"GRASSLANDS AND FORAGE CROPS IN ROTATION"

by

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The title of this paper is suggested by a proposal from the Imperial Bureau of Pastures and Forage crops that a joint publication from the Imperial Bureaux of Soil Science and Pastures and Forage Crops be made on the question of "Grasslands and Forage Crops in Rotations." This work is promulgation in the belief that one of the major trends in the agriculture of many countries is an increase in the attention being devoted to the use of grass swards and forage crops in rotations, and in general to the place of grass in the development of systems of permanent agriculture. I have been asked to make a contribution from New Zealand.

THE INFLUENCE OF CLIMATE ON FARMING IN NEW ZEALAND:

Economic farming practices are dictated by, and formulated upon, natural ecological conditions governed largely by climate.

New Zealand has essentially an insular and temperate climate with a high average rainfall, a not excessive number of rainy days, interspersed with abundant sunshine. These facts are intimately linked up with our farming fortunes. The following meteorological data based on long period averages and supplied by the Director, Meteorological Office, Air Department, give a fairly accurate insight to the climate of New Zealand.

The annual average earth temperatures at 1 ft. deep is 58°F. in the North Island and 55°F. in the South Island. The average for the coldest month in the North Island is 44°F. and for the South Island 37°F. The average for the warmest month is 72°F. in the North Island and 69°F in the South Island

The annual mean air temperature for the North Island is 55°F. and for the South Island, 51°F. The mean annual minimum temperature averaged for North Island stations is 27°F. and for South Island stations 21°F., while the corresponding maximum figures are 83°F. and 86°F. respectively.

The mean daily grass minimum temperatures over the year are North Island 41°F., South Island 35°F., while the mean annual minimum averaged over North Island stations is 20°F. and over the South Island is 13°F. Ground frosts occur on an average, during 56 nights at North Island stations and during 118 nights at South Island stations. Snow falls on an average 3 days annually for the North Island and 6 days for the South Island. The average duration of bright sunshine ranges from 1654 hrs. to 2416 hours for the North Island with a mean of 2110 hours; and in the South Island, from 1584 hours to 2510 hours with a mean of 1935 hours. Wind is prevalent in New Zealand; the mean 24 hourly anemometer run is 127 miles in the North Island and 97 miles in the South Island. The mean annual highest 24 hourly run is 426 miles for the North Island and 368 miles for the South Island.

The mean annual rainfall for the North Island is 48 inches, rain being recorded on 160 days. That for the South Island is 33 inches, falls being recorded on 130 days. The range of annual rainfall in the North Island is from 30-80 inches exclusive of mountains where 150 inches is exceeded in only a few isolated places. East of the ranges of the South Island the range is from 15-35 inches with an average of 28 inches; west of the ranges of the South Island the range is from 80-150 inches, and 150 inches to 250 inches in the Southern Alps. The average is 152 inches recorded on 188 days.

The variations in climate for the North Island and South Island set out above clearly differentiate the type of farming within the two Islands. In this, minimum temperatures and rainfall are the two outstanding factors. Thus a fall of approximately 7°F. in the minimum earth temperatures, 4°F. in the average air temperatures and 6°F. in grass minimum temperatures, together with a decline in rainfall from 48 inches average to 28 in. average (exclusive of west of ranges), predestines the ploughable country of the North Island to practically an all grass farming system, and that of the South Island to rotational pastures and arable crops.

Climate also influences the kind of stock run and whilst there has been but little planned stocking on an animal ecological basis in New Zealand agriculture, yet almost automatically the North Island and wetter parts of the South Island have run predominantly to Romney sheep, while throughout the drier and colder areas of the South Island the Merino and Corriedale are harmoniously attuned to those environments. In this disposition of stock, disease (foot-rot) plays an important part, the latter breeds being quite unable to stand the wet feed conditions that rule in the lush, high production pastures of the wetter areas of both Islands.

