FIVE YEARS' EXPERIENCE

IN THE USE OF NITROGEN ON PASTURES IN N.Z.

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"The greater the change, the greater the resistance to such change;"

is a truism relating to human nature, and is particularly applicable in the realm of Agriculture.

A little over 5 years ago, at least three important new concepts with regard to pastures were brought prominently before the notice of Dominion farmers, namely, Intensive rotational grazing; The significance of strain in grasses and clovers;and the Application of Inorganic Nitrogen to grassland, These new innovations were put before the farmer when he had but dimly realised the significant fact that grass is a "crop" - the most important of all "crops" - particularly in New Zealand. Except in isolated cases, there was very little grass-consciousness among the farming community. It has been well stated that, whatever innovation is projected, the tendency is for it to go to the extreme; this brings its re-action, and I think there Is evidence today of a retreat from the forward post to which grassland workers endeavoured'to guide New Zealand farmers *in* regard to the three developments mentioned above, Whilst, unquestionably, there has been a considerable advance made - particularly by a number of progressive farmers - still the attempt to bring changes by revolutation rather than by evolution has not been as successful, in my opinion, as was at one time hoped.. There is no doubt that all three developments were of extreme importance in New Zealand, but experience is showing that in each sphere there are today distinct signs of modification, Rotational grazing is being practised, but there are very few farms where small paddocks - originally advocated - are in evidence.

Mr Connell, in his paper read at a previous Grassland Conference held at Palmerston North, showed how some farmers had modified the-original intensive method with profit to themselves,

We see today, a tendency to realise that there is a place for other strains of white clover than the N.Z.No.1, and for ryegrass other than the most superior types of certified seed.

There has also been a distinct modification in regard to the use of nitrogenous manures, more especially in connection with a number of periodic applications over the season,

At the time the new systems were advocated, the advocates were not too clear as to the practical applications of the methods suggested, and for very many farmers'the method seemed much too complicated for them to attempt. Mr Cockayne has well said "The attainment of uniformity and a progressively high level in farming, can bc achieved only by a profound simplification of what the farmer has to do." I think this could be well taken as a key to future developments; particularly in regard to the advice given to farmers in connection with grassland work.

It has also become very evident that the experience of farmers has not'been properly taken into account in the putting into operation of the newer methods; this failure has probably cost New Zealand a large sum of money. Over thirty years ago, farmers in some parts of New Zealand were buying ryegrass seed off old pastures and paying double the price ruling for other'types, and yet, until within recent years,no attempt was made to test the significance of their action.

In the use of nitrogen on grassland, .the modified practice of progressive farmers has been of the greatest assistance in developing systems of using this fertiliser on Dominion Grasslands. Much of what appears in this paper is based on the practical experience of a number of farmers who have used nitrogen on grassland,

THE SIGNIFICANCE OF GRASS IN NEW ZEALAND;

It can be definitely stated that the life-blood of'this Country is green - not red - and our whole economic life is based, in the main, on production from our pastures. Unfortunately, grass has a seasonal growth, and, generally speaking, 70% of the production of the Dominion takes place in the four months of Spring and early Summer,

A major problem before farmers is the provision of food in the periods of pasture scarcity; with the considerable variation of soil and climate ranging over New Zealand, the methods adopted must vary in every district - in fact - they can vary on nearly every farm, to some degree, *in* each district.

I think it can be taken for granted that grass is the cheapest and most nutritious food for stock, and that it is a matter of extreme importance to make the maximum use of pasturage on the farm; after that, there is a case for supplementing grass and grass products - ensilage and hay - with other crops. In getting grass to produce to carry the maximum number of stock over the year, I believe there is certain to be a definite trend in districts where this is possible along the lines of having special leys which will produce food at various.times of the year. In the last publication from Aberystwyth, Professor Stapledon writes :

> "The chief and fundamental lesson to be learned from all our researches on seeds mixtures is the need of providing variety and prolonged seasonal growth by having on the farm a well thought-out, sequence of leys each resulting from a simple mixture, and each designed to cater primarily for a particular season and a particular purpose, No attempt is made to provide a wide range of species in one and the same ley by using complicated mixtures - a procedure which, owing to competitive influences, is foredoomed to failure,"

In 1919, I made reference to this point as follows :

> "It is very evident that in many parts the attempt at securing a general purpose pasture by a complicated system is not a success, and that it would be far more profitable in many districts to secure an area of annual pasture by sowing Italian alone, or Italian and Red; a perennial pasture by sowing perennial rye and clovers, and then, where the land sujted, to-sow permanent grasses such as cocksfoot, dogstail and so on, The result of this would give a mixture of grasses, with suitable clovers, on the farm instead of in one paddock,"

Time will not permit of any development of this, but I believe a trend in the direction of simple grass/clover leys is coming, and will materially help to even out the production of grassland over the year,

The making of ensilage and hay is also a method that needs no stressing,

The growing of crops, roots and fodder crops, must also be taken into account, especially in districts where the Winters are on the long side. Experience is showing, however, that there are difficulties with, these crops; turnips and swedes are

liable to disease, excess feeding on them affects animal health, labour costs in growing them are relatively high, on many farms there is insufficient implement equipment to grow them satisfactorily, and on very many farms conditions are not suitable from a soil and topography point of view, When all is said and done, the main object of most farmers in New Zealand should be to get the maximum production from their grassland, since grass is not only the best, but also the cheapest "crop"; the fact that the tendency in New Zealand is to develop along the lines of more wet stock and of early maturing animals, indicates also that there, must be-a case for grass and grass products to be of the highest quality. There can be no question that there is a very considerable loss in New Zealand every year from the insufficient feeding of stock, particularly in the Winter and early Spring,

SOME DAIRY CONSIDERATIONS.

