heuzé's *Les Paturages, Les Prairies Naturelles et Les Herbages*, an excellent work published by La Librairie Agricole de la Maison Rustique, Paris.

7. *The Nutritive Value and Produce of some Permanent Grasses*, by Mr. D. Wilson, M.A., F.C.S., a most important memoir, published in the *Transactions of the Highland and Agricultural Society of Scotland*.

We have also pleasure in acknowledging the courteous help given by the following in the matter of engravings: Messrs. Vilmorin-Andrieux and Cie., Paris; Messrs. Macmillan and Co., Ltd., London, engravings of (1) Spike of Ergotised Rye, page 11, (2) Seeds of Clovers and Dodder, page 27, and (3) Dodder, page 28: all engraved by Mr. Worthington Smith, whose valuable work, *The Diseases of Farm and Garden Crops*, will be known to many of our readers; La Librairie Agricole de la Maison Rustique, Paris, for illustrations of (1) Dodder, page 23, and (2) Broom Rape, page 28; and the U.S.A. Department of Agriculture for illustrations of home-made germinators (Year-book of 1895, Mr. A. J. Pieters).

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PASTURES AND PASTURE PLANTS

CHAPTER I

CULTURAL PREPARATIONS

SOIL

Soil Requirements.—Generally speaking, heavy loams and most clays are especially adapted for the production of profitable pastures ; but good results can be obtained by sowing judiciously composed mixtures of seeds on almost any drained lands, excepting loose sand and poor gravels, provided they be well prepared and in fertile condition. The absolute essentials for the success of a pasture are good drainage, thorough tillage, abundant manuring and freedom from noxious weeds.

PREPARATORY DRAINING

Necessity for Drainage.—As few fodder plants endure stagnant water, drainage must be considered a necessary preliminary to forming pastures on all clay or peat soils in which the best natural grasses do not thrive : for no matter what expense be incurred in the seeding and after-management of a more or less sodden pasture, sooner or later the more nutritive and productive plants will be replaced with worthless sedges, mosses, &c.

The presence of stagnant water makes the land very cold by evaporation, and so neutralizes the beneficial influence of solar heat on vegetation, besides preventing the necessary percolation of air and water in the soil. As a consequence, vegetation starts late in spring and becomes dormant early in water-logged soils, on which, too, the treading of cattle is most injurious to the young shoots of pasture plants.

In brief, it is absolutely essential to the well-being of the best pasture plants that the soil in which they grow should not be too wet.

The Drains.—The length and depth of the drains, as well as the size and nearness of the pipes, are dependent on local peculiarities of soil, climate, &c. ; but it is necessary that each should have a good fall, and not be made longer than is absolutely required. All small branch pipes must be obliquely jointed to the main drains, and not carried into them at right angles. The usual depth is about 3 feet, the rows of pipes being laid some 15 feet apart. The outlets need examining regularly and frequently.

Surface Draining.—When no fall for the pipes is obtainable, damp pastures may be much improved by surface-drains or gutters to carry off surplus flood waters.

PREPARATORY CULTURE

Preceding Crops.—Though a summer bare-fallow permits of successive crops of indigenous annual weeds being most conveniently and effectually destroyed, and also allows plenty of time for thorough tillage, it is seldom that one can be afforded; and the next best preparation is undoubtedly a well manured and hoed root-crop, folded on the land with cake-fed sheep, or a potato crop, the latter being especially desirable to precede autumn sowings. Cereals are less satisfactory, as they leave the land more or less hard, infested with weeds and exhausted of nourishment, although they are harvested earlier than roots, and therefore give more time for preparation. Though undesirable in practice, it is sometimes necessary for a mixture of pasture seeds to follow grasses or grasses and clovers, or for a clover or Sainfoin ley to be converted into permanent pasture.

Deep Tillage.—When surface and subsoils are of almost the same character, deep autumn tillage is desirable; since it not only exposes a greater depth of soil to the disintegrating effects of the atmosphere and natural elements, so opening up stores of plant-food previously inaccessible, but it enables the roots to ramify more deeply, and consequently to endure greater drought; while permeable land also permits excess of moisture to drain away, thus minimising the injury due to very wet seasons.

Object of Preparation.—Apart from enriching the soil, the chief aim of cultural preparation is to produce a fine, firm and level seed-bed. Since few grass seeds germinate at a greater depth than half-an-inch, it is obvious that on a cloddy, ill-prepared surface many of the smaller seeds are utterly lost by being buried too deeply; while those which remain upon the clods vegetate only for the plants to die. A loose soil is equally hurtful, as the delicate seedlings fail to obtain a good root-hold, and thus many perish.

Preparation after Roots.—Immediately the land is free, it must be deeply ploughed, and afterwards thoroughly manured before being ploughed again and laid up rough for the winter, to secure the utmost possible disintegration of its particles by the minute expansion and contraction of the moisture with which the soil is charged, consequent on alternate freezing and thawing. As soon as possible in February or March, it should be crumbled with harrow and roller until a friable, firm and level seed-bed is obtained; and if this can be secured sufficiently early to safely permit of sowing being deferred for a short time, the annual weeds which spring up can be destroyed by a final turn of the harrow.

Preparation after Potatoes.—Couch should be collected and burned at the time an early crop of potatoes is dug; and the land must be made friable and firm by persistent use of the harrow and roller preparatory to autumn sowing.

Preparation after Cereals.—As soon as possible after harvest the stubble should be broken up and cleaned; and when sufficient time has elapsed for annual weeds to start into growth and be destroyed with a harrow, a heavy dressing of dung must be applied, previous to ploughing up the land roughly for the winter. The spring preparation is identical with that already described.

Preparation after Pastures.—While an old sward can be turned under, and another sowing may follow after a few days preparation, this

method is not desirable, as it does not allow time for thorough tillage ; and it is a better plan to take a part-fallow by paring the turf after the second cutting, and some days later harrowing, manuring and ploughing the field. Where paring is not practised, the first ploughing ought to be sufficiently deep to bury the turf well ; and, as a general rule, paring and burning are only advantageous when the pasture overlies a good depth of peaty or clay soil. After successive crops of annual weeds have been killed by dragging and scarifying, the land must be again manured and ploughed up roughly in autumn. If the turf be turned in at once after the hay crop, and the land be heavily manured and sown with vetches or maize, the green fodder need not be cut for 5 or 6 weeks, during which period the old turf rapidly decomposes, making the necessary subsequent tillage more easy of accomplishment.

Converting Old Leys.—When it is desired to convert a clover or sainfoin ley into permanent pasture, the field must be heavily dragged with harrows in autumn, a top-dressing of compost or rich manure being applied in early winter as a preparation for an early sowing of strong-growing seeds.

PREPARATORY MANURING

Necessity for Manure.—Since the nutritive elements of top-dressings applied to pastures are absorbed by the superficial layers of soil, it is obviously impossible to supply fertilizers to lower depths after the pasture is once formed without adopting the costly system of raising turves and burying dung beneath them ; and as we cannot expect profitable returns year after year without liberal manuring, sufficient should be applied when the land is prepared to last the lower layers for a long period.

Manure to Use.—Considering both the chemical constitution and mechanical structure of soils generally, good farmyard manure produces and preserves the physical conditions most favourable to the formation of profitable pastures. For heavy land, long straw-containing qualities are most to be desired, while light soil requires the shorter, decayed manure.

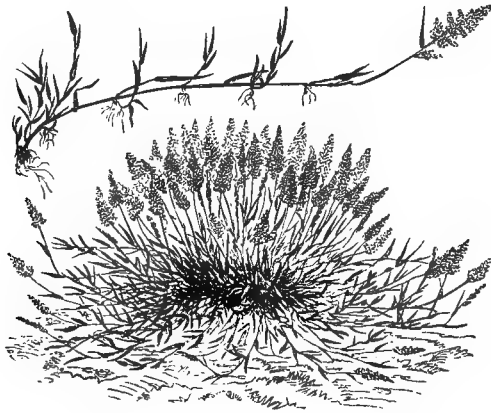
Method of Application.—For spring sowings the best method is to apply the manure immediately before the land is ploughed and laid up rough for the winter ; since it then decomposes sufficiently in the intervening period to provide suitable nourishment for the young plants. If manuring has to be deferred until spring, it should be completed as early as possible, in order that the land may be somewhat enriched before seed-time.

CHAPTER II

OUR PASTURE GRASSES

AGROSTIS—BENT-GRASS

Creeping or Stoloniferous Bent-Grass; Fiorin-Grass (*Agrostis alba*, var. *stolonifera*).—Perennial, with long creeping stems, which root at the nodes and form a compact, felted “bottom-grass”; flowering towards the end of July; and ripening seed in August. The fodder from suitable soils is nutritive, and is eaten, though not relished, by stock; but the plant becomes wiry, unproductive and disagreeable on dry lands. It starts late in spring; develops rapidly, attaining almost to its maximum yield the first year;



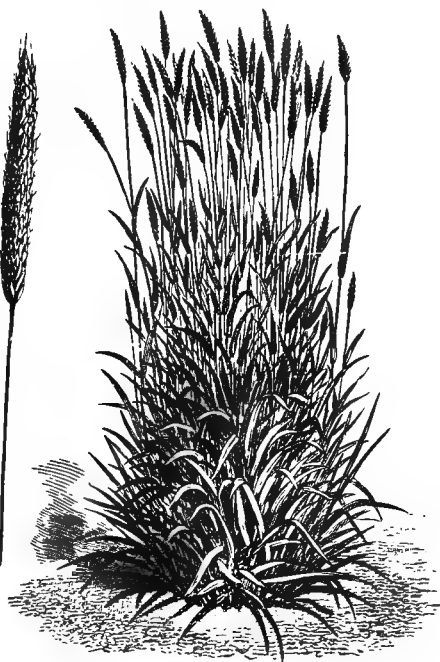
FIORIN.
(*Agrostis alba*, var. *stolonifera*.)

luxuriates on moist soils; and does well under irrigation. Uninjured by cold, this grass continues to grow until winter, and is often grazed so late as December. In this late growth is its only value. The ordinary hay crop is small, the principal produce being obtained at the second cutting or as late pasturage. The following yields per acre have been recorded:—Pinkert, in Germany, 4,400 to 8,800 lbs. of hay per acre; Vianne, 6,290 lbs.; and Sinclair, at the time of flowering, 17,696 lbs. of green, or 7,742 lbs. of dried,

produce, with 2,722 lbs. of aftermath. The seed, which requires special care in sowing owing to its small size, is saved from wild plants; and is often adulterated with those of Brown bent-grass (*Agrostis canina*), Tufted hair-grass (*Aira cæspitosa*) and Spreading wind-grass (*Apera Spica-venti*). Fiorin is apt to get the mastery in a field, and to destroy other more desirable grasses. Indeed, the very poorest pastures in this country are made up almost entirely of this grass, which should be omitted altogether from mixtures of pasture seeds. The creeping roots become exceedingly troublesome weeds in arable land.

ALOPECURUS—FOXTAIL-GRASS

Meadow Foxtail-Grass (*Alopecurus pratensis*).—Strictly perennial, untufted, generally forming short underground stolons; flowering in April, May and June; and ripening seed during June and July. The sweet-tasted produce, both green and dried, forms nutritious and much relished food for all stock. Sharing with Sweet-scented vernal the quality of being the earliest of fodder-grasses in spring, it gives a small crop the first season, attaining to full maturity only the third year; withstands the most extreme cold; grows well under trees; is one of the most valuable “top-grasses”; yields abundantly; and succeeds best in good soils containing humus, especially in clays and rich, moist, sandy loams, from which 3 crops a year can be taken, the lattermath being specially large. It soon dies out from poor and dry lands; and though adapted for moist situations, and consequently for irrigation, it will not endure stagnant water. Sinclair secured, at the time of flowering, 20,418 lbs. of green, or 6,125 lbs. of dried, produce per acre on clayey loam; and Vianne records 28,026 lbs. green fodder, or 8,932 lbs. hay, from 2 cuttings on an acre of fertile loam. The harvesting of fine seed is difficult, as the spikes ripen unequally; and it is generally necessary to strip it by hand before carefully drying it in an airy place. Moreover, the seed is often seriously destroyed by the larvæ of a small fly. Slender foxtail-grass (*Alopecurus agrestis*), Yorkshire fog (*Holcus lanatus*) and Creeping soft-grass (*Holcus mollis*) seeds are frequently used as adulterants. The first-named impurity is somewhat difficult to distinguish. Good seed should have about 65 per cent. of germination and 95 per cent. of purity, 10 lbs. being



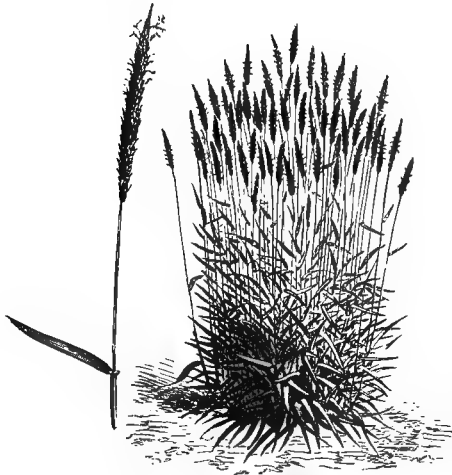
MEADOW FOXTAIL-GRASS.

(*Alopecurus pratensis*.)

required per acre. This grass may well form one-eighth part of all mixtures for permanent pasture; and it is most desirable for leys which are intended to last for 3 years and upwards. Manure of any kind is very beneficial.

ANTHOXANTHUM—VERNAL-GRASS

Sweet-scented Vernal-Grass (*Anthoxanthum odoratum*).—Perennial, forming compact tufts of “bottom-grass”; flowering in April; and perfecting seed during June. Comparatively poor in nutritive value and bulk of produce, this is the earliest of fodder grasses in spring; is almost unaffected by drought, cold or excessive wet; luxuriates under the shade of trees;



SWEET-SCENTED VERNAL-GRASS.

(*Anthoxanthum odoratum*.)

succeeds best on moist sandy loams, though found in pastures on all kinds of land, even in the driest situations; and is neglected by stock, so that the flower-culms are often to be found in quantity in autumn. The autumn growth is less luxuriant than that of spring, but new shoots are thrown up soon after each cutting. According to Sinclair, a brown sandy loam, with manure, yielded per acre, at the time of flowering, 7,827 lbs. of green, or 2,103 lbs. dried, produce, with 6,805 lbs. of aftermath. True seed is gathered from wild plants in the forests of central Germany, but that of Puel's Vernal-grass (*Anthoxanthum Puelii*), a worthless annual variety to which it bears a close resemblance, is usually substituted for it in commerce.

Wavy mountain hair-grass is also employed as an adulterant. Good seed should have 60 per cent. of germination and 95 per cent. of purity, 13·7 lbs. being required per acre. Though cattle eat its bitter foliage only from necessity, Sweet vernal-grass, imparting as it does a pleasant aroma to hay, may be used in mixtures of seeds for permanent and temporary pastures on dry soils, where better grasses do not succeed.

AVENA—OAT-GRASS

Tall Oat-Grass; False Oat-Grass (*Avena elatior*; *Arrhenatherum avenaceum*).—Perennial, forming large, loose tufts; flowering in June and July; and maturing seed towards the end of July. An early and valuable “top-grass,” this withstands drought; gives from 2 to 4 cuttings yearly in good soils; yields well the first season, attaining to its maximum produce the second year; and thrives on warm loams, good clays and deep soils generally, though too much moisture destroys, while poor land stunts, the plant. Though not an enduring perennial, it ripens tolerably early, and so resows itself. The somewhat bitter herbage is not readily eaten by cattle,

unless mixed with other grasses, but it readily dries and keeps well as hay. It must be cut early, since the flower-culms soon harden. The following yields have been recorded :—Sinclair, at the time of flowering, 17,015 lbs. green, or 6,380 lbs. dried, produce, with 13,612 lbs. aftermath, from an acre of loamy clay ; Pinkert, from 2 cuttings, 6,340 lbs. of hay ; Sprengel, 8,800 lbs. ; and Karmrodt, 9,940 lbs. as an average for four years. The seed crop is harvested like a cereal ; and to prevent loss, it is customary to cut the plants early with a scythe, the sheaves being dried, and then matured under cover. Rye brome (*Bromus secalinus*) and Darnel (*Lolium tremulentum*) are used as adulterants. Good commercial seed should have about 80 per cent. of purity and germinating power, 54 lbs. being required to sow an acre. It is a useful fodder grass ; and may with advantage form up to a fifth part of mixtures of seeds for temporary pastures on suitable warm soils. Italian rye-grass is to be preferred to it only for leys of one year duration. Manuring is very beneficial.

Bulbous-rooted oat-grass (*Arrhenatherum elatius*, var. *bulbosum*),—a variety of the common False oat-grass, is distinguished from it by the short internodes at the bases of the culms swelling out into rows of tubers. Principally found on moist sands and loams, it constitutes one of the most pernicious weeds of arable land. Since both varieties are reproduced true from seed, irrespective of the nature of the soil in which

they are grown, it is obvious that this is not, as sometimes supposed, merely the form assumed by *Avena elatior* under certain conditions.

Yellow Oat-Grass (*Avena flavescens* ; *Trisetum flavescens*).—Perennial, forming loose tufts ; flowering in the first fortnight of July ; and maturing seed at the beginning of August. Though quickly stunted by stagnant water or very dry and poor ground, this grass grows well in all situations, from irrigated meadows to dry, upland limestone pastures, succeeding best, how-



TALL OR FALSE OAT-GRASS.
(*Avena elatior*.)

ever, on good calcareous soils and marls, or on sandy loams, better quality clays and other lands rich in humus, especially where recently limed or marled. It starts into growth tolerably early; vegetates freely, giving a crop



YELLOW OAT-GRASS.
(*Avena flavescens*.)

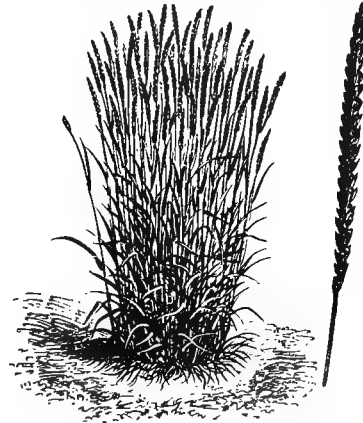
the first season; and may be relied on to yield 2 good cuttings of nutritious fodder yearly, the second being very productive. Mr. Carruthers says it is to a large extent rejected by stock, and is therefore not a desirable element in a pasture. From an acre of clayey loam Sinclair secured, at the time of flowering, 8,167 lbs. of green, or 2,859 lbs. of dried, produce, with 4,083 lbs. of aftermath; while Vianne obtained 5,020 lbs. of hay from an acre of medium fertile soil. Owing to the difficulty and expense of harvesting the seed of Yellow oat-grass, that of Wavy mountain hair-grass (*Aira flexuosa*) or of *Calamagrostis arundinacea* is commonly substituted for it in commerce, but either deception is easily detected under

a lens. Good seed should have about 70 per cent. of purity and 60 per cent. of germination, 11 lbs. being required to sow an acre. It is not adapted for sowing alone, but is sometimes sown in conjunction with other grasses for permanent and temporary pastures. Autumn dressings of farmyard manure are profitable.