Rainfall in the North Island, on the more fertile flat ploughable country particularly, largely differentiates the farming, that country in excess of 35 in. rainfall being devoted largely to dairying, and that under 35 in. to sheep raising; but fat lamb production extends into the higher rainfall belt, full mouthed ewes being bought in annually from the drier districts. Nevertheless, hill country of relatively low production, but of high rainfall is used for sheep and cattle raising, the ratio of cattle to sheep being higher in the high rainfall belts largely on account of the greater difficulty there to control secondary forest growth, scrub, fern, etc.

Grass and clover seed production hinges on climate and rarely is seed production practised in districts where the rainfall is in excess of 35 in.

AGRICULTURAL GROUPS:

Ecologically world agriculture may be divided into three great economic groups, (1) permanent grass of high productivity, (2) permanent grass of low productivity and (3) a complex farming group where cultivation with its concomitant soil amelioration and moisture absorption and conservation plays an enormous part in the production of rotational pastures and annual crops.

Group 1 - Permanent Grass of High Productivity:

Permanent grass of high productivity occupies a very small area speaking in terms of world agriculture. It is of economic significance only in mesophytic environments of highly fertile soils and a climate that makes possible a long seasonal growth spread. Perhaps the outstanding feature of New Zealand agriculture is the relatively large amount of country, compared with other countries, that is naturally of this class or can be made so by topdressing with artificial fertilisers, plus a high per acre stock concentration. Nevertheless, it must be firmly borne in mind that even in New Zealand, the acreage that can really claim a place in this group is small. I would confine the group to that area of land where approximately ¾-1 dairy cow or 6-8 ewes plus cattle per acre may be successfully carried year in and year out. The annual dry matter yields per acrew of such country runs between 10,000 and 16,000 lb. At this station during the past 2 years, under a system of rotational grazing with sheep (wethers), giving complete utilisation by in situ grazing of all herbage a first class permanent pasture yielded 13,675 lb.

dry matter per acre in the first year, and for the 10 months of the second year, 15,231 lb. dry matter per acre. The species predominant in these high production grasslands are perennial ryegrass (Lolium perenne) and white clover (Trifolium repens). Cocksfoot (Dactylis glomerata) comes next in importance with Timothy (Phleum pratense), Yorkshire fog (Holcus lanatus) and Montgomery red clover (Trifolium pratense) in minor amounts. In the northern part of the North Island, Paspalum dilatatum takes the place occupied by cocksfoot further south, and this grass, nicely associated with perennial ryegrass and white clover, constitutes some of our highest yielding pastures.

Within this group supplementary crops occupy less than 1% of the farm. Hay and/or silage taken from permanent grassland of the farm is the main summer and winter supplementary feed. A small area of maize or sorghum or soft turnips or rape may be grown for summer feeding, and a like area of chou mollier, mangolds, carrots, Italian ryegrass or green oats for winter feed. An all-the-year-round outdoor grazing system is practised.

Dairying, fat lamb and fat beef production is characteristic. A useful balance between the excess pasture feed of spring and that of summer and winter is afforded by grass and clover seed production in those permanent pasture areas of both Islands where the annual rainfall does not exceed 35 inches.

With reference to silage, recent work at Palmerston North tends to emphasise the serious invisible dry matter losses in silage making, and this work opens up a wide field of research in the full and the more economical utilisation of the dry matter produced on the farm with the minimum of dry matter losses. In this regard is silage better than hay? What are the merits of silage and hay compared with specially grown or specially saved summer and winter grass grazed in situ during these periods of low pasture productions, and finally should fodder crops replace or reduce the need of large scale grass conservation with its high dry matter losses.

Group 2 - Permanent Grass of Low Productivity:

Permanent grass of low productivity is a world-wide group covering vast areas of intractable hill country and high elevation areas. The North Island of New Zealand within the farming altitudinal zones from sea level up to 3,000 feet, was originally covered with forest or dense fern and scrub. These coverings have, in the main, been removed and the country is settling down to a stable association of low producing grasses and clovers where Danthonia (D. pilosa and D. semiannularis), brown top (Agrostis tenuis) are dominant. Associated with these are sweet vernal (Anthoxanthum odoratum), Chewing's fescue (Festuca rubra var. fallax), Yorkshire fog (Holcus lanatus), ratstail (Sporobolus capensis), bay-grass (Eragrostis elongata) and Indian doob (Cynodon dactylon) with many annuals such as hairgrass (Vulpia bromoides and V. myuros), English hairgrass (Aira praecox and A. caryophyllea), goosegrass (Bromus mollis), Poa annua, suckling clover (Trifolium dubium), striated clover (T. striatum), clustered clover (T. glomeratum) and hares foot trefoil (T. arvense).