Mr A,H.Cockayne has set down some very important considerations in connection with dairying in New Zealand : -

"1. Early calving is essential' to high herd production under the New Zealand system of dairying.

2. Early calving cows must be adequately provided with milk-producing feed in the early Spring.

3. The ordinary farm cannot adequately replace Spring grass shortage by roots, ensilage or hay, either alone or in combination.

4. A really adequate supply of vigorously growing young grass in the early Spring, consumed as such, would make early calving safe and effective throughout New Zealand."

Herd testing figures are showing the trend to earlier calving.; farmers are finding it a matter of extreme importance to get as much production from their herds' as possible before the dry Summer spells set in.

NITROGEN AND "OUT-OF-SEASON" GRASS.

The application of nitrogenous fertilisers has proved to be extremely valuable in assisting farmers to make early calving safe. It is of little use bringing cows in early unless they are adequately fed, and nothing produces milk like young grass, it has an effect on milk stimulation which has never been adequately explained.

SECURING WINTER GRASS;

In many districts, particularly in the North Island,' calving commences in June, sometimes in May, and over a large area early in July; many progressive dairyfarmers have solved the problem of getting highly nutritious milk-producing food at this time of the year. Their method is to topdress suitable pastures with inorganic nitrogen, generally used with phosphate as Ammoniated Super; the suitability of the pastures and the other considerations to be taken into account will be referred to later. The application of Pertilisers is made at a time of the year when there is still growth in the pastures, it is made at a time of the year when growth can be practically assured because of moisture adequacy; the grass is grown into the Winter and is then available for feeding in June and July.

NITROGEN-TREATED GRASS RESISTS FROSTING.

A matter of extreme importance is that the ryegrass. grown with the aid of nitrogen markedly resists frosting. It is known that Italian ryegrass is less liable to be affected by frost than other grasses and the effect of nitrogen is to make perennial ryegrass equivalent to Italian in this connection. Pastures treated with phosphate only in Autumn and saved for Winter grass, "burn" even with moderate frosts and the herbage is then of poor quality as a milk producing food. The method of feeding is to ration cows on the specially grown feed for say one hour a day; it is also advisable to give the cows some of this ration before calving; the cows "soil" the pasture very little and the effect of the nutritious grass at this time is to put them to the "peak" in a very short period, further, - and this is of extreme importance - the effect of this grass is to give extra value to the other class of feed used on the farm, It has been found in Scotland that cows grazed in this way - the on and off method - produced more milk than a similar herd rotationally grazed. Besides stimulating the milk flow, this grass appears to act as a tonic and a medicine and counteracts some of the effects of other forms of winter feeding such as Hay, Ensilage, and Roots, The effect of starting a herd off well is of extreme importance over the whole producing season and the high protein content of the grass produced in this way has this effect,

This system of Autumn manuring with nitrogen for Winter grass has other advantages. When grass appears on other fields, the specially treated pastures can be allowed to grow for ensilage. Ensilage can be cut very early in the season, thus allowing of a good aftermath recovery, and, when cut in the leaf stage, produces ensilage of a good milk-producing quality, Especially when extra phosphate is added after the cutting of the ensilage, an excellent aftermath is secured which comes in most opportunely for Summer grazing since at this time other pastures are often producing fodder that is low in milk-producing qualities, By rationing the grass it is never grazed close, and this is very important since severe grazing in Winter and early Spring is so prejudicial to ryegrass growth later in the year.

MILK-PRODUCING SUMMER GRASS TOO.

So, on many farms, by this system it has been found possible not only to produce Winter grass but also Summer grass of a high milk-producing value; A number'of farmers have carried out this practice on the same field for five years, getting each year the food they desired with an annual improvement in their pastures from the point of view of sward composition.

THE EARLY "BITE".

Apart from the production of Winter grass by applying nitrogen to suitable fields in the early Spring, an early "bite" can be produced weeks earlier than is possible on fields not treated with nitrogen, It has been found in practice that it is inadvisable to apply nitrogen in the "dead" winter period, and better when there is a movement in grass growth on the fields. Also, pastures that have beenspelled and have some leaf growth on them give a quicker response than those hard-grazed prior to the application of the fertiliser. The practice of topdressing with nitrogen in the early Spring is widely carried out on both dairy and sheep farms in New Zealand. It has been found advisable to treat a sufficient acreage to avoid severe grazing of the early grass, as this limits the root system of such plants as ryegrass with a subsequent falling off in production later in the year. On the better soils it has been found possible to get early grass and an early crop of ensilage or hay - sometimes both on the same field, On lighter soils, the paddocks treated for

the early "bite" should be spelled a little when there is abundant grass over the rest of the farm. Sheltered fields are particularly suitable for treating with nitrogen for early Spring grass, and those with a high percentage of ryegrass give the biggest return. In practice, farmers find that the value of the early "bite" in tiding stock over the bottle-neck period of early Spring is very considerable indeed, Whilst the early "bite" can be obtained two to three weeks earlier than where no nitrogen has been used, by the Autumn application mentioned above it is possible to get, grass two and even three months earlier than would be the case where no nitrogen has been used,

Autumn applications of Ammoniated Super have been very effective, also Spring, but Summer dressings - especially of Sulphate of Ammonia alone, should be used with discretion.

SOME EFFECTS OF NITROGEN ON PASTURES,

Apart from the getting of Winter and early Spring grass a certain moderate dressing of nitrogen along with other fertilisers has been found effective in improving the sward content and feeding value of the grass on ordinary pastures, but time will permit of only a brief reference to the influence of nitrogen other than for early grass.

