

Hawkesbury Agricultural College - Pasture

COUNTY OF CUMBERLAND
PASTURE INVESTIGATIONS
AT
HAWKESBURY
AGRICULTURAL COLLEGE



MILK BOARD
NEW SOUTH WALES

FOREWORD

For several years prior to 1952, the Hawkesbury Agricultural College had conducted investigational work on the establishment of satisfactory non-irrigated pasture in the County of Cumberland. Up to that time, the work had been confined chiefly to the College property, but, in 1952, the Principal of the College sought financial assistance from the Board to facilitate an extension of the work to places outside the College where demonstration areas for farmers could be set up and further experimental data obtained. My colleagues and I felt that this work, which was of importance to all producers in the County of Cumberland, merited support, and accordingly, during the two financial years up to 30th June, 1955, the Board made a total of £1,250 available to the College for the project.

The College Principal, Mr. H. R. Richardson, has now supplied a progress report of the results obtained up to 30th June, 1955, which the Board has pleasure in presenting in booklet form. The results of the experiments to date augur well for future work but, even at this stage, the information available in the report is commended to dairy farmers, particularly in the County of Cumberland, as a useful guide to pasture improvement.

J. A. FERGUSON,
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PASTURE INVESTIGATIONS AT HAWKESBURY AGRICULTURAL COLLEGE

Dairy farming to supply whole milk for human consumption in the nearby city area is one of the principal forms of land utilisation in the outer parts of the County of Cumberland. Because of the low uncertain rainfall, the relatively poor soils and the consequent low nutritional value of the native grasses, dairying in the area is burdened with difficulties. To maintain milk production, supplementary feeding has to be practised. This is a costly business which can be minimised or overcome only by the establishment and maintenance of good quality, high-producing pastures composed of introduced species. Numerous attempts have been made over the past decades to do just this. A few successes and many failures have been experienced. In order to elucidate the problems associated with the improvement of County of Cumberland pastures, Hawkesbury Agricultural College, last year undertook a series of trials with finance provided partly by the Milk Board.

These trials embraced the five main avenues of investigation which become obvious when the problems are analysed, viz., water, fertiliser, species, inoculum, and establishment and management. The reasons for investigating each of these aspects may be summarised thus:

(a) **Water:** The rainfall of the area is relatively low—the annual average at the

College is only 29 inches. It is also uncertain as shown by the fact that, over the years, a flood has been recorded in each month of the year. Generally, the most reliable months from the point of view of effective precipitation are during autumn. A period of relatively dry weather can usually be expected during August, September, and October. However, this is not always the pattern, and the uncertainty of the rainfall distribution is a major factor to be considered in any programme of pasture improvement. The obvious way to overcome this problem completely is to irrigate. Because of the topography, much of the land in the County cannot be irrigated and so ways must also be found to utilise these areas to the best advantage under dry land farming conditions.

(b) **Fertiliser:** Except for the restricted areas of alluvium, the soils of the County are poor, often in texture as well as in chemical constituents. Application of the right fertiliser (including minor elements) in the correct quantity is the only practical method of improving the chemical makeup so that the land will carry a sown pasture. This applies equally to both irrigated and dry land pasture improvement.

(c) **Species:** The native species of the County have adapted themselves over a long period to the natural conditions of the area. They are hardy and they persist well, but they are understandably of low nutritive value. Consequently in any scheme of pasture improvement, new species of greater food value must be introduced. This

holds for legumes as well as grasses for both are necessary components of a balanced pasture.

(d) **Inoculum:** In order that legumes might become satisfactorily established and so build up the nitrogen content of the soil, the formation of nodules on the roots of the plants is essential. The organisms forming these nodules on introduced legume species do not occur naturally in many soils of the County. Consequently, they have to be brought in and to do this tests must be carried out to determine the most effective strains of the organism for the various legumes under County conditions.

(e) **Methods of Establishment and Management:** The weather conditions of an area, the topography, the soil type, the type of pasture sown, and many other factors all have a bearing on the ways in which a pasture is established and managed. Because of the number of factors involved these methods vary considerably. Consequently, practical systems must be worked out to suit each area taking into consideration the many variables involved and the fact that each method must prove to be an economic proposition.

Each of these five aspects is obviously intimately related to the others and each has an important bearing on the result of any attempt at pasture improvement.