Such pastures carry approximately one dry sheep on the poorer and up to 1½ ewes per acre on the better portions. Cattle are run largely to keep the ecological balance in favour of grass rather than forest, scrub or fern.

Topdressing with artificial fertilisers, mainly superphosphate, and grazing management in the North Island have improved considerably the carrying capacity of hill pastures and have made tenable such species as perennial ryegrass, cocksfoot, Poa pratensis, crested dogstail (Cynosurus cris-

tatus) timothy, white clover and subterranean clover (Trifolium subterraneum). Paspalum is prevalent on the better hill country of the northern part of the North Island.

These more improved hill country pastures carry up to 3 ewes per acre plus cattle, and may be regarded as excellent breeding country.

In the South Island natural tussock grasslands of the steppe type is the dominant vegetation of the unploughable hill country east of the mountain range - on the wetter west coast it is forest. The natural tussock grasslands occupy some 14,000,000 acres and the dominant vegetation is Fescue tussock (Festuca novae zealandicae), Poa tussock (Poa caespitosa, P. intermedia and P. Colensoi) and Danthonia tussock (Danthonia Raoulii and D. flavencens). The tussock association is interspersed with shrubs and of these the wild-Irishman (Discaria toumatou), native brooms (Carmichaelia spp.) and Hymenanthera dentata var. alpina are common. The wild-Irishman is a very characteristic feature. Associated with these, often in thickets, is the Spaniard (Acphylla colensoi and A. squarrosa). Between the tussocks and shrubs that chacterise the physiognomy of the montane belt are lesser grasses and herbs which provide much of the grazing.

These montane tussock grasslands are essentially a low carrying capacity type, at best one Merino sheep per acre down to 1 per 5 acres. Some parts show marked deterioration and are virtual desert, induced largely by indiscriminate burning and overstocking with sheep and rabbits. The more serious of this deterioration has taken place within the very low rainfall belt, from 10 in. to 15 in. - the most arid climate with the widest seasonal climatic range anywhere in New Zealand.

The high tussock country of the South Island is capable of safe grazing for sheep for 9 months of the year. For the three winter months the flocks are removed to lower areas of the run or on to warm sunny faces before the heavy falls of snow of winter begin. "Snow raking" is common during severe and unusual snow storms that may fall during the winter on the normally safe winter grazing country.

Rotations do not enter into the economy of the grasslands of this group but some summer and winter supplementary crops may be provided on small ploughable areas in the valley bottoms or hill tops. A grazing management that permits of summer roughage is of considerable value in providing winter keep for cattle and a controlled rotational system of grazing has done much to improve the pasture sward and to control scrubm fern and weeds. On the best hill country some top-dressing is practicable but considering the group as a whole, a grazing management that utilises discreetly what nature provides for little or nothing is the only policy to adopt. In such a policy the ecological balance between unpalatable top associations of scrub, fern or tussock and the ground associations of grasses, clover or weeds is paramount. The slash-hook, firestick and the grazing animal, particularly store cattle, are all important in this regard.

Group 3 - Rotational pastures and Annual Crops:

This group is by far the most economically important world-wide agricultural group and it is within this group that the rotation of grassland and crops - forage and cash crops - assumes high significance in any well planned land utilisation programme. Generally speaking the better the soil fertility and the more favourable the climatic conditions for a long sustained growth, the longer is the life of the pasture in the rotation, and, conversely, the harder the agronomic conditions, the more is one bound to rely on the annual, temporary pastures and short rotation pastures. The annual, be it in grassland or arable farming, is of infinite value in the full exploitation of short duration periods, of growth wherein high production is possible only whilst the

conditions for favourable growth last. The cereals are outstanding in this respect. Annual grasses such as Wimmera ryegrass, Italian ryegrass, subterranean clover and annual volunteers such as hairgrass, sweet vernal, goosegrass, suckling clover, etc., have definitely extended the soil range of grazed pastures.