In sowing down, a moderate application of nitrogen ensures a quick establishment of grasses and in some cases of clovers too, which is of extreme importance in keeping out weeds and ensuring good stock 'carrying at an early period. On established swards, nitrogen stimulates the better grass elements such as ryegrass and it also is most effective on the more perennial types of ryegrass - a matter of extreme importance and one that will be more realised when we sow more of the true perennial types of seed and where we use simple mixtures in which persistent ryegrass occupies the main position and is not helped out by other grasses, e.g. Cocksfoot, which produce food at certain periods such as Summer when ryegrass is inclined to take a spell, especially in dry districts.

INCREASES PALATABILITY.

Applications of nitrogen have also been proved to considerably increase the palatability of grasses, and this is being realised particularly on the certified ryegrass swards in parts of the South Island, It also improves the feeding value of the herbage.

ENSILAGE, HAY & SEED CROPS.

The use of nitrogen has been proved to increase the yield of ensilage and hay crops and to allow of them being cut earlier than was normally the case, with a good aftermath recovery. Nitrogen has also been used effectively in increasing the yields of seeds - ryegrass, clover, chewings' fescue, etc. There are indications also of its value - used in moderate amounts - in increasing the yield of red clover seed.

POINTS TO CONSIDER IN THE APPLICATION OF NITROGEN.

Ryegrass, since 'it produces early growth, must occupy a considerable percentage of swards on which nitrogen is used, particularly for early grass; nitrogen also gives the greatest return as indicated on the true perennial species. The more of these there are present, the better the response from nitrogen, at the same time the fact that nitrogen can be used to grade up swardsp particularly where there are vestigal ryegrass and other desirable grass plants, must not be overlooked, and there are a number of instances in New Zealand where this effect of nitrogen has been very manifest.

TIME OF APPLICATION.

Mention has already been made of Autumn and early Spring applications of nitrogen. A number of farmers have used nitrogen during the Summer months to get a quick growth at certain periods and experience must guide individual farmers in this matter,

QUANTITY TO APPLY.

The usual application is the equivalent of 1 cwt of sulphate of ammonia per acre, although in the Northern part of New Zealand greater quantities of this material are used, particularly in the autumn application to get winter grass, sometimes up to 2 cwt per acre being applied. On lighter soil types, smaller applications than 1 cwt may be advisable, particularly on sheep pastures, but it is useless to expect very small amounts to be effedtive in getting "out-of-season" grass. An average treatment of pastures is 5 cwt of lime every year or two, with 3 cwt of Ammoniated Super applied on dairy pastures and 2 cwt per acre on sheep pastures. 1 cwt of sulphate of ammonia alone is used for the production of ensilage, hay, or seed crops, the application being made at the time the pastures are closed from stock.

NITROGEN IS NOT "FOOL-PROOF".

Unlike the commonly used fertiliser - phosphatic and potassic - inorganic nitrogenous fertilisers are not "fool-proof", and to get satisfactory returns from their use a few commonsense rules have to be observed. Failure to observe these has led to a certain prejudice in certain quarters against the use of nitrogen on grassland, Far too often the likely detrimental effects of nitrogen are stressed to the exclusion of its merits. The old Cockle Park experiments, where the management factor in grassland was not sufficiently appreciated, still dominate thought even in the world of scientific agriculture. After all, if all the effects of electricity were stressed, would it be used so widely ? Most good things are not "fool-proof". The individual farmer can ask his soil a question about its nitrogen needs, On some soils it is possible to use heavy quantities every year on the same field even more than once a year, with annual improvement in the pastures and in carrying capacity. In other cases it is advisable to apply relatively light amounts and not to treat some fields every year with inorganic nitrogen. The experimental work done has stressed much more the abuse rather than the judicious use of nitrogen.

The fact that nitrogen is higher in price than phosphate per unit weight is a limiting factor to its wider use; but what is not fully realised is that it performs a function which its valuable ally cannot, If nitrogen does not give a satisfactory return when applied to a field, the first thing to make certain of is as to the quantity applied, time of application, and condition of soil and pasture, Should we condemn nitrogen for being ineffective, or rather seek the cause and if possible remedy the conditions to the end of securing a return from nitrogen, since it is certain that this fertiliser gives its best returns when soil and pasture conditions are favourable.

What is known for certain is that some of the most successful farmers in the Dominion today are using nitrogen substantially and applying it year after year and saying that they could not farm as profitably without it.

The above observations lead one to state that nitrogen then can be used as a yard-stick to reveal to a farmer just how good his pasture is, Nitrogen is not on trial but the pasture is, as, given suitable conditions, nitrogen must give increased grass growth. If the response from say an application of sulphate of

ammonia is less than can be reasonably expected, the farmer should not blame nitrogen, but his pasture, and set about ensuring conditions that will allow a nitrogenous manure to give him a profitable return; namely, look to Lime supply, to adequacy of Phosphate and of Potash, and to the character of the grasses and clovers in the sward, Of course, such matters as right time of application, suitable quantities of fertiliser, and weather conditions, must also be considered, As indicated, the aim.of the grassland farmer should be to'bring his pasture into such a state that the use of nitrogenous manures, correctly applied, will give him a distinctly profitable return.

NITROGEN - A HALL MARK.

In future, will we not consider that the profitable use of nitrogen on pastures will stamp one as an efficient grassland farmer, and should it not be the aim of all to so improve. and manage their pastures that they get the greatest maximum profit from the nitrogen applications, to the end of making its successful use the hall-mark of farming efficiency.

OTHER FERTILISERS.

Five years' experience has shown the extreme importance of applying phosphates, either along with nitrogen or at a period not very remote from the application of the nitrogenous fertiliser.. In this connection, the use of Ammoniated Super (2 parts Super, 1 part Sulphate of Ammonia) has become exceedingly popular with a large number of farmers..