The trials established in 1953, 1954, and early this year were of a general nature and

were aimed at investigating in a broad fashion the aspects mentioned. In this way, it was considered that a wide field could be covered as an initial step and that, based on the findings of this work, specific problems could be defined for further more detailed investigation. These trials can be classified as:

1. Fertiliser trials.
2. Species trials.
3. Inoculum trials.
4. Establishment trials.

Some of these were planted under irrigation and some under dry land conditions. Because of the wide diversity of soil types in the County the sites chosen for the trials were in different localities on different soils. Trials were planted at: North Richmond, Marsden Park, Pitt Town, Rouse Hill, Schofields.

Much valuable information has been obtained from these trials. Some have now been concluded while others are still being observed. The various trials are now discussed in detail under their type classifications:

Fertiliser Trials

(a) **Major Element Trials:** These were designed to test the effect of superphosphate, dolomite, lime, sulphate of ammonia and potash, both individually and in various combinations on the growth of grasses and legumes. Various rates of the fertilisers were used. In autumn 1953 one trial was planted at North

Richmond while in autumn 1954 one was planted at Pitt Town, one at Marsden Park, and one at Rouse Hill, the latter under irrigation.

Due to lack of rain after planting in 1954 poor establishments were obtained at Marsden Park and Pitt Town, but irrigation at Rouse Hill enabled the plants to come away much better. At North Richmond in 1953 good rain enabled quick initial growth.

An early response to sulphate of ammonia at 1 cwt./acre was obtained in the only trial in which it was included (at Marsden Park). It was obvious that the addition of this fertiliser boosted the initial growth of both the grasses and the clovers and generally aided a quicker establishment. From results obtained in this trial it appears that the use of sulphate of ammonia at a suitable rate at the time of sowing warrants further investigation.

In all four trials a great and lasting response to superphosphate was obtained. In many plots from which this was omitted pasture establishment failed completely. Increasing rates of application gave increasing yields up to 2 cwt/acre, but additional responses at higher rates were not so marked. However, more work must be done before the optimum economic rate for each of the different soil types can be precisely determined.

Good responses have also been obtained to dolomite and lime. As is to be

expected responses to these fertilisers were not rapid. At North Richmond after two years it is obvious that a very high rate of dolomite application (4 tons/acre) has had a marked effect on the growth of legumes, particularly lucerne. Without dolomite the lucerne has died out while with diminishing rates of dolomite correspondingly diminishing stands of lucerne have resulted. Similar responses are beginning to appear in the other trials also. More tests are necessary to determine the optimum economic rate of lime and dolomite application on these soils.

No marked response to potash has been obtained in any of the trials.

While good responses to these fertilisers when applied individually have been obvious, the results have been far better when they have been used in various combinations, e.g., lime and superphosphate. However, the best combinations and the number of applications of each over a period have yet to be determined. Although responses to the fertilisers under the irrigated conditions at Rouse Hill followed much the same pattern as the other sites under dry land conditions, the overall growth under irrigation was much greater. The economics of irrigating under these conditions remains to be determined.

As it became necessary to use the trial site at Rouse Hill for grazing the dairy herd, the trial was concluded and the area treated as a commercial paddock.

The other trials are being continued and particular attention is being given to the long-term effects of the dolomite and lime treatments. It is hoped to repeat some of the other treatments (e.g., superphosphate) and continue the trials for some time yet to test the persistence of the various species under these fertiliser applications.

(b) **Minor Element Trials:** These were designed to test the effect of the minor elements, both individually and in combination with one another and other elements, on the growth of sown pastures. One trial was sown in autumn 1953 (North Richmond), and four in autumn 1954 (Marsden Park, Schofields, Rouse Hill and Pitt Town). Both Schofields and Rouse Hill trials were irrigated. As with the major element trials poor initial establishments were obtained at Marsden Park and Pitt Town, because of the lack of rain. Under irrigation the plants came away much better. At North Richmond in 1953 rain enabled good initial growth.

In all trials the most marked overall response was to superphosphate as in the major element trials. Responses to lime are just now beginning to become obvious, also.

Of the minor elements tested **molybdenum** has proved to be the most deficient. Low yields were obtained from plots from which this element had been omitted and a discolouration of the foliage was also evident. A possible

response to boron was also shown in these trials but was not sufficiently marked to warrant definite recommendations regarding its use.

Although the overall growth in the irrigated trials was greater than in dry land ones the responses to the above elements were evident in both types.