CYNOSURUS—DOGTAIL-GRASS

Crested Dogtail-Grass (*Cynosurus cristatus*).—Perennial, growing in small tufts, occasionally rooting at the nodes of the stems, and capable of forming a complete sward if sown sufficiently thickly; flowering at the end of June; and ripening seed about a month later. This enduring and highly nutritive, though not very productive or palatable, “bottom-grass” abounds in the richest and best of natural pastures, though it appears disliked by cattle, while sheep neglect it and permit it to run to seed in autumn except in closely eaten pastures. It luxuriates in well-drained, irrigated lands and in moist soils rich in humus; grows well everywhere, excepting in very wet or sour ground and loose sands; is chiefly desirable for elevated mountain pastures; is better adapted for grazing than mowing; resists cold and shade; and withstands extreme drought, owing to the depth of its root-system. Vegetating moderately early only, it attains to its full development in the second and third years; and gives a good aftermath if cut when in flower, at which period its nutritive value is highest. The flower-culms, which soon harden and are

then rejected by stock, can be partially kept down by early grazing ; but those that are left standing ripen and shed seeds copiously if not cut with a scythe. At the time of flowering, Sinclair obtained 6,125 lbs. of green, or 1,837 lbs. of dried, fodder, with 3,403 lbs. of lattermath per acre from a manured brown loam ; and Vianne secured 2,700 lbs. of hay from an acre of fertile soil. Stebler says that the seed-crop should be taken when the seeds can easily be rubbed out, as they germinate badly if cut too early ; and when mown too late, much of the produce is lost. Yorkshire fog (*Holcus lanatus*) and Capillary sheep's fescue (*Festuca ovina capillata*) are common impurities. Good commercial samples should have 95 per cent. of purity and 75 per cent. of germination, 18.9 lbs. being required to sow an acre. Crested dogstail may be added to mixtures for upland permanent pastures and meadows, and also to those intended for leys of 4 or more years' duration. It is an exceedingly valuable grass for permanent lawns, to produce which it may be sown pure. Manures of all kinds are beneficial. Deer appear to relish its herbage ; and the ripened culms are sometimes employed in the manufacture of straw bonnets.



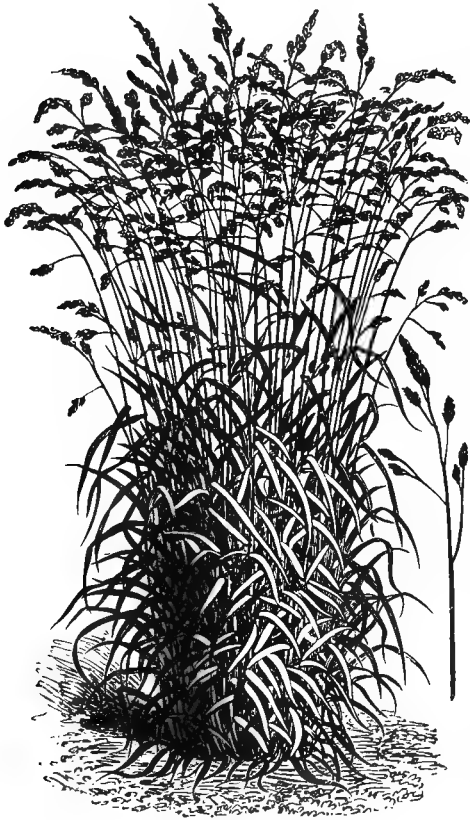
CRESTED DOGSTAIL-GRASS.
(*Cynosurus cristatus*.)

DACTYLIS—COCKSFOOT-GRASS

Cocksfoot-Grass ; Orchard-Grass (*Dactylis glomerata*).—Perennial, forming cushion-like tufts ; flowering from June till August ; and maturing seed from July. Starting into growth tolerably early in spring, yielding moderately the first season, and attaining to its maximum the second or third year, this is one of the hardiest and best of "top-grasses." It gives two cuttings annually ; grows well under trees and in the shade ; succeeds on all soils excepting poor sands and heaths ; luxuriates in moist and deep, good lands which are rich in humus ; is little affected by drought or winter cold ; thrives under irrigation ; and produces excellent green fodder and hay, relished alike by horses, cattle and sheep. After being cut, it rapidly throws up new herbage ; and it is considered to yield the most nutritive aftermath of any grass. The following yields per acre are recorded :—Sinclair, at the time of flowering, 27,905 lbs. green, or 11,859 lbs. dried, produce, with an aftermath of 11,910 lbs., on rich, sandy loam ; Pinkert, 3,520 lbs. of hay ; and Vianne, 15,570 lbs. from a light, moist and fertile soil. Cocksfoot is generally grown alone, or with clovers only, for seed production. Hard fescue-grass and Meadow fescue-grass are common impurities. Good commercial qualities should have 85 per cent. of germination and 90 per cent. of purity, 24.2 lbs. being required per acre. Owing to its tufted growth, it is not adapted for sowing alone, but up to 15 per cent. may be used in mixtures of seeds for permanent pastures and leys of three or more years duration. Stebler mentions Perennial rye-grass, Meadow foxtail, Timothy and clovers

as being specially suitable for sowing with it ; and he advocates only a small proportion being used at first, in order to allow the other grasses to develop, additional Cocksfoot being sown later. Grazing cattle sometimes uproot the tufts of grass, especially during periods of drought, though Sinclair observes

that the herbage, when suffered to grow old, loses half its nutritive worth, and that it is therefore more valuable for depasturing than for hay. Rank tufts, which grow beside unspread droppings and are therefore rejected by stock, must be cut with a scythe. Manuring is most profitable.



COCKSFOOT-GRASS.
(*Dactylis glomerata*.)

FESTUCA—FESCUE-GRASS

Tall Fescue-Grass (*Festuca elatior* ; *Festuca arundinacea*).—Very enduring perennial, growing in large tufts, and sometimes stoloniferous ; flowering in July ; and ripening seed at the end of August. Of somewhat rank habit, Tall fescue-grass produces foliage very early in spring ; is highly productive and nutritive ; is relished by cattle ; makes good quality hay, a little coarser than that of Meadow fescue ; and is specially adapted for rich, moist soils of tenacious clayey nature, moist pastures near rivers and the sea-shore, damp, shady woods, and similar positions where ordinary pasture grasses do not flourish. Sinclair obtained, at the time of flowering, 51,046 lbs. of green, or 17,866 lbs. of dried,

fodder, with 15,654 lbs. of green and succulent aftermath, from an acre of black, rich loam. It is a valuable variety for permanent pastures for grazing on low-lying, medium and strong loams, as well as on undrained clays. The objection to its use is its tendency to attacks of Ergot when in flower. The seed, which is usually sterile when produced in this country, and of which 52 lbs. are required to sow an acre, is a little larger than those of Meadow fescue-grass and Perennial rye-grass, being distinguished from them with difficulty. Good average commercial qualities should have 90 per cent. of purity and germination.

The bluish-black, curved or horn-like growths, or grains in the spikes of certain cereals and grasses, known as Ergot, are produced by the fungus *Claviceps purpurea*, being, indeed, the sclerotia or resting-spores in which the

fungus perennates over winter. In this country *Claviceps purpurea* has been reported as parasitic on Rye (*Secale cereale*) and Wheat (*Triticum sativum*), and on Timothy, Meadow foxtail, Sweet vernal, Cocksfoot, Tall fescue, Meadow fescue, Perennial rye-grass, Fiorin and various other grasses found in our pastures. The terrible muscular contractions and gangrenous diseases



TALL FESCUE-GRASS.
(*Festuca elatior*.)



SPIKE OF ERGOTISED RYE (CORN).
(*Secale cereale*.)

caused by partaking of Ergot are too well known to need description here. They result from poisonous agents contained in the Ergot grains, principally Cornutin, an alkaloid producing contraction of the uterus, and Sphacelic acid, a resinous substance giving rise to gangrene, and producing in large doses strychnine-like cramp, and tetanus of the uterus. Ergotised grass is especially harmful to stock when the uterus is nearly ready to discharge its contents.

The fungus is supposed to abound chiefly in damp situations, so that good drainage is probably beneficial. When the flower-spikes of grasses are ergotised, they should be cut with a sharp scythe, the resulting produce being raked together and burned to prevent abortion being caused by stock consuming it. Mr. Worthington Smith says: "In districts notoriously subject to Ergot the scythe may be used in a similar manner at the flowering time of grasses, for as the spores of *Claviceps* attack the young flowers, it is obvious that the Ergots will be many or few according to the number of grass flowers."

Meadow Fescue-Grass (*Festuca pratensis*).—Perennial, forming compact tufts; flowering at the end of June; and ripening seed during August.



MEADOW FESCUE-GRASS.
(*Festuca pratensis*.)

One of the best grasses for grazing or mowing, Meadow fescue constitutes a great proportion of the herbage of our most valuable natural pastures; commences to grow very early in spring; yields three productive cuttings of nutritious and grateful fodder annually in favourable soils and seasons; is uninjured by winter cold in suitable situations; resists moderate drought; grows well on all soils rich in humus; luxuriates in rich, moist lands in humid climates; and thrives under irrigation. The plant endures grazing very well; gives a moderate yield the first season, its maximum produce being attained in the second and third years; and becomes stunted on poor, dry or shallow soils. Sinclair obtained 13,612 lbs. green fodder, or 6,466 lbs. hay, from an acre of fertile peat; and the following yields of hay per acre have been recorded:—Vianne, 6,030 lbs. the first, and 10,340 lbs. the second, year from a loamy soil; Pinkert, 4,930 lbs. at two cuttings from stiff sandy loam; and

Sprengel, an average of 4,400 lbs. Sinclair says that in point of early produce in the spring, this grass stands next to Meadow foxtail, and is superior to Cocksfoot; and he adds that: "It makes excellent hay, and though a large plant, the leaves or herbage are succulent and tender, and apparently much liked by cattle, as they never form rank tufts, which is the case with the larger grasses." Seed is easily harvested, and should be saved from the first cutting. Commercial qualities often contain 50 per cent. of Perennial rye-grass, the adulteration being very difficult to detect without long practice. The grass should be cut before the flowering period, as it soon afterwards becomes

hard, and decreases in value. Good seed has about 95 per cent. of purity and germination, some 41 lbs. being required per acre. Cultivated alone only for seed-production, Meadow fescue is a most valuable ingredient of mixtures for permanent pastures and alternate husbandry, though not adapted for "clover-grass," or very short leys. Stebler says that for irrigated lands and for meadows it can form 20 per cent., or even more, of the whole mixture; and for short leys, rarely more than 15 per cent. It benefits from applications of farm-yard manure.

Sheep's Fescue-Grass (*Festuca ovina*).—Perennial, of compact and dense tufted growth; flowering early in June; and ripening seed about the middle of July. Though comparatively very small in size and yield, Sheep's fescue possesses the important and valuable qualification of thriving on poor sands and in dry, rocky pastures, where other fodder grasses do not grow, while its root-system is so extensive as to materially improve the land. It flourishes on silicious and shallow soils, dying out in wet situations; resists extremes of drought and cold; yields hay of medium quality; attains to its maximum in the second and third years, giving only an insignificant produce the first, and commencing to deteriorate the third, season. Cattle do not care for its herbage, which, if grazing be not commenced early, soon becomes so hard as to be disliked even by sheep, which otherwise eat it readily. During favourable seasons it continues to grow until the winter. At the time of flowering, Sinclair obtained 5,445 lbs. of green fodder, with an aftermath of 3,403 lbs., from an acre of light sandy loam; while Burger secured 1,280 lbs. of hay per acre. The seed is easily harvested, and is consequently cheap, but it is sometimes adulterated with those of Wavy mountain hair-grass (*Aira flexuosa*) and Purple Melic-grass (*Molinia caerulea*). Good commercial qualities should have 90 per cent. of germination and purity, about 15.5 lbs. being required per acre. As the tufted habit of the plant unfits it for sowing alone, Stebler recommends, for use in conjunction with it, Kidney-vetch (*Anthyllis vulneraria*) on very poor soils, and White clover, Smooth-stalked meadow-grass and, perhaps, Timothy for better sandy lands. Used sometimes in small proportions to form "bottom-grass" for permanent and temporary pastures on good soils, it occupies the place of more productive varieties in such situations, its great value lying in its desirability for grazing on light, dry lands. Its slender, dark green foliage and close growth adapt it for lawns and ornamental grounds. A manured soil is beneficial.

Fine-leaved Sheep's Fescue-Grass (*Festuca ovina tenuifolia*).—A densely tufted perennial grass, only suitable to sow with other varieties as a "bottom-grass" for ornamental purposes, on lawns, etc., especially in shady



SHEEP'S FESCUE-GRASS.
(*Festuca ovina*.)

places, where its fine foliage maintains its dark green colour during very hot and dry weather.

Hard Fescue-Grass (*Festuca ovina*, var. *duriuscula*).—Perennial, of tufted growth; flowering in June; and ripening seed about the middle of July. The principal agricultural difference between this grass and ordinary Sheep's fescue is its greater productiveness. It flourishes in almost all soils and situations, thriving alike in light, dry land and irrigated meadows; resists drought better than many varieties; endures shade; retains its verdure during the most severe winter weather; is relished by sheep, and not disliked by cattle; and is one of the most valuable of the dwarf-growing "bottom-grasses." Vianne obtained 4,180 lbs. of hay per acre; and Sinclair records a yield, at the time



FINE-LEAVED SHEEP'S FESCUE-GRASS.
(*Festuca ovina tenuifolia*.)

HARD FESCUE-GRASS.
(*Festuca duriuscula*.)

of flowering, of 18,376 lbs. of green, or 8,269 lbs. of dried, fodder, with an aftermath of 10,209 lbs., from an acre of manured clayey loam. The latter authority observes that it attains to its greatest perfection when combined with Meadow fescue-grass and Rough-stalked meadow-grass. Good commercial samples should have 90 per cent. of germination and purity, about 15.5 lbs. of seed being required per acre. It is adapted for use as recommended for Sheep's fescue-grass, and it is also desirable for parks and recreation-grounds. Hares are very partial to its foliage; and since it grows under trees, it is suitable for game preserves.

The Hard Fescue-grass of commerce is a robust variety of the common Sheep's fescue-grass, determined by Hackel as *Festuca ovina*, *eu-ovina vulgaris firmula*; and not infrequently the seed of Tufted red fescue-grass (*Festuca fallax*) is offered as *Festuca duriuscula*.

LOLIUM—RYE-GRASS

Perennial Rye-Grass (*Lolium perenne*).—Perennial, growing in compound tufts, which make a complete sward; flowering from early in July to August; and maturing seed about a month after flowering. This is a valuable "bottom-grass" for good, heavy soils, on which it lasts for some years. It starts into growth early; resists drought well; is occasionally injured by severe frost; yields only a moderate bulk of dried fodder, of lower nutritive value than medium-quality hay; is better adapted for grazing than mowing; luxuriates on rich, moist, stiff soils and well-drained clays; grows freely on loamy sands and calcareous lands, when they are not too dry; dies out from heaths, inferior sands and dry soils generally after the second season; and succeeds under irrigation, though injured by stagnant water. It develops tolerably rapidly, attaining to its maximum produce the second year; and endures constant grazing and mowing, appearing to benefit from the treading of cattle. The first and best cutting should be taken before flowering, as the culms then harden and deteriorate in quality. By commencing depasturing early in spring, the culms, which are rejected by cattle, can be partially kept down, but those which are left should be cut before the seed develops, especially as the flower-spikes are peculiarly susceptible to attacks of Ergot-fungus. Sinclair obtained, at the time of flowering, 7,827 lbs. of green fodder, or 3,389 lbs. of hay, with 3,403 lbs. of aftermath, from an acre of rich, brown loam; and the following yields of hay per acre have been recorded:—Vianne, 5,900 lbs. from 2 cuttings on mild, rich clay; Karmrodt, 7,300 lbs. as an average for 4 years; Werner, an average of 3,900 lbs.; and Pinkert, 1,780 lbs. only from a fertile sandy loam. The seed, which is generally saved from the second cutting, is produced abundantly, and is easily harvested. Stebler advises the crop being taken about 4 weeks after flowering, when the seeds are beginning to assume a leathery consistency, and before they become brown and hard. In order to prevent loss, it is customary to thresh it on cloths spread on the field when it is very ripe. Good commercial samples should have 95 per cent. of purity,



PERENNIAL RYE-GRASS.
(*Lolium perenne*.)

and germination, 42·6 lbs. being required to sow an acre. The weight per bushel is usually accepted as the gauge of value, the heaviest and best seeds weighing from 28 to 30 lbs. Perennial rye-grass is seldom, if ever, sown alone, but Stebler says that it may form 80 per cent. of pasturage mixtures with White clover in marshy districts where the soil is good, a lower percentage being suitable for meadows. He also recommends 20 per cent. with clovers for clover leys, up to 10 per cent. for temporary grass lands, and 5 per cent. only where permanence is essential. To the excessive use of so comparatively short-lived a plant as Perennial rye-grass is probably due the generally

experienced period of failure or deterioration of pastures about 4 years after being laid down, as those sown without Rye-grass continue to improve year by year. Nitrogenous manures, especially nitrate of soda, are most beneficial.

Pacey's Rye-Grass (*Lolium perenne tenue*).—A more enduring, productive and hardy grass than the ordinary variety, though perfecting less seed. In commerce the heaviest and finest samples of Perennial rye-grass are sold as Pacey's.