Arable farming in its highest sense may be regarded as a soil preparation practice that ameliorates the soil and affords to the plant optimum conditions for growth and development over that period, short or long, when growth is possible. Under xerophytic conditions moisture absorption and conservation is a vital factor and arable farming alone procures this. The perennial, under xerophytic conditions, is low yielding, slow to start growth in the spring and quick to feel the on-coming drought of summer or cold of winter.

As edaphic conditions improve and climatic conditions ameliorate, so a wider range of crops and style of agriculture become possible. Short rotation systems replace the annual and in these, longer maturing crops, particularly roots, may be successfully employed. The grasslands take on a more than temporary, annual nature. Temporary pastures up to two years' duration in which Italian ryegrass and broad red clover figure as the dominant constituents, are an integral part of the cropping systems interpolated with root and forage crops as well as cereals. From this the development runs to what we term in New Zealand short rotation pastures of 3-4 years' duration, again interpolated with roots, forage crops and cereals.

The development of these short rotation pastures in New Zealand is not without interest, particularly from the point of view of plant evolution towards their fulfilment. The basis of such sowings has been perennial and Italian ryegrass together with broad red clover and white clover, with or without a cereal, soft turnip or rape cover crop. The outcome of some years of perennial-Italian ryegrass mixtures and the saving of these for seed has resulted in the evolution of an hybrid ryegrass that for some years, until marked deterioration set in, provided well for the style of pasture required. Hybridisation is not confined to New Zealand - the short rotation systems of Great Britain and Ireland have likewise produced an hybrid ryegrass typified in the short persistency of both Irish and Aryshire ryegrass.

Short rotation demands something quicker to establish, more bulk and more leafy than the true perennial species. In New Zealand the tendency of the true perennial under adverse climatic and edaphic conditions, is to simulate a xerophyte soon after establishment, such xerophyte being slow to establish, scanty in production and yielding a most unpalatable herbage.

The quicker establishing hybrid makes for earlier feed, a more bulky and a more palatable feed albeit a less persistent pasture. The short rotation ryegrass developed in New Zealand under a system of indiscriminate reaping and sowing, ultimately led to the production of a hybrid type that failed to persist for the required duration of short rotation and hence became of actual less value than a straight sowing of Italian ryegrass and clovers. The position has been rectified to some extent by the production under certification of true perennial ryegrass and true Italian ryegrass, and the use of these in mixtures, affording once more the early and bulky feed from the Italian and the persistency of the perennial for the final 2nd and 3rd years' life of the pasture. The introduction of Montgomery red clover into such swards has also very materially improved the short rotation pasture. More recently a system of controlled hybridisation by the plant breeder has evolved in New Zealand a relatively stable hybrid type between persistent Italian and true perennial ryegrass, and

and the control of such hybrid crops under certification and testing will, I feel, do much to create the plant type suitable for short rotation.

In regard to the clover element in the sward, arable cropping and short rotation systems have also played a large part in plant evolution and lessons here must not be ignored. Within the arable cropping areas of New Zealand, quick establishing and free seeding non-persistent types of white clover have been evolved. In Europe the deterioration has gone even further than in New Zealand, and the typical European Dutch type of white clover may be regarded as an annual, all semblance of its perennial nature being lost. This type is still of value as a stubble white clover along with the annual cereal crops, but it has lost most of its value in rotation and permanent pastures.

Ecotypic selection and plant breeding must now be the rule in the segregation of white clover types that are capable of playing their part in rotation and permanent pastures. In New Zealand pedigree seed production is well under way to provide a type excellent for rotational pastures. Both New Zealand certified pedigree white clover and certified M/S white clover fill this demand well. Similarly the selection by Aberystwyth, S 100, may be employed and there are definite possibilities in the Italian Ladino clover.