Tests in England have indicated that plants take up a modicum of phosphate and nitrogen together, and so it is important to have a sufficiency of phosphate where nitrogen is used,. In certain areas also, due attention must be given to a supply of potash.. Adequate supplies of lime are necessary, (particularly since sulphate of ammonia draws on the lime content of the soil.. Experiments over a long term indicate that when phosphate has been applied to pasture in sufficient amounts, supplementary treatments with nitrogen. increase the efficiency of the phosphate manuring. This'is, of course, if due attention has been given to the soil needs of lime and potash, A noted scientist says : "The influence of fertilisers upon each other follows certain definite trends. Nitrogen has a tendency to depress the efficiency of phosphorus When the latter element is applied in apparently insufficient amounts as a part of various fertiliser combinations; but if adequate amounts of phosphorus are included, small supplementary treatments of nitrogen increase the efficiency of phosphorus.. Phosphorus applied alone in increasing amounts shows successive decreases in efficiency, but when used in combination with nitrogen, or with both nitrogen and potash, there is a c-onsistent increase in efficiency, "

NITROGEN FROM LEGUMES AND ANIMAL EXCRETA.

There is a belief held in some centres that pastures can secure all the nitrogen they require from legumes or from animal excreta. Dealing first with legumes. There is no question that an adequate percentage of a plant such as white clover is of extreme importance in swards and particularly in the drier parts of New Zealand, and the aim should be to maintain clover at all costs. Clover, however, 'starts growth late in the Spring, producing food only from then on until the Autumn, and it cannot assist very materially in extending the period when pastures will provide feed for stock; also, there is a danger in many districts from excess clover, causing bloating.

LESSENING "BLOAT".

One of the outstanding effects following the use of nitrogen in some districts, has been the alleviation of the "bloating" trouble in cattle. In some parts the losses annually from this complaint are serious, Nitrogen, by balancing up the ryegrass with clover in swards, has effectively stopped 'bloating" on many dairyfarms.

NITROGEN CAN HELP CLOVERS AS WELL AS GRASSES.

Few people realise that moderate amounts of nitrogen can assist clover growth as well as grass growth, This has been very evident on Australian pastures, and applications of Ammoniated Super in New Zealand have been shown to definitely increase clover as well as grass in many instances. It is also known that nitrogen has a differential effect on clovers as it has on species of ryegrass. For instance, trials at Aberystwyth show that at the end of the first year, even with heavy applications of nitrogen there had been an increase in N.Z. Wild White clover with a marked suppression of the Dutch and N.Z. Stubble white. I have seen evidence that moderate amounts of nitrogen may be effective in increasing growth of N.Z. No.1 white clover.

The amount of clover in a pasture is largely a matter of management, but there is no time to deal adequately with this matter just now. It can be stated definitely that a large number of farmers in New Zealand who have been using nitrogen over a period of years have done so without in any degree altering detrimentally the clover content of their pastures and it has been pointed out by Messrs Davies and Levy that too much clover in a pasture is not desirable, There has been a lot of talk of suppression of clover, but it must also be realised that vigorous clover can also suppress ryegrass. The main point is to maintain a suitable balance between the two, and with judicious management this is possible, even when comparatively heavy applications of nitrogen are applied.

Animal Excreta. The contention that animal 'excreta is sufficient to maintain pastures in full productivity cannot be sustained. from practical experience. The following is an official opinion from the British Journal of Agriculture for January, 1934. "The former teaching that rapidly-acting nitrogenous fertilisers should not be applied to pasture was backed up by this assertion :

> The excreta of grazing animals, being rich in readily decomposable nitrogenous compounds, were sufficient to, supply the grass with what it needed.

Reviewing available results that bear on this assertion, it can be said that, as a general rule, the excreta of grazing animals are not sufficient to ensure maximum growth of the grass. This is particularly true in the early Spring, but may be true in the late Summer, when it might have been expected that the accumulation of droppings would have provided an ample supply of nitrogen."

It can be definitely shown too that the organic nitrogen secured in this way is of little assistance in the production for instance of early grass, further, it has been gathered from Continental trials that contrary to the view held that animal manure is a substitute for inorganic nitrogen, the returns from the latter fertiliser have been increased on the areas where animal dung has been used, It is of extreme importance to make full use of the animal manure and to this end harrowing of dairy pastures to spread dung is distinctly advisable. On heavily stocked paddocks it has been found that grass growth is unpalatable and that this unpalatability can be modified by the use of a fertiliser such as Ammoniated Super;

also, high concentration of stock on fields must mean less fertility from this source *on* other parts of the farm. It is not possible to spread urine patches and only in rare instances is there sufficient of this nitrogen given to the grass to maintain full productivity of swards. Dairyfarmers on high carrying-capac'ity lands have found that neither legumes nor animal excreta can obviate the necessity of using nitrogen on grassland to get maximum production,

WHAT SUCCESSFUL N.Z. DAIRYFARMERS SAY :

Here are the views of some successful N.Z. Dairyfarmers :

1. "I consider that in dairyfarming grass which has only the urine and droppings from the cattle feeding on it is more profitable if topdressed with Ammoniated Super. One can distribute the droppings by harrowing, but the urine remains where deposited and the consequence is patchy growth which is lessened by Ammoniated Super topdressing. Cattle droppings do not give sufficient nitrogen to supply the farm."

2. "Stock manure is useless for growing "out-of-season" grass. Now, in normal growing season, grass will respond well on stock droppings. Ammoniated Super or straight super improves palatability. Every Winter I concentrate all dry stock on one paddock and feed out till paddocks are black with droppings, then harrow twice, but response is poor in cold winter months. There is no suppression of clover from the use of nitrogenous manures."