Italian Rye-Grass (*Lolium italicum*; *Lolium multiflorum*).—A tall, compactly tufted, grass generally lasting 2 years; coming into flower at the beginning of June. This grass grows more rapidly, and, under suitable conditions, yields more abundantly than any other variety in cultivation. It resists severe drought; is not injured by winter cold in firm soils; luxuriates on warm, moist, rich and stiff lands; grows well everywhere excepting on poor sands and in very dry situations; and succeeds



ITALIAN RYE-GRASS.
(*Lolium italicum*)

perfectly under irrigation. Starting early in spring, it continues growing until late autumn; develops remarkably rapidly; and yields from 4 to 8 or 9 successive cuttings from March till winter. It is superior to Perennial rye-grass in nutritive value; and, like that variety, should always be cut before flowering, as the culms then become hard and deteriorate in value. Thorough rolling is essential, especially in autumn and spring. The following yields of hay per acre have been secured by using liquid manure:—Telfer, 30,800 to 39,600 lbs.; Ralston, 33,800 lbs.; Dickinson, 30,800 lbs.; Vianne, 28,600 lbs.; the Marquis of Ailsa, 17,600 to 22,000 lbs.; Lord Essex, 17,600 lbs.; Pinkert, 26,400 lbs.; and Karmrodt, 5,630 lbs. The quantity of produce is

exceedingly variable, very large crops being obtained only by copious manuring on suitable soils. The seed, which is generally saved from the second cutting, is produced abundantly, and is easily harvested. The crop should be taken at the stage recommended for Perennial rye-grass, as the seeds fall very easily. Good commercial qualities weigh from 16 to 24 lbs. per bushel; should have about 95 per cent. of purity and germinating power; and are sown either in spring or August and September at the relative rate of 35·9 lbs. per acre. Though sometimes grown alone for 1 and 2 year leys, Italian rye-grass is also used in conjunction with clovers for clover leys, from 10 to 50 per cent. being added to mixtures according as the land is more or less rich and moist; but its early development causes its herbage to become hard before the clovers are fit to cut. Mixed with *Trifolium incarnatum*, and sown in August or early September, it gives a heavy yield during the following May; and with Red clover it often succeeds where the clover alone would probably have failed. Its extraordinarily rapid growth adapts it for harrowing and rolling in to fill gaps in deficient leys. Stebler says that not more than 5 per cent. should be used for permanent or temporary meadows, and that no mixture with more than 10 per cent. must be sown, since it vegetates so luxuriantly during the first year as to starve out other grasses. In our opinion, Italian rye-grass should only be used for 1 year leys. Manuring is most profitable,—guano, bone-meal, sulphate of ammonia and nitrate of soda being very beneficial, though the best results are obtained from frequent applications of much diluted liquid manure. Marvellous crops are secured on sewage-farms.

Under the name of *Lolium multiflorum* a very productive variety of Italian rye-grass is found in commerce; but as it is annual in duration, it is less frequently sown than the ordinary Italian rye-grass.

Annual Rye-Grass (*Lolium annuum*).—An annual variety, which vegetates freely, and is considered to be especially suitable for clay lands, where few fodder grasses succeed well. It is adapted only for 1 year leys; and appears to have been generally superseded by Italian rye-grass.

PHLEUM—CATSTAIL-GRASS

Timothy-Grass; Meadow Catstail-Grass (*Phleum pratense*).—A deeply-rooting perennial, forming small, united and tolerably compact tufts, which, having a slight tendency to creep, thinly cover the land; flowering in July; and maturing seed about the end of August. Though rather late and soon becoming hard, this grass is invaluable on cold, wet clays and drained moorlands. It is greatly benefited by rolling; develops tolerably rapidly, giving a crop the first season; luxuriates in deeply ploughed, moist, loamy soils and clays, being stunted by dry situations; is supposed to assist in eradicating moss from meadows; resists extreme drought and winter frost; thrives under irrigation; and begins to grow thin after about 3 years. At Woburn it was considered superior to Cocksfoot-grass for producing early herbage; and Sinclair states that the valuable foliage may be cropped to a late period of the spring without injuring the heavy hay, which, if cut a little time before flowering, is not very hard, and which, being rich in nutritive matter, forms a palatable and very wholesome fodder when mixed with clovers, especially for horses. The green herbage, either alone or in conjunction with clovers and other grasses, is relished by all stock. The produce

largely depends upon the character of the soil and amount of moisture available; but, as a general rule, the aftermath is comparatively small. Sinclair records 40,837 lbs. of green, or 17,355 lbs. of dried, produce at the

time of flowering, with 9,528 lbs. of lattermath, from an acre of clayey loam; and the following yields of hay per acre have been obtained:—Vianne, 5,280 to 13,200 lbs.; Werner, 5,280 to 6,160 lbs.; and Pinkert, 4,050 lbs. The seed, the purest of which comes from North America, is produced abundantly and is easily harvested when the spikes become tinted with orange. As it is sometimes sifted out from clovers, samples must always be examined for the seeds of Dodder. Good commercial qualities should have 97 per cent. of germination and 98 per cent. of purity, 14.7 lbs. being required to sow an acre. Stebler says that from 5 to 20 per cent. of Timothy may be used in mixtures for temporary grass lands according to the character of the soil, but that 10 per cent. must not be exceeded for permanent pastures. Excepting for seed crops, it should always be sown in mixtures of clovers and other grasses, Alsike and Red Clover being specially suitable to produce leys of 2 or 3 years duration in conjunction with it, about 5 lbs. of Timothy being sown with



TIMOTHY.
(*Phleum pratense*.)

10 lbs. of clovers. The application of liquid manures and fertilizers is always profitable.

Bulbous Cat-tail-Grass (*Phleum nodosum*), a form in which the lowest joints of the stems become swollen in the form of tubers, is merely an adaptation of the ordinary variety to dry soils.

POA—MEADOW-GRASS

Smooth-stalked Meadow-Grass (*Poa pratensis*).—Perennial, with very long underground stolons, forming tufts, and so completely covering the surface of the ground; flowering early in June; and ripening seed during the

beginning of July. This moderately nutritious variety starts into growth early in spring; attains to its maximum produce in the third year, yielding only poorly the first season; forms a good "bottom-grass"; resists the greatest extremes of drought and cold; luxuriates in warm, loose lands, rich in humus; grows well in all soils, excepting those which are very stiff, wet or sour; succeeds in shady situations; and should be cut when in flower, as the foliage grows hard afterwards. The great objection to this grass consists in the smallness of its aftermath. Sinclair obtained, at the time of flowering, 10,209 lbs. of green, or 2,871 lbs. of dried, produce, with 4,083 lbs. of lattermath, from an acre of good peat; and Vianne and Sprengel respectively record 6,250 and 3,500 to 4,400 lbs. of hay per acre. Most of the seed found in commerce comes from North America. Good qualities should have 95 per cent. of purity and about 60 per cent. of germination, some 14.7 lbs. being usually rolled in per acre. Inferior samples are often adulterated with chaff and the seeds of Tufted hair-grass (*Aira cæspitosa*). The seed is never sown alone, excepting for lawns; but it may be advantageously added to mixtures for permanent and temporary pastures for dry land, though it is not adapted for clover leys. Thoroughly decayed manure is beneficial. Apart from other botanical differences, *Poa pratensis* is easily distinguished from *Poa trivialis* by its stolons being under, instead of on, the surface of the ground.

Rough-stalked Meadow-Grass (*Poa trivialis*).

—Enduring perennial, producing creeping and rooting branches along the surface of the ground, and so forming a very close sward; flowering in June; and ripening seed in July. This grass, the most reliable and desirable of the Meadow-grasses, shoots tolerably early in spring; succeeds best in moist situations, on mountains, by rivers, in irrigated meadows and in rich, moist soils generally; and is unsuitable for dry and light lands or sunny situations. It forms a good "bottom-grass" in permanent pastures; is soon stunted and scorched by drought; resists cold well as a rule; luxuriates under irrigation and in the shade; and yields a large cutting of nutritious and most palatable fodder under favourable conditions, though producing very little aftermath. Giving only small produce the first year, it attains to its maximum yield the second season; and its creeping roots soon over-run and cover the land, though it never mats like Florin. Cutting should take place before flowering, as the culms have a tendency to become rotten near the ground. At Woburn, Sinclair obtained,



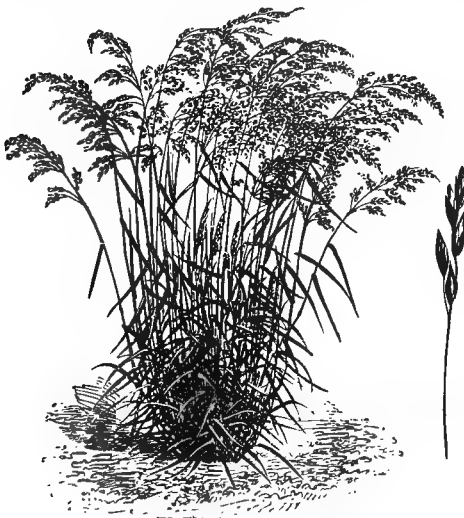
SMOOTH-STALKED MEADOW-GRASS.
(*Poa pratensis*.)

at the time of flowering, 7,486 lbs. of green fodder, or 2,246 lbs. of hay, with 4,764 lbs. of lattermath, from an acre of manured brown loam; while Vianne secured 5,280 lbs., and Pinkert, 3,170 lbs. of hay per acre. The seed is generally collected from wild plants; and in commerce that of Smooth-stalked meadow-grass is often substituted; while Annual meadow-grass (*Poa annua*) is sometimes employed as an adulterant. Good qualities should have about 90 per cent. of purity and 85 per cent. of germination, 11.3 lbs. being usually sown per acre. Rough-stalked meadow-grass is a most valuable variety for permanent pasture in rich and sheltered soils, but it is not desirable for alternate husbandry, as it gives only 1 cutting a year. It is adapted for forming lawns in confined situations in towns. Top-dressing with compost is beneficial; and nitrate of soda, in conjunction with other artificial fertilizers,



ROUGH-STALKED MEADOW-GRASS.
(*Poa trivialis*.)

encourages the growth of the plant.



WOOD MEADOW-GRASS.
(*Poa nemoralis*.)

Wood Meadow - Grass (*Poa nemoralis*).—Perennial, of creeping tendency; flowering in June; and maturing seed towards the end of July. A very early and tolerably productive grass, growing well in the shade and in exposed situations; and resisting extreme drought. Sinclair obtained, at the time of flowering, 9,188 lbs. of green fodder, or 3,905 lbs. of hay, from an acre of brown loam. Its special value lies in its suitability for sowing under trees and in ornamental grounds. Hares and rabbits eat its herbage with avidity; and game-birds appear fond of the seeds, of which 20 lbs. are required to sow an acre.

CHAPTER III

LEGUMINOUS PASTURE PLANTS

LOTUS—BIRDSFOOT-TREFOIL

Common Birdsfoot-Trefoil (*Lotus corniculatus*, var. *vulgaris*).—Very enduring perennial, of spreading, branching habit; flowering in June; and ripening seed at the end of July. Though not very productive, Birdsfoot-trefoil has been occasionally used to form “bottom-herbage.” It withstands intense drought and cold, thrives in almost all soils, and is the most productive of leguminous plants in mountain pastures. Starting tolerably late in spring, it attains to its maximum yield the second season; gives nutritive fodder; and produces only moderate aftermath, although vegetating until late in autumn. The colouring matter of the flowers is disagreeable to stock, so that the herbage should be depastured or mown before flowering, at which period it is most nutritious. The dried leaves easily fall off. At the time of flowering, Sinclair obtained 10,209 lbs. of green, or 3,190 lbs. of dried, fodder from an acre of clayey loam. Charlock (*Sinapis arvensis*) is a common impurity, but it is easily distinguished from the true shining brown seed, which is rare and highly priced in commerce. Though useful in Alpine pastures, Birdsfoot-trefoil is not so in our meadows, and the seed should therefore not be added to any mixtures.



BIRDSFOOT TREFOIL.
(*Lotus corniculatus*.)

MEDICAGO—MEDICK.

Purple or Common Lucerne; Alfalfa (*Medicago sativa*).—Perennial, with very deeply penetrating tap-root and erect branches, which cannot form a

complete covering for the ground ; flowering in June and July. This early and most valuable fodder plant attains to full maturity the second or third season, according as the soil is rich or poor ; and endures from three to twenty years, though the former period is seldom exceeded if the conditions are unfavourable. Its long tap-root penetrates to a remarkable depth, enabling it to resist intense and long-continued drought, while it withstands cold almost equally well. Excessive wet is, however, injurious to the crop. Lucerne requires a clean, friable surface soil, a deep and permeable subsoil, and an abundant supply of lime. Hence it thrives best on warm calcareous loams and sandy marls, which have been deeply broken up ; but it also



LUCERNE.

(Medicago sativa.)

flourishes on soils that are too dry for most clovers. The fodder is relished by all stock, and is more nutritive than medium quality Red clover, being specially rich in albumin. From 3 to 5 equally productive cuttings may be taken a year, the first of which is ready about 2 or 3 weeks before Red clover. The plant is injured by depasturing ; and the stems grow hard about flowering-time, so that the produce should be cut before this period. As the herbage does not dry well, and the leaves very easily break off, the fodder is better used green than made into hay. On account of the great proportion of water it contains, young Lucerne is liable to cause flatulence in stock if fed too freely. Stebler says that land under Lucerne should be broken up in from 5 to 7 years, because the yield diminishes after that time ; and

that, as a general rule, it can recur on the same land only after an interval of rest equivalent in duration to the Lucerne ley. The following yields of hay per acre have been recorded :—Hecke, 4,050 lbs. as an average for 5 years ; Häni, 3,080 to 3,520 lbs. ; Guido Krafft, 5,280 to 8,800 lbs. ; Werner, 7,920 to 10,560 from excellent soil, and 4,400 to 5,280 lbs. from poor land ; and Sprengel, 10,560 lbs. under favourable conditions. As the maturing of



DODDER, GROWING ON LUCERNE.

seed, the best of which comes from Provence, exhausts the plants, it should be saved only from old leys, which are shortly to be destroyed. Trefoil is often, and Dodder sometimes, present in commercial seed, which ought to be plump and yellow, and which should have 98 per cent. of purity and 90 per cent. of germination, 24·9 lbs. being required per acre. Lucerne is specially adapted for sowing pure with a cereal at about the end of April, as grasses

soon crowd it out of existence ; but for short leys of not more than 3 years duration it may be grown in conjunction with clovers. It does best on land that has been well manured for a preceding root crop ; and applications of liquid-manure, ashes, compost and gypsum are all desirable.

Trefoil ; Hop-Clover (*Medicago lupulina*).—Perennial, with widely spreading branches, which eventually interlace, making a complete covering for the ground ; flowering at the end of May. Although neither enduring nor very productive, this plant is useful for forming “bottom-herbage” where better clovers do not succeed. It thrives on all soils containing lime, excepting those that are wet or extremely dry ; luxuriates on stiff marls ; withstands drought well ; and resists cold better than Red clover. Trefoil starts tolerably



TREFOIL.
(*Medicago lupulina*.)

early in spring ; attains to its maximum yield the first season, giving comparatively little latter-math, and generally dies out after being mown the second year. The procumbent growth of the stems makes the plants much more suitable for grazing than mowing ; indeed, they are difficult to cut. The succulent fodder is more nutritive than medium quality Red clover ; but it is not a favourite food of any stock. Sinclair, at the time of flowering, obtained 13,612 lbs. of green, or 5,104 lbs. of dried, fodder from an acre of sandy loam ; and Warner estimates the average yield of hay per acre to be 1,760 to 2,640 lbs. from light, sandy soil, and 3,500 lbs. from better land. Seed is abundantly produced, and the crop should be taken when the pods become black. Charlock (*Sinapis arvensis*) and Plantain (*Plantago lanceolata*) seeds are common impurities. Good commercial samples

ought to have 97 per cent. of purity and 85 per cent. of germination, about 18·5 lbs. of shelled seed being required per acre. It is not adapted for sowing pure, being only suitable for use in mixtures of grasses and clovers for temporary pasturage where Red clover does not thrive, as cattle and sheep seldom eat its herbage except from necessity. On sandy soils it is profitably sown with rather less than twice its weight of White clover ; but Red clover and Italian rye-grass also do excellently in conjunction with it.

ONOBRYCHIS—SAINFOIN

Common or English Sainfoin (*Onobrychis sativa*, var. *communis*).—Very deeply-rooting perennial, with erect, much-branching stems ; flowering towards the middle of June ; and maturing seed about a month later. Its hardiness and enduring character combine to make this the most valuable of

fodder plants for dry or barren chalk lands. Lawson records an instance of it having lasted 100 years, but from 4 to 7 seasons is its average profitable limit ; and in order to avoid "Sainfoin sickness" in the soil, it must only recur after rest-intervals equal to the length of the Sainfoin ley. It withstands intense drought, though the young plants are affected by cold, and the crop is injured by continued cold wet weather. Luxuriating in warm, deep, dry calcareous land, it succeeds well in all soils possessing loose, permeable and dry subsoils, especially in those containing a proportion of lime. Its extensive and deep root-system draws much of its food from the subsoil, and exercises an important ameliorating influence on the surface layers by its decay. Attaining to its maximum produce only the third season, it gives yearly one certain cutting of wholesome and very nutritive hay, specially suitable for horses, and but little aftermath. Grazing or frequent cutting destroys the plants. The crop should be cut when in full flower; and as the leaves are liable to break off, the hay must be dried with as little turning as possible. The following yields of hay per acre have been recorded:—Sinclair, 2,127 lbs.; Young, 2,816 to 4,784 lbs.; Sprengel, 3,520 to 5,280 lbs.; Möllinger, an average of 3,256 lbs.; Langethal, 2,640 to 5,280 lbs.; Guido Krafft, 1,760 to 3,800 lbs.; Count Arnheim, 6,160 lbs.; Werner, 2,640 to 3,520 lbs.; and Häni, 4,270 to 4,900 lbs. As the cutting of mature plants seriously injures them, seed should be saved from the old leys that will soon be broken up: and the crop must be taken when the pods are of a bright brown colour. The produce ought not to be put into cock, as the seeds lose their germinating power if they become heated. Burnet (*Poterium sanguisorba*), Corn crowfoot (*Ranunculus arvensis*) and the Bromegrass seeds are common impurities. Good commercial seed has about 98 per cent. of purity and 85 per cent. of germination, some 146 lbs. unshelled, or 73 lbs. shelled, being required per acre. Sainfoin is usually drilled pure an inch deep in spring, either with or without a cereal; but it may be included in all mixtures of seeds for permanent or temporary grass on soils specially suited to it.



SAINFOIN.
(*Onobrychis sativa*.)

Large-Seeded Sainfoin (*Onobrychis sativa*, var. *bifera*).—This continental variety flowers earlier and grows more luxuriantly than Common sainfoin. It usually gives 2 crops yearly on good soils; and is therefore

better adapted for mixing with Lucerne, Trefoil and other plants from which more than one cut is desired.

TRIFOLIUM—CLOVER

Red or Broad Clover (*Trifolium pratense*).—Red clover endures for several years; is of branching growth; and comes into flower in May. Perhaps the most important fodder plant in cultivation, it forms an excellent preparation for cereals, especially for wheat; and requires a good fertile soil, that has not grown clover for some years.