Cocksfoot and Timothy have also been greatly modified by rotational farming. The Danish type of cocksfoot is essentially the product of free seed production, early establishment and bulk; desirable factors in short rotation. Cocksfoot has not been used largely in New Zealand for short rotation, the New Zealand type being too slow to establish and insufficiently bulky for the short life of these pastures. If cocksfoot is to be of value in short rotation pastures more and more attention must be given by the plant breeder to the evolution of broader leaved, early establishing, bulky and early maturing types. Similarly in regard to timothy the Americans have evolved a hay type that has certain useful characteristics for short rotation. Further breeding towards the ideal short rotation timothy must approximate to the early leafy hay type rather than towards the slower establishing lower producing but persistent pasture types.

LONG ROTATION PASTURES:

These are designed to give profitable grazing for a period of up to nine years, when they are ploughed under and the land sown out to cereals, roots/or forages for one or two years, followed by pasture. True perennial species are at present sown plus temporary elements such as Italian ryegrass, broad red clover and frequently a cereal or rape cover crop.

Certified seeds in New Zealand have definitely made reliable the establishment and persistency of pasture in a long rotation grassland system and there is today a tendency to aim at truly permanent pasture within a climatic range and on particular soil types where long rotational grass is much to be preferred to really permanent grass. Much of New Zealand's ploughed and sown grasslands are on heavy, rather wet clay or loam that runs naturally into dominant Agrostis of a fairly vigorous nature. Such soils benefit greatly by periodic breaking and working and such amelioration of the soil conditions promotes splendid pasture growth which continues whilst the soil remains ameliorated. After some years, however, there is a return to the firm, compacted, rather soggy conditions that militates against thrift of the better producing pasture plants, and there is a distinct invasion of the pasture by Juncus, Agrostis, Anthoxanthum, Holcus and weeks. Such a pasture needs renovation by ploughing to afford soil amelioration, and resowing with or without the interpolation of roots or other annual crops.

EVOLUTION OF SPECIES AND HYBRIDS TO CATER FOR THE MAIN FARMING SYSTEMS:

Controlled hybridisation must in the future play an enormous part in the evolution of pasture plants suitable for short rotation and possibly for long rotation. In the past uncontrolled selection and hybridisation is evident in short rotation pasture systems, and this practice has resulted in the production of seed worthless for the role such seed should play. In its finality there should be species or hybrid types of pasture plants designed and bred and seed produced under a seed certification plan to provide for the following:-

(1) Temporary pastures 1-2 years duration.
(2) Short rotation pastures 1-4 years duration.
(3) Long rotation pastures 1-9 years duration.
(4) Truly perennial pastures up to and exceeding 9 years.

For the temporary pastures I envisage good early, leafy, bulky types of Italian ryegrass, possibly Western Wolths ryegrass, Wimmera ryegrass and broad red clover, subterranean clover and Ladino type white clover, with or without cover crops.

For the short rotation pastures, I envisage bred hybrid ryegrass types with Italian blood predominating; early maturing and broad-leaved cocksfcot and timothy types; early flowering and bulky Montgomery red clover types, persistent broad red clover or hybrids of these with Montgomery red. Ecotypic or bred hybrid strains of white clover, approaching the New Zealand pedigree and certified mother seed type, Aberystwyth S 100 or Ladino white clover.

For the long rotation pasture I envisage species bred with a tendency to earliness and bulk and possibly hybrids with the persistent perennial parent dominant. Thus certain perennial-Italian ryegrass crosses and back crosses to the perennial have afforded here some very promising material. Persistent bulky strains of cocksfcot, timothy, crested dogstail, Montgomery red clover and white clover are required, and in this the clover types lend themselves to hybridisation. Thus very useful white clover types are secured as a result of crossing New Zealand M/S with Kentish wild white clover, and there are other great possibilities within the main ecotypes.

For the truly permanent pasture ecotypic selection and breeding within the true perennial, designed to give optimum production and spread of production, coupled with true perenniality of the strain is the obvious line of approach.

DISPOSITION OF ROTATIONAL PASTURES IN NEW ZEALAND:

The longer winter climate of the South Island definitely makes demand on supplementary winter fodder crops, there being little reliable growth from pasture in June, July and August. The long rotation pasture system fits in excellently well with this demand and the turning over of all grassland once in not less than 9-10 years proves an admirable practice as a basis of land utilisation. In the North Island the demand for roots and forage crops is not as great as in the South Island, and an annual turnover of 10% of the farm is far in excess of this demand.