3. "My cows don't relish their own manure, They won't eat grass grown on paddocks after being heavily stocked and well harrowed, lots of droppings, after living on hay etc., I can make them eat, however, and love it by spreading a little strawberry jam on it - otherwise Ammoniated Super, Animal nitrogen does not supply the farm wants. If farmers fed their cows properly, there is no animal manure, as all "skitters" go back to earth at once and there should be nothing to harrow, I always make hay from these heavily manured paddocks - animal manure, I mean."

SHEEP-FARMING.

Brief reference only can be made to the use of nitrogen on sheep farms., Early grass is quite as important in many districts for lambing ewes as it is for milking cows. The method of getting winter grass from autumn applications has been tried in Canterbury with distinct success, the winter grass grown in this way being used with dry rations for the stock; this has been in the place of turnips. Experience is showing that excess turnip feeding is a pre-disposing cause of ante-partum paralysis, and that the effect of keeping stock too long on turnips is to detrimentally effect the health of the sheep.

Autumn applications of nitrogen on sheep pastures have been found effective - where suitable moisture conditions obtain - in providing a supply of nutritious grass to "flush" ewes prior to mating. Others have found such grass valuable in finishing off lambs, in several instances it has displaced rape for this purpose,

Early Spring grass obtained by nitrogen. is likely to displace, green feed oats on many Canterbury farms, since this crop is costly to grow compared with early grass and it is unsatisfactory as a milk-producing food,

This point may be considered also, Sheep graze leaves more than stemsin grasses, and nitrogen increases leaf production of grasses, also, close sheep grazing makes it *difficult to maintain grasses such as cocksfoot and timothy in swards; even N.Z. No. 1 white clover may suffer under intensive sheep grazing,

Nitrogen applications will assist ryegrass to better carry out its role as the major element in sheep swards, by aiding it to produce more nutritious feed over a larger period than where no ni'trogen is used,

The effect of nitrogen in. increasing palatability of certified ryegrass on sheep swards in the South Island has been, most marked, and it is significant that urine patches show up much more prominently on certified ryegrass swards than on those in which commercial ryegrass predominates.

EXPERIMENTAL WORK WITH NITROGEN.

Unfortunately, much of the experimental work on nitrogen has stressed the negative elements and not the positives, and no method has been evolved which can truly evaluate nitrogen on pastures. Mr Play, at a previous Conference, stressed the inefficiency of the half-paddock trial methods, and more technical methods of evaluating nitrogen such as mowing and grazing must, of necessity, not take note of the quality factor in the pasture, nor of the extreme importance of "out-of-season" grass. This has been indicated by the Experimehtalists in the N.Z. Journal of Agriculture, who say :

"Unfortunately, the trials give no information regarding the effect of "out-of-season" grass on the cow production over the season as a whole. Extra early grass must have an effect in this respect by bringing cows to the lactation peak earlier. Unfortunately , the point could be determined only by an elaborate and costly method of experiment extending over a considerable period.

Economic Aspect of. the Results Obtained. in view of the preceding remarks regarding "out-of-season" grass , the writers are extremely diffident about making comments on the payable nature of the returns. As indicated previously, it would be unfair to use only the increase in cow-days, as represented by so much butterfat, as a measure of the value of the nitrogen dressings. Apart from the value of extra early or extra late grass in reducing the amount of supplementary feed required, a considerable value must be attached to the early grass, especially for early-calving herds, in bringing forward the peak period of production,

Summarising Trials, they State : It is evident therefore, that the use of nitrogen on good pasture for the production of early and late grass will pay , even thcugh we ignore the indirect Value of "out-of-season!' grass."

A very important point has been stated by Mr R.P.Connell in an article which appeared in the Journal of Agriculture for January, 1932, under the heading, "Problems Illustrating Difficulties Relative to Technique", as follows :

"We have the matter of nitrogenous topdressing of dairy farms. Such topdressing, though providing extra growth 'at critical times,, may lead to an all-the-year increase in the number of cows milked. Indirectly,

"this may lead to the more economical utilisation of feed, which, failing the use of nitrogen, would be poorly utilised or wasted. Further, it may lead to the elimination'of the necessity for costly special crops, From all this it seems clear that the returns from nitrogenous topdressing are not to be measured by finding out the number of extra pounds of butterfat produced on the fields to which the nitrogen was applied, or by merely finding out the increase in the amount of grazing, on those fields, and calculating this extra grazing in terms of butterfat or its cash equivalent. The crux of the position lies in the fact that the nitrogen topdressing may influence the returns from fields to which it was not applied, because the use of nitrogen on certain fields may enable the grass growth on other fields to be more effectively utilised."

ECONOMICS OF NITROGEN MANURING.

Even in circles where there is an understanding of the important effects of inorganic nitrogen on pastures, the opinion is sometimes expressed that under present conditions of low prices for primary products nitrogen manuring is un-economic. In the first place it may be pointed out that the price of inorganic nitrogen is today only half that ruling a few years ago, and even then some New Zealand farmers were using this fertiliser to get "out-of-season" grass. These facts must be realised.

Nitrogen, when considered along with the all-important phosphate dressing, is applied to a limited area of the farm. It should be applied also to the best pastures which give the greatest return from the application of fertiliser, and, as has been strongly stressed previously, it provides valuable milk-producing feed at a time when this is at a premium, The cost of getting this good food must be compared with the relative costs of getting other types of feed, and it is very difficult to get feed of a suitable nature - at least for high milk-production, As one farmer has said :

"Growing grass with nitrogen is cheaper than roots and gives more milk."