It luxuriates in stiff, rich land, abounding in humus and free from stagnant water; is unsuitable for cold, wet ground and dry, sandy or calcareous soils; suffers from dry, frosty spring weather; and is sometimes uprooted in loose soils by alternate freezing and thawing during winter, though thorough rolling or an autumn dressing of farm-yard manure obviates this evil. The crop must be cut some time before flowering, since the herbage deteriorates in nutritive value and digestibility with age; and as grazing or frequent mowing directly decreases the yield, 2 cuttings only should be taken in the year. If sown in spring with a cereal, it usually yields a small crop in early autumn. The green produce makes wholesome food for stock, but is not well adapted for making into hay, because the very nutritive and brittle leaves readily break off in moving. For this reason hay should be turned as little as possible. Stebler recommends the crop being either made into stooks, after lying for 2 days in swathe,

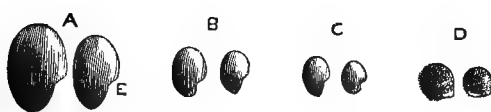


RED OR BROAD CLOVER.
(*Trifolium pratense*.)

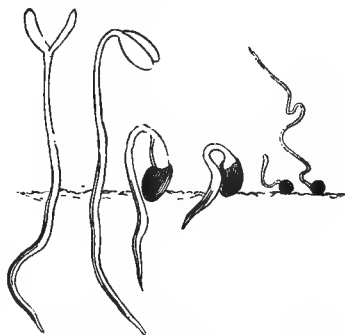
or dried in sheaves. The average yield of hay per acre has been estimated as follows:—Sprengel, 32 to 48 cwts. in proportion as the season is less or more moist; Werner, 48 cwts.; Langethal and Krafft, 32 to 80 cwts. according to the character of the land; and Häni, 56 to 68 cwts. on good soils. The seed, which is most profitably saved from the second cutting, is mature when the flower-heads are changing in colour from brown to black. Very little produce is yielded after the seed crop is cut, as the stems die down. Threshing on the field prevents loss. Dodder is a frequent impurity in foreign Clovers; and Plantain (*Plantago lanceolata*), Docks (*Rumex obtusifolius* et *R. pratensis*), Sheep's sorrel (*Rumex acetosella*) and other weeds are present in many

samples. Plantain seed can only be sieved out before the clover is shelled. Adulteration is seldom attempted; but fraudulent substitution, such as the describing of American seed as English, is by no means uncommon. The nationality of Red clover is of great importance, as the various types cultivated in different countries possess widely varying characteristics. English strains produce tall, succulent and enduring plants, and should be preferred to all of foreign growth; Swiss, Styrian and Silesian are hardy, enduring and of luxuriant habit; French and Italian are not hardy, productive or lasting; and American are undesirable, as they are very susceptible to cold, and do not yield so abundantly as do those of Europe. Good commercial seed should have 98 per cent. of purity and germination, about 16.4 lbs. being usually sown per acre during March or April, preferably with a thin crop of oats, which will be cut green. It is suitable only for alternate husbandry; and if hay be desired, should be sown with a mixture of grasses. As a general rule, mixtures in which Red clover predominates give better results than pure Clover. In conjunction with Timothy and Italian rye-grass, it is specially adapted for rapidly covering bare patches in deficient leys; and it is often associated with Trefoil, Italian rye-grass, Sainfoin and Lucerne. Nitrogenous manures are undesirable, gypsum, basic slag and wood-ashes giving the best results of all fertilizers.

"Clover-sickness," the name given to the disease which causes the well-known weakly and dwindling growth of clovers, is directly attributable to the crop recurring too frequently, and without alternation, on the same land. No remedy exists, excepting that of allowing from 8 to 12 years to elapse before again sowing clover. Mr. Worthington Smith says that "as the fungus hibernates in decayed clover plants, it is obvious that the best mode of preventing attacks is, where possible, to destroy all clover refuse with fire."



SEEDS OF RED CLOVER, TREFOIL, DUTCH CLOVER
AND CLOVER DODDER.
(Five times natural size.)



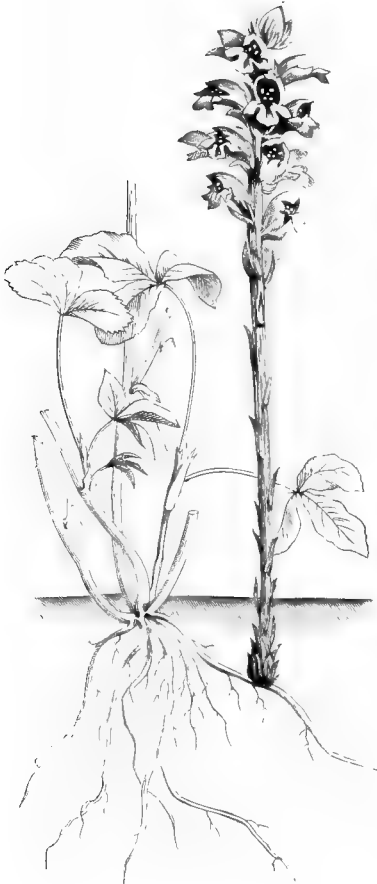
GERMINATING CLOVER AND DODDER
SEEDS.
(Twice natural size.)

Clover dodder (*Cuscuta Trifolii*) is unfortunately too well known to need description; the seeds are dull brown in colour, and, when seen under a strong lens, minutely granular or pitted on the outside. Careful sifting of all clover seeds, and the sowing only of those of English production, are the best preventives of attack. At the first signs of the yellow patches in fields, all clover plants should be removed for a width of 18 inches round the infested area, the Dodder being at the same time carefully raked together and burned. The resulting bare patches can be sown with strong-growing grasses.

Broom, or Clover, rape (*Orobanche minor*) is a less frequent parasite, the

roots of which penetrate into and draw their nourishment from Clover roots. Infested fields should at once be sown down with grass seeds.

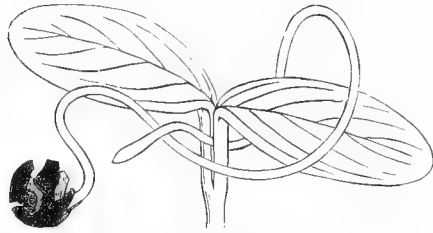
There appears to be no difference in the persistence or duration of the forms of Red clover. On many markets extra-fine samples are designated Cow-grass.



BROOM, OR CLOVER, RAPE.

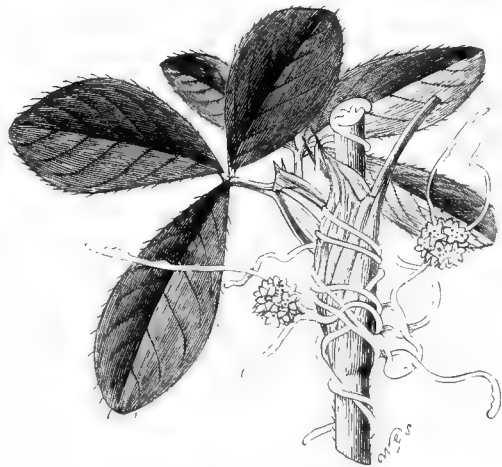
Orobancha minor, growing on Clover Root.

(About $\frac{1}{3}$ natural size.)



GERMINATING DODDER, WITH THREAD-LIKE STEM FIXING ON SEEDLING CLOVER.

(Ten times natural size.)



CLOVER DODDER.

Cuscuta Trifolii, growing on Clover.

(Twice natural size.)

White or Dutch Clover (*Trifolium repens*).—Perennial, with solid, creeping stems, which produce surface-roots at the nodes; coming into flower in May. As compared with Red clover, this valuable “bottom-herbage” plant, which grows in all pastures, is less productive, more nutritive and lasting, and less sensitive to climatic influences. Though resisting drought well, owing to the length of the central tap-root, and destroyed by stagnant water, it is adapted for irrigation in well-drained land, and vegetates most luxuriantly in warm, moist situations, in moderately firm marls, clays, and

loams, containing lime and humus. Its abundant occurrence is regarded as an indication of good soils, but in such cases the creeping stems sometimes do injury by suppressing other plants. White clover develops rapidly, endures grazing well, and provides excellent pasturage from early spring until autumn. Frequent rolling is most beneficial. The green produce, which should be fed in conjunction with dry fodder, is relished by stock, and is less liable to induce flatulence than is Red clover, but more difficult to dry, though the leaves do not fall away so readily. The average yield of hay per acre has been estimated by Block at 2,108 lbs., by Langethal at about $\frac{2}{3}$ that of Red clover, and by Guido Krafft at from 1,672 to 2,640 lbs. The seed, which is abundantly produced and easily harvested, is generally saved from the first cutting. Plantain, Sheep's sorrel (*Rumex acetosella*) and Field chamomile (*Anthemis arvensis*) are frequent impurities, and Dodder is sometimes present in samples. Old seeds are occasionally rubbed with sulphur to give them a fresh, bright colour. Good commercial seed should have about 96 per cent. of purity and 85 per cent. of germination, some 9·2 lbs. being required to sow an acre. White clover is seldom sown pure, but often with perennial rye-grass only. It should be used in all mixtures for permanent or temporary pastures and meadows, especially on low-lying lands. Owing to the surface-rooting habit of the plant, applications of such potash fertilisers as wood-ashes and the drainage from manure-heaps are most profitable; and marl and, on rich soils, gypsum are desirable. Nitrogenous artificials appear to be directly injurious.



WHITE CLOVER.
(*Trifolium repens*.)

It should be used in all mixtures for permanent or temporary pastures and meadows, especially on low-lying lands. Owing to the surface-rooting habit of the plant, applications of such potash fertilisers as wood-ashes and the drainage from manure-heaps are most profitable; and marl and, on rich soils, gypsum are desirable. Nitrogenous artificials appear to be directly injurious.

Alsike Clover (*Trifolium hybridum*).—Perennial, of very tall and leafy growth, producing stems that lie on the ground at their bases; coming into flower at the middle or end of May, and remaining green for some time. This excellent and very nutritive fodder plant endures for from 3 to 5 or 6 years, and produces abundant crops in stiff clays and soils which are too wet for other clovers. It flourishes most luxuriantly in moist loams and clays, being the only clover really suitable for irrigation; but it also succeeds well on mountains and in light, good land, and grows in dry soils, for which it is, however, least adapted. Alsike is practically unaffected by extreme cold, and is rather favoured by excessively wet seasons, though, owing to its surface-rooting habit, the yield is diminished by continued drought. It appears immune from "clover-sickness"; is consequently peculiarly valuable for "clover-sick" land; and can recur at shorter intervals than other clovers. Starting a little late in spring, it attains to its maximum nutritive value at flowering, between the two cuttings of Red clover, and the first crop is considerably the greater. The slightly bitter produce can be used green or dried, but

in the latter case care must be taken to prevent the exceedingly nutritive leaves falling off. The average yield per acre has been estimated at from 4,000 to 4,840 lbs. by Pinkert, and at from 3,500 to 4,400 lbs. by Werner, while Schrober records an average of 3,080 lbs. from the first cutting. Seed is abundantly produced at the first crop, and is easily harvested on moderately dry ground when the flower-heads have become brown. White clover, Trefoil and such weed seeds as Plantain (*Plantago lanceolata*), Sheep's sorrel (*Rumex acetosella*) and Self-heal (*Prunella vulgaris*) are common impurities ; and Dodder occurs even more frequently than in Red clover, it being quite impossible to remove those seeds which are as large as the Alsike itself.



ALSIKE CLOVER.

(*Trifolium hybridum*.)

Old seed is sometimes dyed a fresh green ; but, as Stebler observes, the fraud is easily detected by rubbing the seeds with a white cloth, which readily removes the artificial colouring matter. Good commercial qualities should have about 90 per cent. of germination and 97 per cent. of purity, some 10·3 lbs. being usually sown per acre. Excepting very occasionally for pasturage, Alsike is not sown pure, as its peculiarly bent stem-growth renders it very liable to be laid unless supported by grasses ; but it is a most important constituent of mixtures for permanent or temporary pastures or meadows. Timothy, Cocksfoot and Perennial rye-grass are very suitable to sow in conjunction with it on heavy soils. Stebler recommends 50 per cent. of Red clover with 25 per cent. each of Timothy and Alsike for alternate husbandry. Thorough preparatory manuring is essential, as the superficial roots soon exhaust the surface layers of soil.

Yellow Suckling Clover (*Trifolium filiforme*).—Annual, occasionally biennial, with procumbent stems ; flowering during June. This variety, which seeds itself down, is sometimes used in small proportions in mixtures of seeds for permanent pasturage on dry, gravelly and stony soils, but it is best adapted for pleasure grounds on light land.

OTHER PASTURE PLANTS

ACHILLEA—MILFOIL; YARROW.

Common Milfoil; Yarrow (*Achillea Millefolium*).—Very enduring perennial ; flowering from June to August. This early plant resists the most intense drought, flourishes in dry soils, and yields excellent pasturage, which is always kept closely cropped by stock. The seed, of which from 5 to 6 lbs. are required per acre for a pure sowing, should be added in small proportions to all pasturage mixtures on medium or dry lands.

PETROSELINUM—PARSLEY.

Common or Sheep's Parsley (*Petroselinum sativum*).—Biennial ; flowering in June and July. This variety, which is greatly relished by sheep, is often included in small proportions in pasturage mixtures for elevated lands. The herbage is supposed to be a preventive of scab and rot in sheep ; and it is eaten with avidity by hares and rabbits.

CHAPTER IV

SELECTION OF PASTURE PLANTS

UNDESIRABLE METHODS

Sowing "Hay Seeds."—The sowing of "hay seeds" cannot be too strongly condemned, as they consist principally of chaff, dust and impurities; while it is probable that a single lb. of a prepared mixture of average commercial seeds contains on an average as many germinating seeds of desirable fodder plants as 40 lbs. of hay seeds: besides which, the latter contains hundreds of thousands of noxious weed seeds.

The results of all the experiments which have been made with "hay seeds" conclusively demonstrate that their produce is always small, of inferior quality, and infested with numberless objectionable plants.

A sample of "hay seeds" recently analysed in the laboratory of the Consulting Botanist to the R. A. S. E. contained:—

Yorkshire fog	50·5
Perennial rye-grass	33·0
Wavy hair-grass... ..	10·5
Brome-grass	2·5
Italian rye-grass	0·5
Crested dogstail-grass	0·5
Buttercup, Sorrel and other weeds	2·5

100

Mr. Carruthers significantly adds: "And I have had worse."

Going to Grass.—The old method of allowing arable land or worn-out leys to slowly form pastures by producing spontaneously whatever fodder plants they might be, fortunately, very seldom practised now.

In rainy districts a covering can soon be obtained for the ground; but the herbage consists principally of Creeping bent-grass, Yorkshire fog (*Holcus lanatus*), Creeping buttercup (*Ranunculus repens*), Sheep's sorrel (*Rumex acetosella*), etc.; and it can only be improved by seeding directly with what is called a renovating mixture, or indirectly with the seeds contained in liquid manure, as explained on page 62. The latter method must be considered as very costly, since a large proportion of the fertilizer applied is necessarily wasted if the land be not completely occupied with good plants; and in any case, it is very much more profitable to commence by sowing a judiciously composed mixture of seeds that will yield a good return the first year.

CLASSIFICATION BY FLOWERING

In the pages following those species only which are desirable are mentioned.

Early-Flowering Plants.

	Duration.	Vegetation.
Meadow foxtail-grass	Perennial	Very early.
Sweet vernal-grass	Perennial	Very early.
Tall oat-grass	Perennial	Very early.
Yellow oat-grass	Perennial	Early.
Cocksfoot-grass	Perennial	Early.
Sheep's fescue-grass	Perennial	Early.
Hard fescue-grass	Perennial	Early.
Perennial rye-grass	Several years	Very early.
Italian rye-grass (only for 1 year leys)	Annual	Very early.
Smooth-stalked meadow-grass	Perennial	Very early.
Rough-stalked meadow-grass	Perennial	Early.
Wood meadow-grass	Perennial	Very early.
Trefoil	Biennial	Very early.
Sainfoin	Perennial	Early.
White clover	Perennial	Early.

Mid-Season-Flowering Plants.

Crested dogtail-grass	Perennial	Medium late.
Meadow fescue-grass	Perennial	Medium late.
Red clover	Several years	Medium early.

Late Flowering Plants.

Tall fescue-grass	Perennial	Late.
Timothy	Perennial	Late.
Lucerne	Perennial	Medium early.
Alsike	Several years	Late.
Yarrow	Perennial	Early.

CLASSIFICATION BY SOILS

The importance of soil-classification must not be—as is very general—over-estimated, because the best pasture plants,—Cocksfoot, Meadow fescue, Meadow foxtail, Tall fescue, Timothy, the Meadow-grasses (especially Rough-stalked meadow-grass), White clover and a little Yarrow, grow naturally on any of our cultivated lands.

Silicious, Rocky and Dry Soils.

Meadow foxtail-grass	Perennial rye-grass
Sweet vernal-grass	Smooth-stalked meadow-grass
Tall oat-grass	Rough-stalked meadow-grass
Yellow oat-grass	Trefoil
Crested dogtail-grass	Common sainfoin
Cocksfoot-grass	Red clover
Sheep's fescue-grass	White clover
Hard fescue-grass	

Clayey, Clayey-Silicious, Cool and Fertile Soils.

Meadow foxtail-grass	Perennial rye-grass
Sweet vernal-grass	Timothy
Tall oat-grass	Smooth-stalked meadow-grass
Yellow oat-grass	Trefoil
Crested dogtail-grass	Red clover
Cocksfoot-grass	White clover
Tall fescue-grass	Alsike clover
Meadow fescue-grass	Yarrow
Hard fescue grass	

Calcareous-Clayey and Calcareous-Silicious Soils.

Sweet vernal-grass	Smooth-stalked meadow-grass
Tall oat-grass	Lucerne
Yellow oat-grass	Trefoil
Cocksfoot-grass	Sainfoin
Sheep's fescue-grass	Red clover
Hard fescue-grass	White clover
Perennial rye grass	Yarrow

Wet, Marshy and Peaty Soils.

Meadow foxtail-grass	Perennial rye-grass
Crested dogtail-grass	Timothy
Cocksfoot-grass	Rough-stalked meadow-grass
Tall fescue-grass	White clover
Meadow fescue-grass	

Soils in Shady Situations.

Cocksfoot-grass	Rough-stalked meadow grass
Sweet vernal-grass	Wood meadow-grass
Smooth-stalked meadow-grass	

CLASSIFICATION BY PRODUCE

Poor Yield.

Sweet vernal-grass	Crested dogtail-grass
--------------------	-----------------------

Medium Yield.

Meadow foxtail-grass	Trefoil
Yellow oat-grass	Sainfoin
Hard fescue-grass	Alsike
Wood meadow-grass	Yarrow

Excellent Yield.

Tall oat-grass	Timothy
Cocksfoot-grass	Smooth-stalked meadow-grass
Tall fescue-grass	Rough-stalked meadow-grass
Meadow fescue-grass	Lucerne
Perennial rye-grass	Red clover
Italian rye-grass	White clover

CLASSIFICATION BY HAY

Mediocre Quality.

Sheep's fescue-grass

| Yarrow

Medium Quality.

Tall oat-grass

| Tall fescue-grass

Hard fescue-grass

Excellent Quality.