Nevertheless there are counties where upwards of 5% of the farm is turned over every year for summer and winter forages, particularly in fat lamb raising. Despite the fact that crops are not needed up to 10% of the farmed area, good results accrue from turning over worn out grasslands in their 8-9th year, and reseeding again to pasture without the intervention of a crop.

For the most part temporary and short rotation pastures are confined to the drier parts of the South Island. The more severe winter and drier summers and the somewhat greater disparity between winter cold and summer heat throws greater emphasis on the cereal crops, fodder crops, temporary and short rotation pastures. Howbeit no strict rotational system is practised? Cereals may occupy the ground for one or two years, followed by oats and vetches or temporary or short rotation pastures. Roots, forage crops and potatoes may occupy the ground for one year followed by cereals or short or long rotation pastures. Seed production of perennial ryegrass, Italian ryegrass, cocksfoot, crested dogstail, broad red clover, Montgomery red clover, white clover and brassicae is a special feature.

THE COVER CROP:

In the laying down of rotational pastures temporary elements such as cereals, soft and intermediate hard turnips, rape, millet, and blue lupins are profitably employed, and pastures established under these are quite successful wherever the rainfall is sufficient in the establishment year. The actual manurial return to the pasture sward as a result of grazing the cover crop is often such as to give the young sward its initial stimulus, as a result of the stock nitrogen supplied by the grazing animal. The financial returns from feeding off the cover crop is often such as to go a very long way towards paying for the ploughing, cultivation and relaying down of the pasture.

In the colder areas of the South Island the protective cover often leads to a much improved legume take in the sward.

The full exploitation of the cover crop practice in rotational farming, would, in my opinion, go a long way to justify rotational farming and this is particularly true where a short rotation farming system is practised. Just so long as the cover crop does not form too dense a canopy as to smother the slower establishing grasses and clovers, a possibility that must be carefully guarded against in grazing management, the early feed provided by the cover crop enables stock to be grazed on, and the return of stock nitrogen to the sward does much to establish the young grass into a healthy and thriving sward. This is true of all pasture types; the sooner stock can be grazed in situ after sowing the sooner does the pasture develop into a thriving sward.

In conclusion the foregoing endeavours to set out the relationship in New Zealand of grassland, cereal production, roots and crops. Statistically New Zealand is predominantly grassland. Over 94% of our exportable wealth comes from grassland. Such figures, however, do not show the real significance of the cereal, root and forage crops grown nor the influence on grassland that the periodic breaking up, cropping and resowing makes in the production from grassland. The tendency in the North Island to leave land permanently in grass has in the past been influenced largely by resowing down with inferior strains of grasses and clovers - the product of unscientific seed production practices. With the advent of certified and pedigree seeds and a classification of types for specific farming purposes breaking up for temporary, short or long leys or truly permanent pasture is now being undertaken with a very much greater confidence.

Nevertheless farm economy may in many cases still direct the policy of leaving down country to grass longer than the mere call for higher production would warrant and there are many millions of acres in permanent grass in New Zealand that are left down because of the fear of difficulties in regaining the dense turf on certain friable soil types and in the encouragement that cultivation gives to such weeds as Californian thistle (Cirsium arvense), and to milk-tainting weeds such as Hogcress (Coronopus didymus).

It can be truly said that most of New Zealand grasslands are actually stock made and the practice of topdressing with phosphates and lime to stimulate clover development is an initial phase that is carried to completion by stock treading and stock manuring.

Fencing to give full scope to a periodic high stock concentration, to ensure uniform treading and grazing and an even distribution of the animal residues to the sward has a wide significance and application in the permanent grasslands, particularly of the North Island. In this New Zealand is greatly blessed by the mildness of its climate that provides a long seasonal spread of production and all-the-year-round out-door grazing. Consequently there is a continual flow of animal residues on to the pasture sward.