Another man considered that the return was worth twice'what the manure cost him for the first month alone, From the use of 1 ton of Sulphate of Ammonia, a Taranaki farmer got another 1,000 lbs of butterfat from his herd in September. Before using nitrogen, a Waikato farmer secured 2,400 lbs of butterfat for the four months from June to, September. After using nitrogen he secured nearly 6,000 lbs for the same period, and his return over the whole year was 500% greater than before he used nitrogen, without any material alteration in his pasture other than that effected by nitrogen on the herd. It is sometimes charged against nitrogen that when applied to pastures it gives returns for the investment too quickly - most people like quick returns from investments. The quick-acting nature of nitrogen is one of its greatest. assets. At the same time, as can be demonstrated on many pastures in N.Z., the effect of nitrogenous applications in grading up swards - improving ryegrass content - indicates that there is a long-term effect, delaying the time when pastures need to be renewed, and giving increased carrying capacity each year.

EARLY SPRING GRASS MAKES EARLY CALVING & EARLY LAMBING SAFE.

A point that is stressed by a number of farmers is that it pays to calve early. Winter and early Spring grass on the farm makes

this practice safe. With'unfavourable weatherconditions, it is not possible to postpone calving or lambing dates,- The use of nitrogen in obtaining "out-of-season" grass therefore acts as an Insurance policy:' It has been found that on a one-hundred acre farm the cost of providing this valuable early feed is less then 5/- per cow. Apart from the value of feed at that period must be considered the fact that the herd or flock that starts off well is half way to a good season's production. It is significant that the number. of dairyfarmers who are producing butterfat at a particularly low price are consistent and substantial users of nitrogen on grass.,, What must be realised by-farmers is that the fertiliser must be considered not so much, from its initial cost point of view, but from the effect it has. in reducing costs of production. This fact was well emphasised in the survey made by Mr Fawcett;. he showed that the cost of producing butter-fat was lowest on farms where the highest amount of phosphatic fertiliser had been used.

Since New Zealand has to face World competition with her dairy products, the lowering of unit costs of production must be a paramount consideration. We have great advantages in our soil and climate-, but most of these have been already capitalised, as one American put it - "New Zealand has capitalised her sunshine and rain as well as her land".

QUALITY OF PRODUCTS EXPORTED.

Quality of produce is going to count in our main market - Britain - and it has already been pointed out that the food value of butterfat produced from pastures is superior to that produced in Countries where other methods of feeding have to be adopted. 'Grass is also the' safest food from the point of view of avoiding taint in milk. Care has to be taken in the feeding of all cruciferous crops and with ensilage; even clover is suspect.,. since excess of it in ensilage causes taint in milk,

WINTER DAIRYING..,

I feel convinced that Winter dairying must expand over certain areas in New Zealand, so as to supply our main market - Britain - with more even quantities over the year.- Nitrogen is going to be a God-send in assisting Winter dairying.

Further, I believe that if low prices for dairy products- continue. to rule,as possibly they will, for some time, we in New Zealand will have to -farm more efficiently the more efficient acres and even abandon marginal and sub-marginal land. This means producing, on better class- lands, pastures on which nitrogen can give its greatest return. It has been suggested that there is a considerable difference between "farming" 'and being "on the land", and I believe that this difference is going to be intensified under economic conditions that will rule in the Agricultural World for some time to' come. Although New Zealand has so many advantages from a stock point of view, I am convinced, after studying the matter fairly closely from all points of view, that we will have to make the fullest use of artificial aids, and in this direction I believe nitrogen is destined 'to play an ever-increasingly important part in the Dominion..

/EM.
28/9/34.

SUMMARY AND GENERAL OBSERVATIONS,

In the foregoing statement, I have given it as my opinion that in New Zealand those associated with grassland development work have had to retreat from the forward position suggested five years ago, namely, in the case of Nitrogen, we have practically abandoned the three or four applications of nitrogen every year on intensively grazed farms , and I have indicated that there is a tendency to retreat also in connection with very in.tensive rotational grazing and in the use of the more specialised strains of grasses and clovers. The bases for the statement made regarding the use of nitrogen by farmers in New Zealand has come from personal contact with a large number of users in both Islands. In this connection I would like to acknowledge the valuable assistance rendered by my colleague, Mr A.Y.Montgomery. A considerable amount of data has also been secured as a result of sending a special questionnaire, each year, to 1,000 users of nitrogen.

I have pointed out that the use of nitrogen on suitable pastures produces, when applied in the Autumn, extremely valuable milk-producing feed in the Winter. In a measure, it"Italianises" perennial ryegrass, causing it to resist frost, and to have all the value of Italian ryegrass for Winter feeding without the necessity of the cost of producing it by means of ploughing, cultivating, and seeding,

I have stressed the extreme importance of even a small acreage of such grass in giving extra value to all other food used on the farm. I have indicated too that the system of Winter grass has also possibilities in that when the pasture is allowed to grow in the early Spring and is cut for short ensilage it supplies a valuable milk-producing feed in the Summer. So the system produces, under certain conditions, not only Winter but also Summer milk-producing grass.

I have indicated that nitrogen brings grass earlier in the Spring; increases ensilage and hay, also grass-seed crops. Of course, it is 'obvious that nitrogen cannot be used on all pastures; it cannot convert browntop into-early grass, although I have seen some surprising effects on some old browntop swards which have been previously with good grass, and where the effect of nitrogen has been to bring up ryegrass and timothy more prominently in a sward in which it had not been observed for fifteen years, Again, it is useless growing Winter and early Spring grass on swampy areas where it is not possible to feed them off,

Under Present economic' conditions, where low prices rule for primary products, it is suggested that more and more dependence must be placed on grass in New Zealand - which - fortunately - more than any other Country - can depend on high production from its pastures, The seasonal nature of grassland production has been emphasised and the importance of shortening the period of pasture scarcity also stressed. Grass is not only-the cheapest,, but it is also the best and most 'fool-proof" food for stock. It is not suggested that the crops supplementary to grass should not be grown, but it is con-tended that these should be considered only after full use has been made of growing grass and of saved grass - ensilage and hay.