Meadow foxtail-grass

| Smooth-stalked meadow-grass

Sweet vernal-grass

| Rough-stalked meadow-grass

Yellow oat-grass

| Wood meadow-grass

Crested dogtail-grass

| Lucerne

Cocksfoot-grass

| Trefoil

Meadow fescue-grass

| Sainfoin

Perennial rye-grass

| Red clover

Italian rye-grass

| White clover

Timothy

| Alsike clover

THE BEST GRASSES

. The following table, prepared by Mr. Carruthers from Mr. David Wilson's experiments, contains very valuable information about 15 of our common grasses. "The figures may be held to represent quantity or money value. Thus, if a given area produces 100 tons of green food when sown with Cocksfoot, it would yield 49 tons with Perennial rye-grass, and only 17 tons with Sheep's fescue. Or, if the feeding value of the produce of a given area in Cocksfoot is worth 100s., in rye-grass it would be worth 52s., and in Sheep's fescue 30s."

In Mr. Carruthers' judgment, the grasses marked with an asterisk are not deserving to rank in the first places.

RELATIVE VALUE OF THE QUANTITY PRODUCED IN A YEAR ON AN EQUAL SPACE OF GROUND AND OF THE FEEDING VALUE OF THAT QUANTITY OF THE FOLLOWING GRASSES :—

Name of variety.	Quantity produced a year on an equal space of ground.	Feeding value of the same quantity.
Cocksfoot	100	100
*Tall oat-grass.....	94	114
Meadow foxtail ...	75	88
Tall fescue	67	72
*Sweet vernal	63	75
*Yellow oat-grass	59	77
Meadow fescue	58	73
Timothy	54	68
*Rye-grass	49	52
*Wood meadow-grass	37	57
Rough-stalked meadow-grass	37	53
Smooth-stalked meadow-grass.....	32	51
*Crested dogtail.....	23	39
*Hard fescue	24	35
*Sheep's fescue	17	30

To prevent such figures being misleading, it must always be remembered that the chemical analysis of any plant cannot be accepted as the true gauge of worth, because stock have their likes and dislikes in the matter of foods.

PURE CULTURES

Disadvantages.—Experiment has conclusively demonstrated that Red clover, Lucerne and Sainfoin, the three fodder plants usually sown pure in this country, do not endure so long cultivated alone as when mixed with suitable proportions of grasses and clovers; and various grave objections are justly urged against their extended pure culture. Thus, Red clover, from its liability to “Clover-sickness,” should be sown only at intervals of at least 6 years in duration, while there is always some risk from frost, especially in the case of foreign seeds; Lucerne succeeds on comparatively few soils; and Sainfoin, though invaluable in some situations, causes “Sainfoin-sickness” by its too frequent recurrence, gives only a small crop at the second cutting, and cannot be depended on in excessively wet seasons.

MIXTURES OF PLANTS

Advantages.—Not only do judicious mixtures of grasses and leguminous plants suppress weeds by more completely occupying the ground, but they utilise the different strata of soil more profitably and fully, as explained in a subsequent paragraph, than can any species cultivated alone, and are much less likely to cause partial chemical exhaustion of the land by using up any one element too rapidly. Emile Wolff found that 1,000 air-dried parts of the following plants contain :—

Name of variety.	Potash.	Lime.	Magnesia.	Silica.
Rye-grass	7'20	1'50	0'40	6'50
Timothy.....	7'40	1'60	0'70	7'70
Red clover.....	4'40	4'80	1'50	0'03
Alsike.....	2'40	3'00	1'10	0'40
Lucerne	4'60	7'90	1'00	1'10
Sainfoin	3'40	4'40	0'80	1'00

From which analysis it is obvious that while grasses draw more heavily on silica, leguminous plants require much the greater proportions of lime. Again, mixtures are much less sensitive to adverse external influences, such as drought, excessive moisture, frost, fungous diseases and insect attacks, since if any variety be injured, another more hardy or resistant temporarily takes its place, and fills the blank which would otherwise be left. Frost is less harmful, as the robust shelter more sensitive plants; and Dodder and Broom-rape, should they appear, are not nearly so injurious. Hence the most abundant, certain and sustained yields are given by carefully composed mixtures of grasses and leguminous plants, which also provide more wholesome and grateful fodder than do pure sowings of either. Clovers and other leguminous plants dry, too, much more readily and economically in conjunction with grasses.

THEORY OF SELECTION

Necessity for Selection.—The varying characteristics of fodder plants are of the utmost importance from an agricultural point of view, since many varieties endure for years, others only for brief periods; some luxuriate on moist or clayey soils, some in light, dry situations, and yet others only where the subsoil is deep and permeable; many form erect tufts alone, some produce creeping and rooting stolons, either under or above the surface of the ground, and others still, wholly or partially decumbent stems; and while some start into growth rapidly after being mown or depastured, so yielding several crops in a season, others again give but a single cutting a year. Many additional and equally striking variations exist, but sufficient have been mentioned to render it obvious that the judicious selection of varieties, or composition of mixtures, for any particular soil or purpose must be founded on an accurate knowledge of the growth, requirements and peculiarities of the pasture plants.

Design in Selection.—The object of selecting pasture plants should be to form a complete sward, which will yield the greatest possible, most certain and sustained annual produce of palatable food for a desired period.

Duration of Varieties.—The intended duration of a pasture is an important guide to the selection of the most suitable fodder plants; and each mixture should be principally composed of varieties which naturally endure for the contemplated time.

Soil and Climate.—A judiciously composed mixture must contain only those species which may reasonably be expected to thrive under the proposed conditions of soil and climate, since most fodder plants become unproductive or die out altogether amidst uncongenial surroundings.

Habit of Growth.—Many pasture plants, especially simply tufted grasses, are incapable of forming a complete covering for the ground; and to prevent indigenous weeds springing up between, and possibly suppressing, them, suitable proportions of creeping or stoloniferous species must be added to form “bottom-herbage” and occupy every vacant space. While the finely-growing grasses usually root only in the surface vegetable-soil, taller kinds penetrate deeper, and leguminous plants, which also possess the power of assimilating and storing up free nitrogen from the atmosphere, send down central tap-roots deep into the subsoil in search of the necessary minerals and water. Fraas says that leguminous roots can penetrate to the following depths:—White clover, 6 inches; Red clover, 25; Lucerne, 50; and Sainfoin from 37 to 150. Thus, it becomes evident that the available elements of plant-growth can only be fully taken advantage of when a pasture contains proper proportions of large and small grasses and leguminous plants.

Development and Yield.—While some fodder plants vegetate early in spring and yield their principal produce at the first cutting, others grow until late autumn, and provide abundant aftermath; and different varieties attain to their maximum development at widely varying periods after being sown; so that a well arranged mixture must include early and late plants and some developing fully the first, and some the second, year, thus ensuring a profitable return from the first season onwards.

CALCULATION OF MIXTURES

Purity and Germination.—By percentages of purity and germination are understood the numbers of pure and of germinating seeds respectively in

100. For instance, a guarantee of 98 per cent. of purity and 90 per cent. of germination with Red clover signifies that 98 of every 100 seeds are pure or true, and that 90 of them grow.

Real Values.—Since impure seeds and those that have lost their power of germination by injury or age are useless, the percentage of pure and germinating seeds of any sample indicates its real value. This is easily determined by multiplying the percentages of purity and germination together, and dividing the product by 100. Thus, the real value of any seed

$$= \frac{\text{Purity} \times \text{Germination}}{100}, \text{ that of the Red clover mentioned in the preceding}$$

paragraph being $\frac{98 \times 90}{100} = 88.2$ per cent. or, approximately, 88 per cent. of pure and germinating seed. The real value being known, it is a simple matter to ascertain the actual weight of useful seed in any parcel. Supposing a bag of Red clover to contain 10 lbs. having 88 per cent. real value, then $\frac{88}{100}$ only of the weight of the whole is useful, that is $\frac{88}{100}$ of 10 lbs.

$$= \frac{88 \times 10}{100} = 8.8 \text{ lbs.}$$

The real value also shows the comparative worth of different samples, since 1 lb. possessing 88 per cent. of pure and germinating seed is equal in value to 2 lbs. with 44 per cent., or to 4 lbs. with 22 per cent. only, because $1 \times 88 = 2 \times 44 = 4 \times 22 = 88$.

Percentage-lb.-Value.—Stebler has suggested that the weight of any quantity of seed multiplied by its real value be called its percentage-lb.-value; and this appears to be the most simple and satisfactory method of expressing the exact worth of the whole parcel; and it also admits of the relative worth of different weights of seeds of varying qualities being readily compared, as will be seen from the following instances:—

Name of variety.	Weight in lbs.	Percentage of real value.	Percentage-lb.-value.
Red clover	20	80	1,600
Do.	40	20	800
Do.	80	10	800

The percentage-lb.-values of the 20, 40, and 80 lb. bags are respectively 1,600, 800, and 800, so that the 20 lbs. is equal in value to the united worth of the 40 and 80 lbs., since $1,600 = 800 + 800$.

Quantity per Acre.—Since, then, 1 lb. of Red clover with 88 per cent. of pure and germinating seeds is worth 2 lbs. having 44 per cent. only, it is clear that the weight of any variety required to sow an acre depends entirely on the real value of the actual seed to be sown; and it is equally evident that calculations can only be safely based upon the amounts of perfectly pure and germinating seeds (100 per cent. real value) that experience proves are needed per acre for pure sowing. Such data have been compiled by many agricultural writers, but the following tabulated statements, the second of which is partially after Stebler, may be regarded as reliable.

TABLE I.

NUMBER OF LBS. OF GOOD COMMERCIAL SEED REQUIRED PER ACRE FOR PURE SOWINGS.

Name of seed.	Lbs. of seed required per acre.	Percentage of purity.	Percentage of germination.	Percentage of pure and germinating seeds = Real value.	Lbs. of seed with the addition of																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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* This column is usually employed in calculating permanent mixtures.

TABLE II.

NUMBER OF LBS. OF PERFECTLY PURE AND GERMINATING SEEDS (100 PER CENT. REAL VALUE) REQUIRED PER ACRE FOR PURE SOWINGS.

Name of seed.	Number of column —	Lbs. of seed with the addition of											
		1	2	3	4	10 per cent.	20 per cent.	30 per cent.	40 per cent.	50 per cent.	60 per cent.	70 per cent.	80 per cent.
				Percentage of germination.	Percentage of pure and germinating seeds = Real value.								
Meadow foxtail-grass	6.2	100	100	100	100	6.82	7.44	8.06	8.68	9.3	9.92	10.54	11.16
Sweet-scented vernal-grass	7.8	100	100	100	100	8.58	9.36	10.14	10.92	11.7	12.48	13.26	14.04
Tall or False oat-grass	34.5	100	100	100	100	37.95	41.4	44.85	48.3	51.75	55.2	58.65	62.1
Yellow oat-grass	4.6	100	100	100	100	5.06	5.52	5.98	6.44	6.9	7.36	7.82	8.28
Crested dogtail-grass	13.5	100	100	100	100	14.85	16.2	17.55	18.9	20.25	21.6	22.95	24.3
Cocksfoot-grass	18.5	100	100	100	100	20.35	22.2	24.05	25.9	27.75	29.6	31.45	33.3
Meadow fescue-grass	37	100	100	100	100	40.7	44.4	48.1	51.8	55.5	59.2	62.9	66.6
Sheep's fescue-grass	12.6	100	100	100	100	13.86	15.12	16.38	17.64	18.90	20.16	21.42	22.68
Hard fescue-grass	12.6	100	100	100	100	13.86	15.12	16.38	17.64	18.90	20.16	21.42	22.68
Perennial rye-grass	38.5	100	100	100	100	42.35	46.2	50.05	53.9	57.75	61.6	65.45	69.3
Italian rye-grass	32.4	100	100	100	100	35.64	38.88	42.12	45.36	48.6	51.84	55.08	58.32
Timothy; Meadow catstail-grass...	14	100	100	100	100	15.4	16.8	18.2	19.6	21	22.4	23.8	25.2
Smooth-stalked meadow-grass...	8.4	100	100	100	100	9.24	10.08	10.92	11.76	12.6	13.44	14.28	15.12
Rough-stalked meadow-grass	8.7	100	100	100	100	9.57	10.44	11.31	12.18	13.05	13.92	14.79	15.66
Lucerne	22	100	100	100	100	24.2	26.4	28.6	30.8	33	35.2	37.4	39.6
Trefoil	15.25	100	100	100	100	16.77	18.3	19.82	21.35	22.87	24.4	25.92	27.45
Sainfoin (shelled seed)	60.8	100	100	100	100	68.88	72.96	79.04	85.12	91.2	97.28	103.36	109.44
Red or Broad clover	15.8	100	100	100	100	17.38	18.96	20.54	22.12	23.7	25.28	26.86	28.44
White clover	7.5	100	100	100	100	8.25	9	9.75	10.5	11.25	12	12.75	13.5
Alsike	9	100	100	100	100	9.9	10.8	11.7	12.6	13.5	14.4	15.3	16.2

* This column is usually employed in calculating permanent mixtures.

Table I.—In the first column of Table I. are the numbers of lbs. of good average commercial seeds required for a pure sowing of an acre ; and if the percentage of pure and germinating seeds in any sample be lower or higher than the average real value mentioned in column 4, more or less weight is needed per acre.

When seeds approximate in real value to the averages here fixed, that is to say when they are of good average commercial quality, this Table may be employed to save trouble, but otherwise Table II. will be found more convenient.

Table II.—Column 1 of Table II. gives the exact weights of perfectly pure and germinating seeds (100 per cent. real value) needed per acre for a pure sowing ; and from these figures the required quantity of any sample, of which the real value is known, can be readily deduced. Suppose the real value of a bag of Alsike clover to be 80 per cent., we know from column 1 that 9 lbs. of perfectly pure and germinating seeds are necessary per acre ; and the amount of 80 per cent.—quality seed to be used for the same area is ascertained thus :—

If of 100 per cent. pure and germinating seeds we sow per acre 9 lbs.,						
Then, of	1	„	„	„	„	9 × 100 lbs. ;
And of 80	„	„	„	„	„	$\frac{9 \times 100}{80} = 11.25$ lbs.

Hence, the weight of any quality seed required to sow an acre of ground may be quickly calculated by multiplying the weight of perfectly pure and germinating seeds (100 per cent. real value) needed per acre for a pure sowing (Column 1, Table II.) by 100, and dividing the product by the real value of the seed to be sown : or

$$\text{the required quantity per acre} = \frac{\left(\begin{array}{c} \text{Weight of pure and} \\ \text{germinating seed} \\ \text{required per acre} \\ \text{for a pure sowing.} \end{array} \right) \times 100}{\left(\begin{array}{c} \text{Real value of the} \\ \text{seed to be sown.} \end{array} \right)} \text{ lbs.}$$

The quantities fixed by Column 1 are calculated for pure sowings, made in good time on medium soil ; and they must not be regarded as invariable under other conditions, since on rich, fertile and well-tilled land the plants will tiller out more freely, and less seed is therefore required per acre ; while, on the other hand, light, cold or bad soils and those in bleak, exposed aspects or dry situations need additional weights of seeds per acre proportionate to their inferiority to good medium land. In this connection the preparation of the seed-bed is of so great importance that Stebler says a sowing of 50 lbs. on a fine, firm, friable and level surface will yield better results than 100 lbs. on a cloddy and ill-prepared one, where many of the seeds would fail to germinate. Then, too, late sowings in spring and autumn must be more liberal than those made at more favourable seasons, because the young plants will probably suffer to some extent from adverse weather, such as drought or frost.

We have seen that different pasture plants draw their sustenance from different depths of the soil, and also that leguminous plants and grasses tax the soil for different chemical constituents ; and from these premisses it is an obvious deduction that a given area will profitably support a much greater

number of mixed plants than of any one kind cultivated alone. Hence the more complex a mixture, *i.e.*, the greater number of species of varying habit it contains, the more the weight of seed that should be sown per acre.

In both tables, columns 5 to 12, which are added to save calculation, give the necessary weights required per acre, with additions of from 10 to 80 per cent.

Another Method.—The Woburn experiments have demonstrated that the use of 10,000,000 living pasture seeds per acre produces a heavy yield ; and Mr. W. Carruthers recommends this as the basis of his calculations for estimating seed mixtures for pastures and hay.

The average number of grains in a lb. of pure seed of each of the principal grasses and clovers is given in the table following ; but this value is relative only, since some species vary greatly.

Name.	Number of seeds.	Name.	Number of seeds.
Meadow foxtail-grass	907,000	Italian rye grass	285,000
Sweet vernal-grass	924,000	Timothy	1,170,500
Tall oat-grass	159,000	Smooth-stalked meadow- grass	2,400,000
Yellow oat-grass	2,045,000	Rough-stalked meadow-grass	3,250,000
Crested dogstail-grass.....	1,127,000	Lucerne.....	209,500
Rough cocksfoot-grass	579,500	Trefoil	328,000
Tall fescue-grass	318,200	Sainfoin	22,500
Meadow fescue-grass	318,200	Red clover	279,000
Sheep's fescue-grass	680,000	White clover	740,000
Hard fescue-grass	680,000	Alsike clover	707,000
Perennial rye-grass	336,800		

From these data the number of germinating grains in a lb. of any seed is readily ascertained if its percentage of germination be known. Assuming the germination of a sample of Red clover to be 80, we see from the above statement that 1 lb. of pure seed contains on an average 279,000 grains ; but the seed under consideration has only 80 per cent. of living grains ; and it will therefore contain only 80 per cent. of the number of useful seeds in an average lb. of pure seed,—that is 80 per cent. of $279,000 = \frac{80}{100}$ of 279,000 = 223,200 grains.

After the species to be sown are selected, and the number of living grains in a lb. of each has been calculated, the quantities required to make up 10,000,000 seeds may be readily determined.

PRACTICAL COMPOSITION OF MIXTURES

Choice of Varieties.—The first necessity in the actual composition of a pasture mixture is to carefully select those varieties which are best adapted for the soil and contemplated end. Endurance, habit of growth, and development must be considered ; the proper proportions of deep and shallow-rooting species should be added to profitably utilise the whole available soil ; and the inclusion of sufficient stoloniferous varieties to form “bottom-herbage” and completely fill the spaces between taller-growing plants is absolutely necessary. Useful hints can sometimes be gathered from an examination of the indigenous flora, but such considerations are always subservient to the vital necessity of selecting only the most productive and

nutritious species, which will also provide palatable food for stock; and it is very important to entirely omit those grasses that produce flower-culms freely in autumn. When eating the leaves of a grass, animals must of necessity bite off the top of the undeveloped stem too, so that the appearance of a flower-stalk in a well-grazed pasture is an obvious proof that that particular plant has been passed over by stock; and it is surely evident that all species which are rejected by animals are undesirable, notwithstanding their possibly high nutritive value as ascertained by chemical analysis.