Supplementary roots and fodder crops fed in conjunction with grassland materially help to raise the per acre stock carrying capacity of the farm and this tends to extend the area in profitable permanent grassland. This principle is now being widely exploited throughout both Islands. Climate alone decides whether sufficient stock may be carried throughout the year to make all the grassland on the farm permanent and highly productive. Where such is not the case more and more reliance must be placed on the plough and rotations for the profitable exploitation of the land. New Zealand is fortunate in having but little ploughable land suited only for the production of cereals, or for its alternative, very low producing permanent grassland.

METEOROLOGICAL CORRELATION WITH AGRICULTURE:

Up to the present there has been in New Zealand an unconscious alignment of agricultural practice with climate but little has been done to apply meteorological data *per se* towards evolving a farming system harmoniously attuned to climate. Meteorological stations have been set up sparsely throughout the country the observations for which are dependent largely on the good nature and personal interest of the observer. Insufficient meteorological stations are established to record the general climatic conditions and there is further a need for correlation of a farming practice to more local and microclimatic conditions within a general climatic zone.

Climate is so intimately linked with agricultural practice that its recording to secure long period averages is really necessary before a sound agricultural plan may be fully formulated and understood.

DISCUSSION

MR. WEBSTER: suggested that the qualitative changes in silage, particularly loss of carbonhydrates, might be of more importance than quantitative losses. Excessive carbohydrate losses alter the Ketogenic - Antiketogenic ratio of the food and may thus predispose to digestive disorders of dairy stock.

As an alternative to silage, would like to see a development of grass drying as practised in England. At present there appear to be almost insurmountable difficulties in securing economic operation of drying units to produce a cheap product. This difficulty may be overcome in the future by collectivised farming methods, should the present trend of thought towards land nationalisation be translated into practice.

DR. FILMER: congratulated the workers of Grasslands Division on the excellent work being conducted. He suggested that pasture was of more importance in New Zealand than climate in relation to animal ecology. He stressed the great advantage of single breed of dairy cattle and sheep in New Zealand, and suggested that this should not be lightly discarded. While hoping that the research would diminish losses in silage making, he hoped that these would not discourage saving of silage. He indicated the possibility of production not necessarily following carrying capacity, especially in the case of hoggets which may not thrive on high class pastures.

MR. W. M. HAMILTON: Mr. Bruce Levy's contention that climate is the major factor needs some careful consideration. It is quite possible that soils and other things are more important and it should be remembered that climate and soil were very strictly inter-related - in the long run soil type being a function of climate.

I would also point out that New Zealand has tremendously greater variation in the rainfall gradient compared with continental countries, and very considerable differences can occur within relatively short distances.

Finally, I am inclined to doubt the validity of any attempt to view a biological problem piecemeal in the manner of say a chemist.

MR. M. M. COOPER: Turning to Mr. Hamilton's contention that biological problems should be looked at in their entirety, I would like to express the view that though the perspective of the whole problem must be retained, it is necessary in research to approach a biological problem from different fundamental angles. To use a topical simile, one has got to make bricks before building the chimney, and, mixing one's metaphors, if we make the approach of the complete agriculturalist there is a danger of not seeing the trees for the wood. I feel there is a real need for the differing approaches of the agrostologist, the plant chemist, and the animal physiologist, but their results must be integrated to obtain the final picture.

In connection with Mr. Sears' suggestion that Italian ryegrass should be incorporated in a seeds mixture in the establishment of a dominant cocksfoot sward, I would like to know the type of grazing management that should be adopted in the early spring in the first season of establishment in order to avoid undue smothering by the Italian ryegrass on the one hand, and excessive defoliation of cocksfoot on the other.

MR. HOLFORD: In respect to the adaptation of stock, breeds and type, to the country and its regions, there has already been considerable developments in New Zealand. For example, we have a distinctly new breed, the Corriedale sheep, and have greatly changed the Romney substantially from its English prototype. I suggest also that our Jersey cattle are of a more robust type than the Home stock. More sunshine as well as soil conditions appear to develop bigger framed animals.

There appears to be scope for further evolution of, if not stock breeds, then types to suit some New Zealand regions. Possibly a dash of Cheviot with the Romney may be indicated for country a little hard for the ordinary Romney.