In securing a provision of suitable grass for a greater period over the year, it has been indicated that there are distinct possibilities,where ploughing can be carried out, in simple leys of grasses and clovers such as Italian and Red clover, Perennial and White clover,& Cocksfoot and Montgomery Red Clover, which produce food at different times of the year, and which each require a special type of management. We are now realising more than ever that the grazing animal is the major dominating factor in all grassland work and the tendency now is for all pasture seed sowings and pasture utilisation to be regulated by that fact.

We know now that it is possible to play a tune on pastures, increasing ryegrass or clover at will, and the problem before farmers is to learn how to play the tune. In such cases, as seems likely, where more and more reliance will be placed on true perennial ryegrass, there is a distinct case for the use of nitrogen to enable ryegrass to perform its functions more fully, since in the simple ryegrass/white-clover sward there is no assistance from such a plant as cocksfoot which helps out in production at certain times of the year.

I believe that in connection with dairyfarming in New Zealand there is a case for consideration being given to the British system of pastures and meadows, the hay crops being produced on the heavily dunged pastures with the aid of nitrogen, and the pastures being maintained in a grazing condition with the aid of Lime, Phosphate, and Potash where necessary, together with moderate amounts of nitrogen. Whilst it is indicated that nitrogen exerts its greatest effect on swards containing a high percentage of true perennial ryegrass, there is a case for it in the grading up of swards, particularly where there are vestigal ryegrass plants which can respond to the nitrogenous fertiliser. The fact that nitrogen exerts its greatest influence on the true perennial species of both grass and clover is a matter calling for special comment,

I have endeavoured to show that nitrogen, whilst it can suppress clover, can also aid it, and under reasonably sane management conditions there need be no fear of suppression of white clover from the use of judicious amounts of nitrogen; I have also indicated that nitrogen can stimuiate white clover. I think we are inclined to be too much dominated by the idea that if there is no 'production of clover in a sward it is necessarily bad, I believe that in New Zealand, there are more swards calling for an increase in ryegrass than an increase in clover. At the same time, the extreme importance of a percentage of clover, particularly in grazing swards, has been emphasised,

EXPERIMENTAL WORK.

I have indicated that the experimental work done 'both on plots and in grazing trials has not given an indication of the value of "out-of-season" grass. This fact was realised by the Experimenters.. However, the conduct of experiments, often using quantities of nitrogen much in excess of that used on an ordinary farm, with measurement made in a similar wag, without any indication of the digestibility, nutritive value, and value of "out-of-season" grass, is to my mind - so far as nitrogen is concerned - like playing "Hamlet" without the "Prince of Denmark". The Officers of. the Department of Agriculture conducting the experiments have taken extreme pains to point out the conditions under which the trials have been held.' In their general comments in Bulletin No. 31 issued by the Dept. of Scientific & Industrial Research, they state :

> "Applications of nitrogen as used in this experiment are not advocate5 in this country either by the Dept. of Agriculture or the representatives of the principal nitrogen fertiliser interests, Generally speaking, nitrogen is regarded as a special-purpose fertiliser for the production, so far as pastures under grazing are concerned, of "out-of-season" grass on a portion of the farm, and on pastures well supplied with the better and earlier grasses especially ryegrass. The time may not be far distant, however, when the prices of our primary products-in relation to those of fertilisers containing soluble nitrogen may make the more general use of nitrogen a highly remunerative investment, and it is important that our knowledge of how to make the best use of it and avoid

"its undesirable consequences, where such occur, should be advanced as rapidly as possible,".

The so-called "slumping" of pastures under heavy nitrogen applications has, I believe, been given an altogether untoward significance; the great Huxley has said that "Action is more important than knowledge in itself", and I am afraid the attempt to get knowledge by methods as carried out in such of the trials has, if it has done nothing else, certainly inhibited action so far as a more extended use of nitrogen on pastures in New Zealand is concerned. I think we have to be very careful in interpreting results from experimental plots; these are certainly very valuable as a finger-post to the road but they are not the broad highway, to knowledge. Let me quote again Mr R.P.Connell, as he wrote in the Journal of Agriculture for January, 1932. :

> "Instructional work is at times linked with field experimentation involving the use of plots. There seems to be a widespread feeling among farmers' that at times they cannot place a great deal of reliance on the evidence provided by such plots. Farmers who readily admit the need for investigating and who allow that the specialist may find plots of value in his work yet act on the belief that such plots by themselves do not provide a reliable guidance to better farming. In this connection the farmer may not be illustrating his unreasoning conservatism, as some would hold, but his good judgment, which possibly has enabled him to recognise more readily than those who would teach him, the shortcomings of the plot system. Of prime importance among these shortcomings is the questionable validity of the means of measuring plot results."

That scientific workers are beginning to realise the extreme importance of taking all factors into consideration in Agricultural Research, has been indicated in a statement made by the Imperial Bureau of Soil Science, and is set out in a communication by Dr Tennyson D. Jarvis of the Ontario Research Foundation. He has evidently coined a new word - "coincidence", which refers to-the co-ordinating of factors, he states :

> "It is suggested that the application. of agricultural science to practice should be based on the determination of the natural coincidences occurring in a locality. The determination of a coincidence requires a knowledge of a large number of factors such as latitude, altitude, climatic data, natural soil fertility, species and variety of crop to be grown, possible diseases, past history of the locality, etc. Equally important, for practical Agriculture - are economic factors such as marketing and labour conditions, cost of and response to fertilisers and cultivation, and land values, since economic liabilities may often outweigh ecological assets, and a high yield will not long be maintained if there is no market for the crop."