The results of Mr. W. Carruthers' invaluable examinations of the herbage of many of our most celebrated pastures show that inferior plants often produce good feed on fertile lands. Indeed, one cannot but be impressed with the low quality of some of the grasses which predominate in most of the instances cited by him. It is, however, certain that much better results would be attained if these indifferent species were replaced by nutritious grasses that are relished by stock; so that the composition of natural pastures must never be accepted as a standard by which to lay down land to grass.

Additions and Weights.—Having selected our varieties, we must consider the desirability of additions to compensate for mediocrity of soil or aspect, lateness of sowing, complexity of mixture, and age or lightness of any particular variety of seed. As a general rule, it is advisable to add to each species, on account of complexity of mixture alone, 10 per cent. when 3, 20 per cent. when 4, 30 per cent. when 5, and 50 per cent. when many different pasture plants are comprised in a mixture, as they fit into each other in their occupation of the soil. The fifty per cent. addition column in either table should be used in the composition of permanent pastures.

Proportions of Varieties.—The proportion (percentage) of a pasture which each plant is to eventually occupy must be definitely fixed before proceeding further, those species that may reasonably be expected to thrive best under the specific conditions of soil, climate, etc., being most extensively employed. The requisite weight of each constituent of a mixture is then simply ascertained, as exemplified in the following paragraphs.

Suppose we desire to form a pasture of some years duration, using only Alsike clover of 90 per cent. real value, White clover of 80 per cent. and Perennial rye-grass of 77 per cent. Then it will be seen that these percentages of pure and germinating seeds are not sufficiently near to those fixed for good average commercial qualities to permit of our employing Table I.; and the required weights must be deduced from Table II. Presuming that the most suitable proportions (percentages) of Alsike clover, White clover and Perennial rye-grass in a pasture be 20, 60 and 20 per cent. respectively, we will calculate the exact weights of seeds, of the real values mentioned above, needed to produce these proportions. If the seeds be new, heavy and plump, and the sowing be made in good time on medium soil, an addition of 10 per cent. for complexity of mixture only will be needed. Referring to column 5 (the 10 per cent. addition column) in Table II., we find that 9.9 lbs. of Alsike, 8.25 lbs. of White clover or 42.35 lbs. of Perennial rye-grass, of 100 per cent. real value, are needed per acre for a pure sowing with 10 per cent. addition. A pure sowing of any species, of course, produces 100 per cent. (the whole pasture) of that species; and in the mixture we are composing we desire 20 per cent. of the herbage to be Alsike clover, 60 per cent. to be White clover and the remaining 20 per cent. to be Perennial rye-grass. Besides which, the seeds we have to use are

not of 100 per real cent. value, the Alsike clover, White clover and Perennial rye-grass possessing respectively only 90, 80 and 77 per cent. of pure and germinating seeds; but—

If to produce 100 % of pasture with 100 % value Alsike we sow 9'9 lbs.—

Then	„	1 %	„	1 %	„	„	$\frac{9'9 \times 100}{100}$ lbs. ;
And	„	20 %	„	90 %	„	„	$\frac{9'2 \times 100 \times 20}{100 \times 90} = 2'2$ lbs.

So the weight of any quality seed required per acre to produce a certain percentage of the whole herbage of the pasture may be quickly calculated by multiplying the weight of perfectly pure and germinating seeds (100 per cent. real value) needed per acre (Column 1, Table II.) for a pure sowing by the percentage of the herbage to be formed with the particular plant under consideration, and dividing the product by the real value of the seed to be sown; or

$$\left. \begin{array}{l} \text{the required quantity} \\ \text{(to form a certain} \\ \text{percentage of the} \\ \text{whole herbage)} \end{array} \right\} = \left(\begin{array}{l} \text{weight of pure and} \\ \text{germinating seed} \\ \text{required per acre} \\ \text{for a pure sowing.} \end{array} \right) \times \left(\begin{array}{l} \text{percentage of} \\ \text{herbage of pas-} \\ \text{ture to be formed} \end{array} \right) \\ \text{(real value of the seed to be sown.)}$$

Thus we ascertain that 6'19 lbs. of our White clover seed are required to produce 60 per cent. of the plant of the entire pasture, while the requisite 20 per cent. of Perennial rye-grass may be obtained by sowing 11 lbs. of seed. These deductions are conveniently tabulated thus :—

Name of seed.	Real value.	Percentage of pasture to be occupied.	Weight in lbs. required per acre.
Alsike clover	90	20	2'2
White clover	80	60	6'19
Perennial rye-grass	77	20	11'0

TEMPORARY PASTURES

To last from 1 to 3 years

Introductory.—As a general rule it is highly advantageous to alternate the culture of grass leys of three years duration with cereals and roots, because less labour and horses are needed than on a purely arable holding; strong-growing pasture grasses materially assist in cleaning the land by smothering weeds; leguminous plants enrich the soil by means of the nitrogen they accumulate from the atmosphere, and the ramification and decay of their roots leave the ground in an excellent condition for a corn crop; the soil constituents are utilised more economically; the land can be kept in a higher state of fertility; and the farmer is insured sufficient roots and hay to keep his stock during the winter.

When a temporary pasture of three years duration is broken up, another

should be sown down to replace it, so that it is a good practice to break up an old ley and seed a fresh portion of land yearly.

It would not be easy to suggest a more ameliorating and satisfactory rotation for many lands than the following: 1st year, roots; 2nd year, cereals; 3rd year, an annual fodder plant; 4th year, cereals; 5th year, temporary pasture; 6th year, temporary pasture; 7th year, temporary pasture; and 8th year, cereals.

Thus, on a holding of 80 acres, the plan of rotation would be :

ROTATION ON 10-ACRE PLOTS.

Year.	Plot 1.	Plot 2.	Plot 3.	Plot 4.
1	Roots	Cereals	Annual fodder crop	Cereals
2	Cereals	Annual fodder crop	Cereals	Temporary pasture
3	Annual fodder crop	Cereals	Temporary pasture	Temporary pasture
4	Cereals	Temporary pasture	Temporary pasture	Temporary pasture
5	Temporary pasture	Temporary pasture	Temporary pasture	Cereals
6	Temporary pasture	Temporary pasture	Cereals	Roots
7	Temporary pasture	Cereals	Roots	Cereals
8	Cereals	Roots	Cereals	Annual fodder crop

Year.	Plot 5.	Plot 6.	Plot 7.	Plot 8.
1	Temporary pasture	Temporary pasture	Temporary pasture	Cereals
2	Temporary pasture	Temporary pasture	Cereals	Roots
3	Temporary pasture	Cereals	Roots	Cereals
4	Cereals	Roots	Cereals	Annual fodder crop
5	Roots	Cereals	Annual fodder crop	Cereals
6	Cereals	Annual fodder crop	Cereals	Temporary pasture
7	Annual fodder crop	Cereals	Temporary pasture	Temporary pasture
8	Cereals	Temporary pasture	Temporary pasture	Temporary pasture

So that each year there are 30 acres of pasturage, 10 acres of some fodder plant, and 10 acres of roots, in all 50 acres of food for stock, and 30 acres of cereals. If the temporary pasture be mown the first year, as is customary, there are 20 acres of pasturage and 20 acres of fodder yearly, besides roots and corn.

Relative Proportions.—In mixtures intended to endure for periods of 1, 2 or 3 years, from 40 to 90 per cent. of clovers may be employed in proportion as the land is specially adapted to their requirements.

Selection of Species.—Grasses should predominate on poor soils, and grasses and Alsike on those that have recently borne clovers. White clover ought principally to be used for purely pasturage mixtures. Trefoil is not a favourite food, and is much neglected by stock.

The grasses principally sown for such short leys are Italian rye-grass, Timothy, Perennial rye-grass and—less frequently—Cocksfoot and Tall oat-grass.

Specimen Mixtures.—Red clover and Italian rye-grass (for 1 year). Red clover and Timothy (for 1 or 2 years). Alsike clover and Timothy (for 2 or 3 years on "clover-sick" land). Red clover, Alsike clover and Timothy (for 2 or 3 years). White clover, Alsike clover and Perennial rye-grass (for 2 or

3 years, for pasturage). Red clover, Alsike clover and Timothy (for 2 or 3 years).

Other mixtures can easily be prepared by adding to the last mentioned White clover, Trefoil, Cocksfoot, Tall oat-grass and Lucerne.

When calculating the quantities of various seeds required, allowance must be made for complexity of mixture, as explained on page 41.

To last 3 or 4 years

Relative Proportions.—Leguminous species should not form more than $\frac{1}{3}$ of the plant of any temporary pasture intended to last for more than 3 years.

Selection of Species.—Red clover—with Alsike and White clover—will constitute the bulk of leguminous plants, as Trefoil is seldom eaten by stock.

Proper proportions of the most enduring perennial grasses, such as Cocksfoot, Meadow fescue and Meadow foxtail, and suitable quantities of bottom, middle and top-grasses must be added to utilise the soil completely. Not more than 5 per cent. of Italian rye-grass should be used in any mixture, as its disappearance after the second year may cause gaps in the herbage. Though Perennial rye-grass endures for longer periods than the Italian variety, not more than 10 per cent. of it ought to be employed.

Duration.—By liberal annual applications of liquid manure, the duration of the pasture may generally be profitably extended to 5 or 6 years; but, otherwise, it is necessary to break up the ley the fourth year, preparatory to taking a succession of other crops.

PERMANENT PASTURES

Introductory.—Permanent grass is preferable to temporary pastures in very stiff, compact soils, which are difficult to work, on lands exposed to occasional floodings, and in districts unfavourable to the growth of cereals.

Relative Proportions.—Leguminous species ought not to constitute more than 20 per cent. of the plant of any permanent pasture.

Selection of Species.—Short-lived plants should be excluded to prevent deterioration and, possibly, failure after the third or fourth year. For this reason not more than 5 per cent. of Perennial rye-grass is admissible under any circumstances in permanent mixtures; and, indeed, it is well to omit even this small proportion on light lands. There is no period of deterioration in pastures laid down only with the best and most enduring species, such as Cocksfoot, Meadow fescue, Meadow foxtail, Tall fescue, Timothy, the Meadow-grasses (especially Rough-stalked Meadow-grass), White clover and a little Yarrow; and, generally speaking, these thrive where any pasture plants flourish.

CHAPTER V

BUYING PASTURE SEEDS

Necessity for Caution.—That good seed is absolutely essential for success is not even yet so generally recognised by agriculturists as it should be ; for no matter how much time, labour and money be expended in preparing the land, if the seed contain a considerable proportion of weeds or even useless grasses, or if it fail to germinate freely, the resulting crop will be proportionately poor and unprofitable, and it may even become necessary to incur the expense of thoroughly cleaning and re-sowing the land. Every seeding is exposed to sufficient hazards from climatic extremes, insects, fungous diseases and other injurious influences more or less beyond human control, without being wilfully exposed to such serious and totally unnecessary risks as the employment of inferior seeds.

Mixed Pasture Seeds.—In Germany and elsewhere waste tracts of land are utilised to produce crops of seeds, which are harvested all together, regardless of species ; and for these samples, though consisting principally of Wavy mountain hair-grass (*Aira flexuosa*), Yorkshire Fog (*Holcus lanatus*), Italian and Perennial rye-grasses, Soft brome-grass (*Bromus mollis*), &c., buyers can always be found. Unscrupulous seedsmen, too, make a practice of preparing pasture mixtures containing only the cheapest and least valuable species ; and it is no unusual occurrence for the very cleanings from various agricultural seeds to be added to mixtures for grass-lands. Such sowings cannot possibly yield good, but may produce most injurious results. Now, when it is considered that extended experience and, we would add, a special training are required to justly estimate the value of a mixture of seeds, it is apparent that agriculturists incur great risks by purchasing ready-mixed pasture seeds, excepting from honourable firms, possessing very considerable botanical and technical skill.

Buying Seeds Separately.—It is comparatively a simple matter to determine approximately the worth of seeds if examined separately ; and when the proportions desired are purchased thus, samples can always be subjected to expert analysis, so that we strongly urge the advisability of buying only unmixed seeds.

Guarantees.—With every species of pasture-seed, guarantees of purity and germination should be required, that is to say, the seed merchant ought always to specify the exact percentages of pure or true and of germinating seeds in each parcel ; and the buyer must see that these percentages approximate to those mentioned in columns 2 and 3 of Table I., page 39, as being the averages for good commercial qualities.

Gauge of Value.—The only reliable gauge of the worth of seed is its real value, determined as described in paragraph 2, page 38. Indeed, the gross weight of any parcel indicates absolutely nothing as to its practical worth unless its real value be known, since it may contain 90 or only 10 per cent. of pure and germinating seeds.

Cost of Seeds.—From the preceding paragraph it is obvious that the cost per lb. of pure and germinating seeds should form the basis of all purchases, and not merely the price per lb. gross,—a truth readily illustrated by comparing 2 bags, A and B, of Red clover seed, sold respectively at 6d. and 7d. per lb. :—

Mark of bag.	Weight in lbs. of seed in bag.	Percentage of purity of seed.	Percentage of germination of seed.	Cost per lb. of seed.	Total cost of seed in bag.
A (red clover)	10	60	40	6d.	5/-
B „	20	90	90	7d.	11/8

The real value of the seed in A = $\frac{60 \times 40}{100} \left(\frac{\text{Purity} \times \text{Germination}}{100} \right) = 24$ per

cent., while that of B is $\frac{90 \times 90}{100} = 81$ per cent. Then $\frac{24}{100}$ of A = $\frac{24}{100}$

of 10 lbs. = 2.4 lbs. is useful (pure and germinating) seed, as against $\frac{81}{100}$ of

B = $\frac{81}{100}$ of 20 lbs. = 16.2 lbs. But the 2.4 lbs. of useful seed in A cost 5s.,

or 2s. 1d. per lb., and the 16.2 lbs. of B are obtained for 11s. 8d., which is approximately 8½d. per lb.; so that the 6d. seed is really considerably dearer than that sold at 7d. per lb. Whence it is evident that the purchasing of cheap seeds merely because they are cheap is a grave error, apart from the important question of the greater proportions of noxious species present in low-quality samples.

Appearance and Weight.—While the true gauge of value is the percentage of pure and germinating seeds, preference should always be given to new, heavy, plump and fresh-looking qualities, since imperfectly matured, light and small seeds, though they may possibly germinate satisfactorily, produce only feeble plants that are exceedingly susceptible to external injurious influences.

CHAPTER VI

TESTING PASTURE SEEDS AT HOME

PRELIMINARY CONSIDERATIONS

Introductory.—While absolute accuracy can only be ensured by costly apparatus, the purity and germinating power of seeds may be simply and inexpensively ascertained at home sufficiently exactly for the results to constitute a valuable check on the guarantees given by seed-merchants; and, undoubtedly, if every sample were tested before purchase by the farmer himself, the risk of failure from inferior seed would be practically eliminated.

Useless Methods.—The method of testing usually employed is to sow a handful of seeds, and judge the worth of the sample by the thickness with which the seedlings come up: but it is hardly necessary to say that no system, which does not involve actual counting, can be even moderately accurate. Again, a very general impression obtains that if seeds be thrown into water, the good grains sink, while the light and dead ones float on the surface; but experiment conclusively proves that the floating seeds germinate slightly better as a rule than do the remainder.

Taking Samples.—The taking of samples is of the utmost importance if fair results are to be obtained; and the only safe method in the case of pasture seeds is to spread out each bulk; mix it thoroughly, and take numerous small samples with a clover-sampler. These in turn are mixed in a wide-mouthed flask, from which the seed is then poured slowly, small quantities being taken from the stream at regular intervals with a spoon. The seed so obtained is known as the “smaller average sample,” and is what is employed in the tests unless the presence of Dodder be detected, when the whole of the larger sample should be subjected to examination.

TESTING FOR PURITY

Volume of Test Sample.—An egg-cupful of seed makes a convenient “smaller average sample” for home-testing.

Genuineness of Seeds.—The genuineness or purity of a sample is usually ascertained directly by an examination, with a magnifying-glass if necessary, of the external appearance of the seeds comprising it, though that of the varieties of any species can only be determined by trial in the field or greenhouse.

Impurities.—All sand, chaff, stones, earth, seeds of other species or varieties, and broken or badly damaged seeds of the kind being tested must be regarded as impurities.

Method of Procedure.—The “smaller average sample” should be spread out on a smooth, black or white surface, such as an enamelled board, while the impurities are carefully separated out and weighed ; so that the percentage of pure or true seeds may be easily calculated.

Identification of Weeds.—So far as possible each weed-seed must be identified, because some are very much more noxious than others.

The presence of certain species is sometimes useful in determining the nationality of the seed under investigation ; but too much reliance must not be placed on conclusions of this description, owing to the ubiquitous nature of most weeds, and also to the fact that seeds of various nationalities are often mixed into one bulk.

TESTING FOR GERMINATION

Essentials for Tests.—The absolute essentials for accurate tests are suitable temperature, proper supply of moisture and free ventilation, though darkness is also highly desirable.

Temperature of Tests.—The normal temperature of germination under natural conditions is from 55°—65° F. ; and in artificial tests a constant temperature between 60° and 80° F. should be maintained. The heat of an ordinary living-room will, however, generally be found sufficient for home-tests, though a little fire may be advantageously provided if the night-temperature appear likely to fall very low.

Supply of Moisture.—Free access to water is necessary, but seeds do not germinate satisfactorily when immersed ; so that some such medium as felt, flannel, stout blotting-paper, etc., must be employed to supply abundant moisture without permitting water to actually accumulate round the seeds.

Ventilation of Tests.—Free access of air is most important, as carbonic acid gas is given off by the germinating seeds.

Darkness of Tests.—Light appears to exert a directly harmful influence on germination, so all tests should, as far as possible, be made in darkness, excepting those of seeds of the Meadow-Grasses (*Poas*), which do not germinate in darkness, but *must* be tested in the light. Yellow oat-grass seeds also germinate better in the light than in darkness.

Selection of Seeds.—Some of the genuine or pure seeds separated in the purity test are employed in the germination trials ; and it is most essential that those used should fairly represent the sample, proper proportions being taken of large, small and medium-sized, light and dark-coloured grains, of different stages of maturity.

Selecting Grass Seeds.—In the case of some grass seeds, it is not an easy matter to at once distinguish between empty glumes and those containing grains ; but this difficulty is surmounted by wetting the seeds and spreading them on a sheet of glass, which must be held up to the light, when the useful seed will appear opaque, and the chaff or empty glumes, translucent.

Number of Seeds.—As it is always desirable to make duplicate trials, two lots of 200 seeds of each leguminous species and three lots of 200 seeds of any grass should be tested.

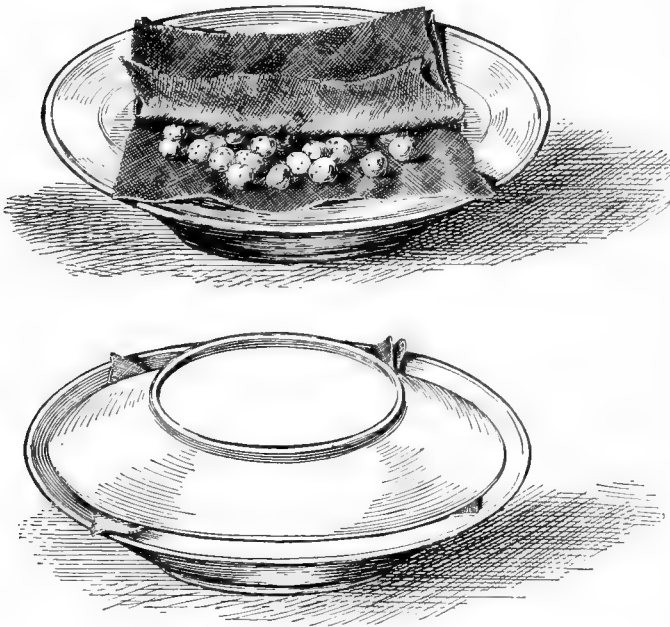
Preparing Seeds.—Since seeds soon become mouldy in a warm, moist atmosphere, it is well to hasten the process of germination by soaking them in water for from 6 to 15 hours before placing them in the germinator.

Duration of Experiment.—The following periods are those generally adopted for germination tests :—

- 10 days for Clovers and most other seeds,
- 14 days for Rye-grasses and Timothy,
- 21 days for all Grasses, excepting Meadow and Rye-grasses and Timothy,
- 28 days for Meadow-grasses.

Hard Seeds.—After most tests of leguminous species, a number of hard-shelled seeds will be found remaining apparently fresh and unswollen ; and though these are not reckoned when determining the percentage of germination of the sample, they should be carefully counted, since some proportion of them would germinate if allowed sufficient time.

Home-Made Germinators.—Perhaps the best and most simple apparatus for home testing is prepared by taking two plates, in one of which



HOME-MADE GERMINATOR (NO. 1).

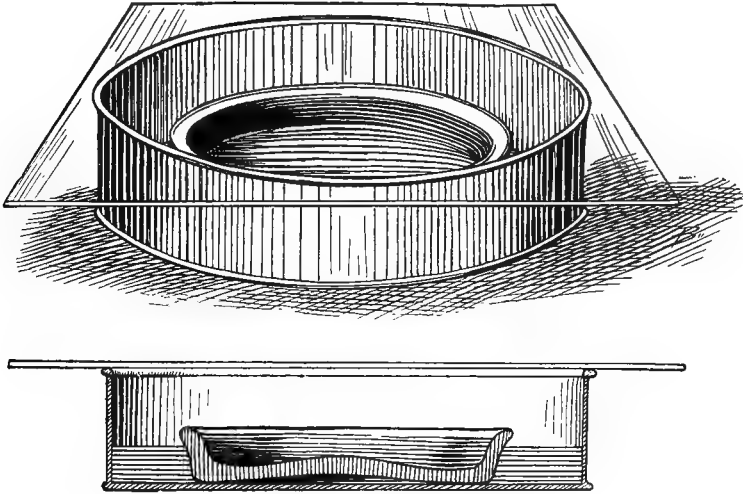
is placed a folded flannel or other woollen cloth which is very damp without being soaked. The seeds are placed regularly between the folds, and the whole is then covered by inverting the other plate over it (1).

Another equally simple apparatus is made by soaking a handful of cotton-wool in a glass or tin dish containing a little water. The seeds are placed on the cotton-wool, previous to the dish being covered with a sheet of glass.

Seeds may also be tested by placing them between the folds of damp flannel or blotting paper in a porous saucer standing in about half its height of water in a tin pan, which must be covered with a sheet of glass. Sufficient moisture will soak through the porous saucer to supply pasture seeds (2).

To test several samples at once, obtain a large dripping-pan, and place an inverted flower-pot saucer in each of the four corners. On these rest a flat,

wire frame-work, on which folded pieces of flannel or blotting-paper are placed, each with an end or flap hanging down into the water in the dripping-pan. The seeds are put between the folds; and the hanging flaps, by capillary

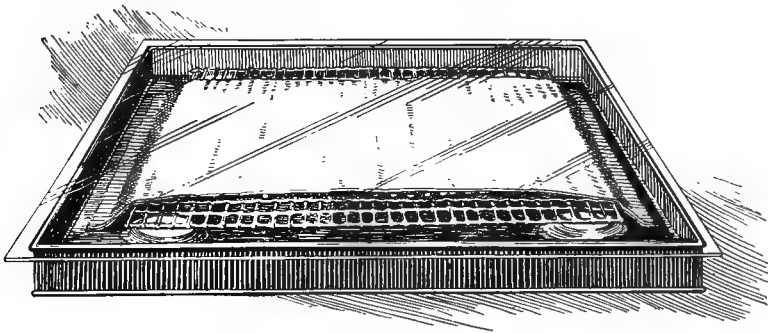


HOME-MADE GERMINATOR (No. 2).

action, keep them supplied with moisture. Of course, it is best to cover the tin with a sheet of glass to minimise evaporation (3).

Precautions.—All record papers should be marked only with lead pencil, as ink is liable to become blurred by contact with water.

The cloth between the folds of which seeds are to be germinated should



HOME-MADE GERMINATOR (No. 3).

preferably be made of wool; and it is most important that it be free from dyes which might injuriously affect the seeds.

As tins are very liable to rust during germinating-tests, every one that is used should be prepared by giving it two good coats of paint.

Mould is very troublesome when testing seeds; and all cloths, saucers,

tins, dishes, etc., used must be sterilized by being washed in boiling water, to destroy fungus spores.

Method of Procedure.—Having placed our seeds between the folds of the flannel or blotting-paper in whichever apparatus is most conveniently prepared, together with a slip of paper bearing in pencil the name of the species or variety, the number of seeds employed and the date of the commencement of the experiment, we must each day count and remove all sprouted seeds, at the same time marking in pencil on the paper the number so abstracted. At the end of the period of germination previously specified, the total number of germinated seeds is counted; and from their sum the percentage of germination is readily calculated. Though the hard-shelled seeds are not included in the number of sprouted grains, special mention should be made of them after they have been carefully counted.

CHAPTER VII

SOWING PASTURE SEEDS

PROTECTIVE CROPS

General Considerations.—Not only does a protective crop shield the young pasture from the evil effects of drought, frost and wind, but it profitably utilises the soil while the grasses and leguminous plants develop, and renders great assistance by keeping weeds in check until the young pasture plants are sufficiently strong to successfully contest the ground with them. If the seeds be sown without a protective cereal, a costly process of weeding is usually necessary to remove noxious species which are propagated principally by their roots, the annual seed-producing kinds being, of course, readily destroyed by an occasional mowing with a scythe, an operation of great benefit to the young grasses. It follows, therefore, that a protecting crop is desirable in all cases, excepting perhaps for the formation of ornamental swards. In the interests of the future pasture, it is much preferable to cut a cereal for green fodder than to permit it to mature for the production of grain or straw, because the necessary protection is thus afforded without shading the pasture plants too long and without taking so much out of the land. The choice of corn must naturally to some extent be controlled by the character of the land.

Thickness of Sowing.—Thick seeding with a cereal is directly injurious, as the plants tiller out and occupy the space which should be devoted to the grasses and clovers; besides which, the heavier the sowing, so much the greater is the danger and loss to be apprehended from the crop being laid. Indeed, it is absolutely essential to the success of a pasture that any protective cereal be sown thinly only; and this is especially so in the case of winter corn in which a mixture is to be sown in spring. Not more than half the usual quantity of Barley should be used, though greater proportions of other cereals may be employed.

Cereals to Cut Green.—Of all spring-sown protective crops, Oats, to be cut green, are most to be preferred, because they do not occupy the land too long when cultivated in this way, while, if properly managed, they give a good supply of excellent green fodder. By taking the first cutting when the crop is not more than 6 or 7 inches in height, all risk of injury to the grasses and clovers is obviated; a second and considerable crop of green fodder is obtained from the Oats; and a third and final cutting may be taken in autumn from the young pasture plants.

Summer bearded Wheat is sometimes sown to shelter young pastures and supply abundant green fodder; but as it springs oftener and continues

growing longer than Oats, it is apt to shade the ground too late in the season.

Rye excels Oats in hardiness, and is therefore more often used for autumn sowings to produce green fodder.

Cereals for the Grain.—Amongst spring-sown protective cereals, Wheat is most desirable, since it dies out of the land sooner than Oats, and does not tiller out too freely.

Summer barley can only be relied on in good land ; does not yield much straw ; and in favourable seasons occasionally tillers out so luxuriantly as to eventually leave vacant spaces in the pasture.

Oats occupy the land too long, and are too easily laid for a desirable protective crop.

Winter Wheat and Rye are sometimes employed to protect spring-sown seeds ; but they are readily laid, and are frequently thus responsible for serious injury to the young fodder plants, especially to leguminous varieties.

Other Protective Crops.—Rape and Flax have been employed with more or less success ; but the latter is not generally cultivated in this country, while sheep do great damage to the young pasture when feeding off the former.

TIME OF SOWING

Spring Sowing.—Spring is undoubtedly the most favourable season for the sowing of pasture mixtures, because there is always sufficient moisture remaining in the land from the winter to ensure germination and to support the young plants. From the third week of March until the end of the first week in May is the safest time ; and as a general rule, the earlier the seeds can be got in during this period the better will be the results. Sowings made in early March incur risk of serious injury from late frosts, unless they are protected by winter corn.

Leguminous plants and some grasses do not resist severe frost and the uprooting action of alternate freezing and thawing so well when the seed is sown in autumn as when the seeding is done in spring, because the spring-raised plants have a longer period in which to become established before the winter, while the seedlings generally vegetate more freely during spring than in autumn, and are consequently better able to defend themselves against such encroaching plants as Fiorin. In addition, the plants from a spring sowing always grow more luxuriantly during the following spring than do those of autumn-sown pastures.

Sowing with Corn.—It is permissible to sow considerably earlier in a winter cereal, as the young fodder plants are sheltered by the corn, which should be about 2 inches in height when the seeds are sown. The more general practice, however, is to sow immediately the protective cereal has been got in during spring, preferably in April.

Sowing on old Leys.—Seeds may be sown at the end of February or quite at the beginning of March on an old Clover or Sainfoin ley which was heavily dragged the preceding autumn, and top-dressed in early winter.

Summer Sowing.—Pasture seeds are occasionally sown in June after green Rye or Vetches, the first hay crop, Trifolium, &c., but such sowings are reliable only in very wet seasons.

Autumn Sowing.—While autumn sowings after potatoes, green fodder crops and, occasionally, cereals are always hazardous excepting in wet years, they are sometimes absolutely necessary, owing to the impossibility of

preparing heavy, tenacious land in good time in spring; but the plants are liable to injury both from drought and early winter frosts, by the latter of which young clovers are often killed outright. August and the first week of September is the safest period in autumn for getting in the seeds.

THEORY OF SOWING

Design in Sowing.—The aim in sowing pasture seeds should be to ensure their distribution at the most suitable depths as regularly as possible all over the surface of the field, so that no bare patches may be found in the sward later in the year: for not only is patching difficult, but it is also a relatively costly process.

Depth of Sowing.—On heavy land it is not really necessary to cover pasture seeds at all; and many seeds, indeed, will not, as previously mentioned, germinate in any soil at a greater depth than half-an-inch, so that the object should be to just hide the seeds, to protect them from being scorched by the hot sun or eaten by birds. Sainfoin and, generally, Tall oat-grass seeds require burying as deeply as does that of the protecting cereal, and may advantageously be mixed, sown and harrowed in with it; while the Meadow-grasses and Crested dogstail-grass germinate most surely and become established best when merely pressed into the surface of the earth by the roller.

Mixing the Seeds.—Owing to the fact that clover and Timothy seeds are heavier than those of the remaining grasses, it is impossible to mix them sufficiently thoroughly to ensure their regular distribution, as the more weighty species naturally work to the bottom of the bags. Moreover, when sown broadcast, the lighter seeds are not thrown so far as those of relatively greater weight. Hence it is obvious that 2 mixtures should be prepared and sown separately, one containing the heavy, and the other the lighter seeds. The following division is desirable:—

<i>Heavy Seeds.</i>	<i>Light Seeds.</i>
Red clover.	Perennial rye-grass.
White clover.	Italian rye-grass.
Alsike clover.	Meadow fescue-grass.
Lucerne.	Cocksfoot-grass (in husk).
Other leguminous species.	Meadow foxtail-grass.
Timothy.	Sweet vernal-grass (in husk).
Cocksfoot-grass (husked).	Fescue-grasses, fine-seeded.
Sweet vernal-grass (husked).	Yellow oat-grass.
Crested dogstail-grass (heavy seed).	{ Crested dogstail-grass (light seed).
	{ Meadow grasses.

Since, however, Crested dogstail and the Meadow-grasses germinate best when only pressed into the soil, it is advisable to make them into a separate mixture, to be sown immediately before rolling.

Cross-Sowing.—By distributing a portion of the seeds up and down the field, and the remainder from side to side across the land, much less risk of bare patches being left is incurred. The heavy seeds should therefore be sown first, the lighter species being distributed afterwards across the previous sowing. If, however, the seeds are all mixed together, half of the bulk must be sown in each direction.

PRACTICAL SOWING

Essentials for Success.—Beyond a fine, firm and level seed-bed, the necessity for which has been already demonstrated, a sufficiently dry soil to permit of the harrow and roller working without clogging and a day still enough for the seeds to be distributed tolerably regularly are essential.

Preparation for Seeds.—Immediately before sowing a harrow must be run over the land. When it is merely intended to roll the seed in, a ring, or Cambridge, roller may be substituted for the harrow.

Sowing the Cereal.—Sow the protective cereal broadcast, mixed with what Sainfoin and Tall oat-grass seeds are to be used ; and harrow the sowing in. If intended to mature for grain or straw, the corn is sometimes drilled alone, so that the pasture shall not be too densely shaded ; but the method of broadcasting appears to keep weeds in check better by more fully occupying the ground with the grasses and clovers.

Preparation of Mixtures.—Separate the seeds to be sown into 2 mixtures, containing respectively the heavy and light species. Where the slight additional expense of crossing the land a third time is not a consideration, make a separate mixture of the Meadow-grasses and Crested dogstail-grass, though this is unnecessary when the seeds are to be only rolled in and not covered with a harrow.

Distributing and Covering.—Though excellent results are often obtained by skilful broadcasting, the seed-barrow distributes the grains nearer to the ground, and should therefore be preferred under ordinary conditions.

The heavy seeds must be sown up and down the field, the lighter mixture following next across the land.

The whole should then be touched over as lightly as possible with a bush or light iron harrow. If the soil be heavy, the process of harrowing may be omitted if desired.

Immediately after the harrowing, the mixture of the Meadow-grasses and Crested dogstail-grass is sown ; and finally a tolerably heavy roller must be passed over the whole field twice in opposite directions.

When sown in a winter cereal, the seeds cannot be harrowed in, but are merely pressed into the surface with a roller, as this operation does not injure the corn at all.

CHAPTER VIII

CARE OF NEW PASTURES

ROLLING

Objects of Rolling.—The immediate objects of rolling pastures are,—first, by consolidating the soil, to enable plants to get a good grip of it; second, to rebury the grasses which are partially or wholly uprooted by alternate freezing and thawing in winter; and third, to level down those species that grow, like Hard fescue-grass, in tufts into a good, level mowing-surface.

Rolling Young Pastures.—In the case of young pastures it is not only essential to roll the land as heavily as possible immediately after sowing, but also after the first cutting in autumn and 2 or 3 times during the ensuing spring, when the ground is dry. Each of these operations should be repeated annually for several years.

MANURING

Top-Dressing Young Pastures.—During the first year no liquid manure should be given, as it is then hurtful to the finer grasses; but a top-dressing of strawy manure may be afforded in autumn to at once improve the soil and protect the pasture plants from winter frosts.

EARLY TREATMENT

Pastures without Corn.—When pasture seeds are sown without a protective cereal, the young plants should be topped with a scythe directly they are 3 or 4 inches high, the roller being passed over the land immediately afterwards. By continuing to mow and roll frequently during the summer the young grass is much strengthened, and annual weeds are kept in check, though hand-weeding is necessary to destroy deeply-rooting perennial species. In early autumn the pasture may be laid in for a small cutting, to be followed by grazing with cake-fed cattle only.

Towards the middle of May it will be easy to see where the seeds have taken; and every bare patch must be broken up, raked or harrowed, and re-sown, before being rolled. If the failure is general, the land should at once be shallowly cultivated, harrowed and rolled to a fine tilth, re-sown and finally rolled.

Pastures with Corn.—If the corn be intended to produce green fodder only, it is most important in the interests of the young pasture that the first cutting be taken when the cereal is about 6 or 7 inches high ; but the necessity for this has already been fully considered on page 54, under the heading of “ Protective Crops.”

When corn is sown for the production of grain or straw, nothing can be done for the young fodder plants, excepting hand-weeding of Docks, Thistles, &c., until the cereal is off the land. Sheep must never be permitted to graze the stubble in autumn, as they uproot large proportions of the finer grasses ; and it is questionable if horned stock should be allowed on the land, even after a wet and growing summer, though a small cutting may generally be taken.

Directly the corn is harvested, the plant must be carefully examined for bare patches, which should be broken up, re-sown and rolled ; and it will, of course, be necessary to re-examine the patched places in spring to see if the seeds have taken properly. When the sowing appears to have failed entirely, re-sowing is usually deferred until spring, owing to the difficulty of preparing a stubble in time for autumn seeding.

As a cereal takes a good deal out of the land, a liberal top-dressing of manure ought to be given in autumn.

Autumn-Sown Pastures.—The growth of the plants must be encouraged by frequent use of the scythe and roller before winter ; and in late autumn a light top-dressing of strawy manure should be given, as much for protection to the young plants as to enrich the soil. The grass is topped and rolled in spring, preparatory to an early hay crop being taken ; after which, grazing with cake-fed cattle may follow. Sheep must be kept off the land for 18 months or so after sowing.

During March bare patches in autumn-sown pastures must be sought out and re-sown ; and if the clover-plant appear to have failed, more seeds should be bushed and rolled in.

Water-Meadows.—Newly-sown water-meadows must be irrigated very little for the first two years,—until the young plants are firmly established.

CHAPTER IX

CARE OF ESTABLISHED PASTURES

EXTIRPATION OF UNDESIRABLE SPECIES

Necessity for After-Care.—Without after-care good pastures rapidly depreciate in value.