I consider the mowing and grazing technique evolved by Mr Hudson an extremely useful measuring instrument, particularly, for measuring the influence of factors that are distinctly comparable, e.g., in measuring production from two types of phosphate. I am inclined to think, however, that an attempt to measure phosphate against phosphate and nitrogen under this system,, is somewhat on a par with the attempt to measure the Italian and perennial types of ryegrass. Nitrogen exerts its greatest influence when grass is allowed to grow, and when a substantial return is secured in the hay crop. It is possible to get the fullest value from nitrogen when it is grown for Winter and early Spring grass and when this is rationed.

I am afraid nitrogen, like all other so-called artificial aids to greater production from land, will have to go through the "fear" complex stage; even such a simple thing as Lime has been charged with "enriching the father and impoverishing the son". When phosphates were applied to root crops in England in the early part of the last century, Sir John Russell, in an article, quotes this opinion as expressed by one of the Observers as being typical of the attitude of local farmers to a crop of Swedes grown with. the aid of artificial fertilisers :

> "Wise men shook their heads and held their tongues at it. Nobody would have been at all surprised if, on going to the field some fine morning, he had found it altogether vanished. By what means short of the supernatural, could a mere powder sown by the hand, produce this great fat thriving mass of roots and leaves. Surely it must, at any rate, be a fraud upon the land after all, and the next crop would show the different results of real manure and a mere stimulant."

We may say therefore that both Lime and Phosphate have had to go through this suspect stage. The results of experiments carried out at Rothamsted and Cockle Park, where nitrogen was used under conditions totally different to what they are today, still dominate the minds of a great many people. The great Goethe, one of the clearest thinkers the World has ever known, said :

> "If anyone has anything new, which contradicts, perhaps threatens to overturn the creed which we for years respected and have handed down to others, all passions are raised against- him, and every effort is made to crush him. 'People resist with all their,.. might; they act as if they had never heard nor 'could comprehend; they speak of the'view with contempt, as if it were not worth the trouble of even so much 'as an investigation or a regard; and thus a new truth may wait a long time before it can make its way,"

I think however, that economic conditions may force us to appreciate the value of nitrogen much earlier than many think. Science is already effecting primary production in a way that'threatens, according to Mr J. B. S. Haldane, to make Agriculture in the future only a hobby for the well--to-do, Today we have margarine. as a substitute for 'butter,, synthetic fibres substituting cotton; there is synthetic leather and-even a suggestion of synthetic meat. Is there, therefore not a case for 'using science to counteract her efforts to sub-merge agriculture, namely,, using artificial nitrogen which can produce foodstuffs so cheap that there will be less desire to produce the-substitutes

WHAT SHAW SAYS :

In a lecture given before the Fabian Society in London in November,. 1933, .Mr George Bernard Shaw made this; observation :

> "I want to know about the production of food, which is the one thing we want. Have we progressed so tremendously in it ? I have heard of one helpful thing. Imperial Chemical Industries have learned that, if you feed the dried grass grown from nitrogen-treated ground to cows, they will produce a much more nutritious sort of butter, a much more vital sort of

> "milk, and if you eat that butter and drink that milk, you will never suffer from disease and you will never die."

The elimination of death may be rather too much to claim, even for nitrogen. We know that as a basic element in explosives it can cause death in a wholesale manner, but, in its peaceful moods - when figuratively the soil has been turned to the ploughshare, inorganic nitrogen has shown that it can do much for mankind. Parenthetically, one may from time to time think that in ectogenesis or artificial birth, nitrogen will play its part since it is an essential element of protoplasm, or life essence; also, since it is probably the most important element of food, it will aid any prolongation of life - if not in the human sphere, at least in the plant world, and, specifically dealing with pastures, nitrogen can help them in the swaddling slothes stage of establishment, can rejuvenate the languishing, and, for perennial species, give them the equivalent to Life Everlasting.

May I remark that all soil nitrogen owes its origin to the air, since the mineral elements of the earth did not contain it in the beginning. Nature, by selection, has raised a series of plants - the legumes - that capture some of the atmospheric nitrogen by a partnership with soil bacteria. Nature also gave man the hint of how he could get it for himself direct from the air, by giving us the thunderstorm, the accompanying lightning producing nitrogen in a form fit for plants, Our ancient fore-fathers, smelling this combined nitrogen, thought it was an emanation from Hell, we now know it is mana from heaven and that it is there for the taking to the tune of 20 million tons over every square mile of the Earth. So man is able to break the monopolistic ring of the legumes as nitrogen.-garnishers, as with his man-made lightning - electricity - the nitrogen can be captured, and from an inert material - atmospheric nitrogen - be made into a life-giving substance - fixed nitrogen, and so we gain "fertility from the skies".

The only catch is that man has to apply it, and this no 'doubt is where the legumes win; but could grass summon to its aid such willing subterranean workers as the nitrogen-fixing bacteria of the soil, it would get its man-made nitrogen much quicker'and much'more abundantly than at present.

In conclusion, may I quote a statement made by Prof. Sir Fredrick Keeble, Sc. D. , F.R.S. , M. R.I., in an address given before the Royal Institute of Great' Britain, on "The Nitrogen Hunger of the World."

> "Now, however, a mightier agent - man the chemist - has mastered this refractory element. Having given loyal effect for so long to the first clause of the primal divine ordinance "be fruitful and multiply", mankind are diverting their obedience to the fulfilment of the latter clause, "replenish the Earth and subdue it".
>
> The chemist has. intervened to redress the balance of the old world by calling in a new; a new world wherein never more need'the gaunt spectre of famine stalk the earth and where health shall be the rule and disease the'rare exception; the world of nitrogen plenty."

"Prometheus brought down fire from heaven: a new Prometheus has arisen, who brings down fertility from the skies, That old, much worn, and very threadbare fabric, the soil, whence comes all life, may now at last be renovated - made stronger and more beautiful; for with the nitrogen that man can give it, all things that live upon the earth may grow lustier than they are, Facts attest that this is no empty verbiage."'