Methods of Extirpation.—While annual weeds may be eradicated by frequent mowing, which prevents the maturing of seeds, and surface-rooting perennials, like Creeping buttercup (*Ranunculus repens*), can be torn up with a short-toothed harrow, such deeply-penetrating species as Thistles, Docks, &c., must, if possible, be removed with a spud or two-pronged lever. Hand-weeding is, however, only effectual if undertaken early and while the noxious plants are confined to local spots. Where labour is not available for hand-pulling, the weeds must be cut when in full flower, the process being repeated 2 or 3 times until the plants are exhausted and destroyed.

Breaking-up Pastures.—If a pasture has once become foul with the seeds and roots of perennial weeds, no remedy remains but that of breaking it up, and taking a course of cleansing crops before returning the land to grass. The prevalence of Sedges (the genus *Carex*), Marsh thistle (*Carduus palustris*) and similar moisture-loving species indicates the necessity of drainage, liming and rotation under horse-hoe husbandry until all the weeds have disappeared.

The roots of couch and other perennial weeds must be collected into heaps by hand after ploughing, to be burned conveniently, as the root-fragments possess the power of vegetation.

Methods of Improvement.—The surest method of overcoming weeds is to ameliorate the physical condition of the land by thorough drainage, ploughing and the liberal application of suitable fertilizers, especially of super-phosphate.

Such undesirable grasses as Crested dogstail which are rejected and allowed to flower by stock become self-seeding, and consequently possess so great advantage in the struggle for existence over those that are kept cropped by animals as to enable them to predominate in the pastures where they occur, because the better, closely-eaten species are dependent on their roots or creeping stems for increase. The only method of replacing inferior by desirable grasses is to gradually weaken the former by mowing them annually when they are in full flower and before they have matured seeds, and to afterwards scatter the seeds of the latter over the pasture in early autumn.

Spreading Droppings.—As the value of the droppings of stock is

discussed on page 62, we need here merely point out the necessity of frequently spreading them evenly over the surface of the pasture to prevent loss of food, as the grasses in immediate contact with unspread manure are rejected by stock and grow into rank tufts, and also to obviate the possibility of Ergot attacking the flower-heads which are thus produced.

GRAZING

Profitable Grazing.—Not only must the improvement of stock be considered, but it is most important to maintain or increase the fertility of the land by stocking it with cake-fed animals or otherwise manuring it.

Horses and mules bite very closely to the ground, and by their continual movements waste more herbage than cattle. When feeding off a pasture it is advisable to confine its use at first to horned stock, which chiefly gather the taller herbage, horses following, and sheep, which eat without repugnance what is left, coming last of all.

Some horses or sheep are necessary in every pasture, but too great a proportion injures the sprouting of the plants. By properly proportioning the animals and regularly moving them, pastures can be fed off evenly, and wholesome changes of diet may be provided.

In orchards it is sometimes necessary to fasten a kind of martingale on cattle, to prevent them reaching the branches of fruit-trees and hedge-plants, while allowing them as much liberty as possible. As a general rule, liberty is as essential for profitable grazing as is freedom from disturbing influences.

Grazing in Spring.—The date at which grazing can be safely commenced in spring varies with the seasons; but cattle should not be turned out until the grasses have made a fair start and until the ground is sufficiently firm to prevent treading injuring the young shoots, though by too great delay a portion of the fodder, growing hard and unpalatable, may be rejected by stock. It is especially important to keep sheep off grass which is just starting into growth, since they eat some plants off so closely as to occasionally destroy them altogether; besides which their peculiar snatching method of feeding is responsible for the uprooting of many young grasses. Of course, those pastures in which early species predominate will be ready for grazing first.

Grazing in Autumn.—Pastures should be eaten down close before winter; but the time at which stock must be taken off the land depends entirely upon the season; and should be so regulated that autumn grazing does not interfere with the spring pasturage.

Irrigated Pastures.—Irrigated pastures can only be grazed during summer and the first days of autumn, when the soil is so dry that the hoofs of stock do not make an impression on the surface. When depastured in late autumn or winter, the banks of the ditches are often broken down, and the treading of heavy stock makes cavities in the ground, in which water accumulates and rests during the winter, to the detriment of desirable pasture plants and the encouragement of sedges and other weeds of moist lands.

Tufts and Culms.—If from neglect in spreading droppings or from any other cause certain plants are rejected by stock and grow into coarse tufts, they must be cut with a scythe; after which the new herbage will be readily eaten. Every tuft should be cut in December.

The flower-culms of such grasses as Crested dogstail and, to a less degree, Perennial rye-grass—which are passed over by stock—must be prevented from

seeding by mowing, since the very fact of animals permitting them to mature seeds while neighbouring species are bitten down closely, is conclusive evidence of their unfitness for pastures.

ENRICHING PASTURES

Origin of Weeds.—In most cases the presence of noxious weeds is directly due to the land being starved; and it is obviously useless to expend labour and money in endeavouring to improve the herbage by seeding until this defect be remedied.

Droppings of Stock.—Too general an impression prevails that the droppings of stock fed on the herbage of a pasture alone are sufficient to maintain its fertility; but it should be unnecessary to point out that thus there is a continual drain on the land for the production of meat, milk, etc., and that the soil must consequently grow poorer year by year.

Undoubtedly the most economical method of manuring a pasture is that of heavily stocking it with animals receiving liberal rations of cake (preferably decorticated cotton), corn and other foods, as not only is the cost of cartage saved, but the droppings are richer in fertilizing constituents than is ordinary farmyard dung, because there is no waste by drainage and much less by volatilizing than when manure is stacked in heaps.

Farmyard Manure.—Beyond its manurial constituents, farmyard dung abounds in valuable humus-forming matter, which is most important in ordinary soils. It should, to avoid risk of rendering the herbage impure, be applied to pastures only after the last autumn cutting; though liquid manure, which usually gives the best results on grasses, may be used even when the plants are in active growth.

Liquid Farmyard Manure.—Liquid manure made from fresh dung contains so many seeds of White and Red clovers, which have passed through stock undigested and without losing their germinating power, that its application is equal to a light seeding of these species, though, of course, there is the risk of a like proportion of noxious weed seeds being introduced.

Selection of Artificials.—Sir John Bennett Lawes and Sir J. H. Gilbert's famous experiments demonstrate that while nitrogenous manures, such as ammonium-salts and nitrate of soda, are most beneficial to grasses, potash and phosphoric acid produce the most profitable crops of leguminous plants; that the application of any fertilizer, by increasing the luxuriance of some individual plants, more or less reduces the total number of species; that "if artificial manures are largely or mainly relied upon, certain descriptions of herbage will be unduly forced at the expense of others; and also that the character of development of the plants will be materially affected. In order to maintain a due admixture of herbage on grass-land mown for hay, farmyard or stable dung should be liberally applied; and it is also conducive to the same end to consume the second crop on the land with cake or corn. The more a good condition of the herbage is induced and maintained by such means, the more safely may some increased luxuriance, and so increased produce, be obtained, by the judicious use of artificial manures. Provided dung be liberally used, it will not as a rule be necessary to apply potash artificially; but phosphates may advantageously be used as basic slag, and nitrogenous manure in the form of nitrate of soda, which, however, should seldom be used at the rate of more than 1 cwt., or at most 1½ cwt., per acre."

Sir John B. Lawes recently informed us that one of the very best artificial manures which could be applied to pasture land is

1 cwt. Saltpetre }
3 cwt. Basic slag } per acre ; sown early in March.

Manurially speaking, the elements required for plant-growth are nitrogen, phosphoric acid, potash and, occasionally, lime.

Heinrich recommends the following trials as the best and most simple method of determining experimentally which of these nutritive elements are required by any particular soil. Nine small plots of uniform size are marked off and dressed as follows, equal quantities of the same fertilizers being, of course, applied to the different plots :—

1st plot :	Potash.
2nd „	Gypsum.
3rd „	Phosphoric acid (superphosphate).
4th „	Nitrogen (dried blood ground to powder).
5th „	Potash and phosphoric acid.
6th „	Potash and nitrogen.
7th „	Phosphoric acid and nitrogen.
8th „	Phosphoric acid, nitrogen and potash.
9th „	No manure.

The manure applied to the plot which gives the largest yield contains the element, or elements, required by the soil. If the heaviest crop be obtained from plot 1, 2, 3 or 4, one nutritive element is wanted only ; if from plot 5, 6 or 7, two substances ; and if from plot 8, phosphoric acid, nitrogen and potash are needed ; while if from plot 9, the land is not lacking in any of the 3 principal elements of plant-growth.

Such experiments are of more use, however, if they are continued for several years.

HARROWING

Harrowing Old Pastures.—A succession of wet seasons often has the effect of eliminating some grasses which are only adapted for dry soils ; and not infrequently a felted turf of such kinds as Fiorin is formed to the great injury of more productive species, which are liable to be stifled because the matted network of stems does not permit the access of sufficient heat and air. The result of this state of affairs is that the land becomes sour and unwholesome, and little by little produces worthless sedges and mosses, instead of nutritive herbage.

In such cases and, indeed, in all old pastures infested with moss or matted plants, harrowing at the end of March, in April or during early autumn, is of the utmost importance to tear up mosses and creeping surface-rooting species, and so admit light and heat to the soil, to permit the growth of more productive and nutritive grasses and leguminous plants.

After the moss and worthless seeds have been torn up and raked together, a well-mixed compost containing some $\frac{1}{5}$ of its bulk of lime may be applied to the pasture, to be spread with the harrow, which, of course, levels such inequalities as mole-hills and ant-heaps. Every harrowing should be immediately followed by a heavy rolling.

Moles and Mole-hills.—The runs and hills of moles are decidedly

injurious to pastures, especially in low-lying valleys and irrigated lands. Their hills, which make the surface of the pasture uneven, and so prevent close and economical mowing, must be levelled with a light harrow after the crop has been taken, or in winter while the pasture plants are dormant, very old and hard ones being broken up with a fork. The moles are easily destroyed by setting in their runs skilfully prepared mole-traps or foods treated with *Nux Vomica* (*Strychnos Nux-vomica*).

SEEDING OLD PASTURES

Seeding.—Given a tolerably fertile soil, chiefly occupied by inferior grasses, a pasture may be very much improved by the introduction of more nutritive species by seeding.

Selection of Seeds.—Clover, Timothy and Yarrow seeds are heavy and smooth, and readily find their way to the soil through the herbage of a pasture, as also do those of Cocksfoot, Meadow foxtail and Tall fescue by means of the upward-directed stiff hairs of the seed-covering; and fortunately White clover, Timothy, Cocksfoot and Yarrow are the species principally required for improving most pastures.

Method of Sowing.—About $\frac{1}{2}$ of the quantity of seed required to form a new pasture should be sown after harrowing; and the sward must then at once be firmly rolled down. On damp lands it is well to apply a good dressing of compost before sowing.

In the case of meadows, seeds can be bushed in before the grass starts into growth in spring, directly the hay-crop has been carried during June, or in early autumn.

WATER-MEADOWS

Method of Treatment.—Water-meadows are ordinarily grazed during the summer, and folded or, less often, mown in the following spring. The water-furrows must be thoroughly cleaned in autumn; and several successive overflows should be given during the winter.

HAY-MAKING

Clearing the Land.—Since the “bottom-herbage” is always thicker than the top in a good meadow, it is most important to set the mowing machine as low as possible; and this can only be safely done when stones have been picked off the land early in spring.

Early Cutting.—Not only do most pasture plants become hard and depreciate in nutritive value and digestibility with age, but the ripening of seed weakens them and seriously lessens their aftermath. Indeed, if some of the less robust grasses be allowed to mature seed while young, or for several years in succession when thoroughly established, they disappear altogether from the land, leaving gaps to be filled with worthless and, possibly, noxious indigenous herbage. Hence the crop, especially in the case of young meadows, should be cut before the earliest species have formed seeds, even though the produce is liable to shrink proportionately slightly more than would that of older growth.

The following table, arranged by Mr. W. Carruthers from data amassed

by Mr. David Wilson, clearly illustrates the depreciation of pasture grasses in food value with age.

COMPARATIVE FOOD VALUE OF TWELVE GRASSES AT DIFFERENT STAGES OF THEIR LIFE.

Name of variety.	In full leaf.	Beginning to bloom.	After bloom.	Seeds ripe.
Cocksfoot	137	100	87	70
Meadow foxtail.....	148	106	89	81
Tall fescue	136	103	92	73
Meadow fescue	149	116	82	74
Sweet vernal	146	113	89	82
Yellow oat-grass	140	97	80	77
Timothy.....	137	104	83	79
Rye-grass	136	106	84	78
Wood meadow-grass	129	101	91	80
Rough-stalked meadow-grass ...	112	104	100	73
Crested dogtail	131	106	83	74
Hard fescue	145	99	108	100

Briefly, one loses in quantity by too early cutting, and in quality by too late mowing, while late cutting is prejudicial to the aftermath.

It is occasionally necessary to cut early in order to prevent specially noxious weeds maturing seed, and also when the crop is laid and liable to rot ; and in very wet years late mowing is sometimes unavoidable, since hay which is a little fibrous and hard is better than that injured by excess of moisture.

Lattermath Cuttings.—Though lattermath hay is generally considered superior in nutritive value, the heavy autumnal dews and succulence of the plants themselves combine to render its making precarious ; and it is perhaps better to utilise the crop green or as ensilage.

Drying by Sun.—The usual method of drying hay is to spread it out in the sun as soon as it is cut. On the following day it is turned once or more, and at night is made into cocks, to be spread out again the next morning when the dew has evaporated. As dew is most injurious, it is, however, a much better plan to make it into cocks the first night as well.

In favourable weather, the tedding-machine may be used freely the second day for ordinary meadow hay ; and crops which are not very heavy or do not contain large proportions of leguminous plants can generally be carried during the evening of the third day. In periods of continued wet the grass must be left as cut unless it is made into silage.

The leaves of clovers and other leguminous plants, when dry, are brittle and break off very easily ; and the produce of such plants should be carefully turned by hand in the swathe as little as is absolutely necessary.

There is always a risk of injurious heating in the rick if succulent grasses or clovers be carried before sufficient moisture has evaporated. An excellent method of testing their dryness is to twist a few stems into a rope, when—if moisture exude—the crop is not yet fit to carry.

As rain washes a large amount of nutriment out of the plants (Wolff states that cold water passed through clover-hay extracts from 25 to 40 per cent. of the dry substance), partially dried hay should always be made into compact cocks if rain be feared, because less water has access to it thus. When heated cocks are spread out in fine weather, the hay dries very rapidly.

Brown Hay.—While greenness is justly regarded as an indication of well-made hay, it is sometimes desirable to make clovers into brown hay to obviate the necessity of frequent turning and consequent loss of leaf. The plants, being turned only once during the period, are dried in the sun until about $\frac{2}{3}$ of the contained water is evaporated, and are then made into large cocks, the heating of which completes the process of drying in 5 or 6 weeks.

Drying by Air.—To prevent loss, Red clover and Lucerne are sometimes cut with the scythe; and, after drying for 2 or 3 days in the swathe, are made into small sheaves, the driest plants being placed in the centre. These sheaves are bound with strong flower-culms at the top, and are formed into stocks, the cut ends resting on the ground, so that free access of air beneath is possible. A few days complete the process of drying; but if the stocks are overturned by wind, they must be set up again at once.

Remaining Herbage.—Some proportion of the hay is always left behind in the meadow; and cattle should be run over the land for a few days to clear up remnants and also the grass not touched by the mowing machine.

Inferior Hay.—Herbage cut too late, carelessly made into hay, or exposed too long to the action of solar heat or rain, yields brittle, dry hay, of little savour; while hay imperfectly sheltered from rain and dew, or which has been ricked before being properly dried, becomes discoloured and acquires a disagreeable odour, owing to the internal fermentation set up by excess of moisture. The herbage of river-side pastures exposed to spring floodings also yields bad quality hay, dry, brittle and dusty, with a more or less pronounced marshy smell.

Generally speaking, low quality hay gives off, when shaken, an irritating dust, that is injurious to stock.

The thorough shaking of inferior hay with a pitchfork will detach much objectionable dust, and most of the particles of lime or sand adhering to the stems and leaves, but it is a better practice to put it through the threshing machine, as the greatest possible amount of dust should be removed. After thoroughly shaking it, soak it for an hour in a brine made from salt and water, 15 lbs. of salt being used for every ton of hay. Of course this is not necessary if salt has been sprinkled in the rick as advised in a subsequent paragraph. Finally mix it in as small proportion as convenient with good, well-made hay before feeding it to stock.

The fetid smell of really bad hay unfits it for use even as litter, and it should therefore be conveyed to the dung heap.

RICK-BUILDING.

Staddles for Rick.—So far as possible, ricks should always be built on stone or iron staddles, both on account of the excellent bottom ventilation thus afforded, and to prevent injury to the hay from soil-moisture.

If staddles cannot be provided, a layer of faggots will serve as a foundation for the rick.

Shape of Rick.—The least possible surface must be exposed to the air, so that a square shape, with roof just sufficiently steep to shoot off snow and rain, is most desirable. Of course the bottom of every rick should be smaller than the top, so that drippings from the thatch may fall clear to the ground.

Method of Building.—When building a rick, the centre is always kept higher than the outside; and every layer must be firmly trodden down.

Coarse or weathered hay may be rendered much more palatable by sprinkling each layer with rough salt, about 15 lbs. being used to the ton.

Ventilation of Rick.—Ventilating shafts, made by pulling up hay in the centre of the rick, are only necessary when the crop cannot be carried in really good condition.

Rick-Cloths.—Rick-cloths prevent injury from rain, and also obviate the necessity for running up and thatching a rick before the first rise of heat is properly dissipated.

ENSILAGE.

Preparation of Silos.—The essential parts of a silo are 4 walls and a floor, as nearly dry and air-tight as possible, and a movable zinc or iron roof or lid, fitting closely inside these 4 walls. So then, if a suitable building be not available, a well-drained pit, the floor and sides of which are formed of concrete, stones or even dry earth, may be utilised.

The necessary downward pressure on the lid can be provided by screws, levers, stones or barrels of water.

Advantages of Silos.—In very wet seasons much waste is obviated by preserving meadow-grass, clovers, etc., in silos instead of making them into hay; and this always applies more or less to lattermath cuttings. Loss of leaf by leguminous plants and of the short "bottom-grass" of meadows are prevented by converting the produce into ensilage; and coarse, hard grasses are rendered much more palatable and wholesome. Silage takes the place of fresh grass in winter, being especially valuable for dairy cows, though desirable for all stock.

Method of Procedure.—The crop must be cut on a fine day while the stems are yet very succulent,—a little sooner than for hay; and it is, after some hours exposure to the atmosphere, carried, placed in the soil, being well trodden down round the walls, and closely covered to exclude air. Preparatory chaffing of course adds to the expense.

Sour silage, which is not always relished by cattle at first, is made by carrying the produce immediately it is mown.

After time has been allowed for shrinkage, more herbage is added until the silo is quite full, when the lid is promptly replaced and properly weighted.

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