The trial at Schofields has now been concluded because of recent poor growth in the plots mainly due to recent water-logging. As it was necessary to topdress the trial site at Rouse Hill and use the feed available for the dairy herd this trial has also been discarded. The trial at North Richmond has also been concluded as has that at Pitt Town where luxuriant growth on old stump sites over the trial area masked fertiliser responses to a large extent. The trial at Marsden Park is being continued. Although most of these trials have now been discarded as Minor Element Trials for various reasons, the sites are still inspected periodically to observe the persistence of the sown species.

Species Trials

A number of species trials of four different types were planted in 1953 and 1954. The aim of these trials was to test the suitability of new pasture species both individually and in various combinations. These trials were sown at rates considered at the present time to be the best. The four trial types are:

Species Trial A—To test various combinations of Clovers and Perennial grasses.

Species Trial B—To test various combinations of Clovers (excluding sub. clover) and Rye grasses.

Species Trial C—To test various combinations of the different sub. clovers and Rye grasses.

Species Trial D—To test various clovers and grasses individually.

Two trials of type A, two of type B, two of type C, and three of type D were planted in autumn 1954 on different soil types and one of type D in autumn 1953. One of the type D trials was irrigated. Because of the dry conditions soon after planting initial establishments were poor except under irrigation. However, the plants have responded well to rain since then and valuable information has been obtained.

A number of grasses have shown promise but *Phalaris* has proved to be the best under dry land conditions. Its chief strong points are that it has the ability to produce good feed with favourable rainfall, it can "persist" during dry spells and can recover quickly with the first rains. In these trials it combined well with clovers, particularly sub. clover. It has not combined well with the Rye grasses. The latter have tended to choke *Phalaris* in those places where they have built up high plant populations. Results of these trials lend weight to the argument that it is better not

to plant Phalaris and Rye grass together. (A trial which, it was hoped would give more evidence on this aspect was established in autumn 1954 at Pitt Town. In this trial, different rates of Phalaris and Rye grass were planted in combination and also individually. However, this trial failed because of poor germination and dry weather conditions after planting and emergence.)

Of the Rye grasses, H1 has proved to be the most satisfactory. Given sufficient autumn-winter rain, it produces an abundance of good quality feed and has combined well with the clovers. Other grass species showing promise include Green Panic and Tall Fescue but more tests on a larger scale and under grazing conditions are necessary before recommendations regarding their use can be made.

A number of clover species and varieties have been tested. Results of these trials to date indicate that sub. clover is the best of the clover species under dry land conditions and that Yarloop, Bacchus Marsh, and Tallarook are perhaps the best varieties with the new early variety "Clare" also showing exceptional promise. All these clovers combine well with the best of the grasses under dry land conditions. A number of other species tested also show promise and include Lotus Major and Sheep's Burnet (not a legume). Again, however, these species cannot be recommended until tests to ascertain their ability to tolerate grazing have been carried out. Lucerne, under proper conditions of fertiliser, water, and management also has a place on the better soils in the County.

In addition to the above trials an introduction nursery is being maintained at the College. In these plots all new species and strains are given an initial test and the best of them are then given further, more detailed trials in the field. Several hundred new strains from both Australia and overseas have been tested and evaluated over the past two years. Seed of the most promising is being held awaiting further testing. Until now all species have been tested under dry land conditions but it is hoped in the near future to have a section of the nursery available for tests of species under irrigation.

While some very promising species of both grasses and clovers have been grown in these species trials, it must again be emphasised that until they are given further tests under proper conditions of grazing and management, no definite recommendations regarding their use can be made.

Inoculation Trials

In order that legumes may be satisfactorily established suitable strains of nodule forming organisms must be available to the young plants. Most soils in the County lack these essential organisms and so they must be introduced by inoculating the seed. The fertiliser applied at the time of planting affects these introduced organisms and so a trial was established at Marsden Park in autumn 1954 to determine which fertiliser best aids the formation of nodules. Various combinations and rates of the following fertilisers were used:

Lime, dolomite, superphosphate, molyb-

denum, sulphate of ammonia, and farmyard manure.

Although the trial was slightly set back initially by dry weather it came away very well when rain did fall.

Broadly results are similar to those obtained in the fertiliser trials, viz., lime and dolomite assured good nodulation over a long term period while the application of superphosphate also helped nodulation. Lime (or dolomite) and superphosphate in combination gave a better result than each individually. The higher rates used (four cwt. lime and four cwt. superphosphate per acre) gave the best nodulation. Sulphate of ammonia at half and one cwt. per acre gave an initial impetus to plant growth and the plots receiving this nodulated better and quicker than those without it. Farmyard manure at rates up to one ton/acre had a quick, lasting and beneficial effect on both nodulation and subsequent plant growth. No really marked effect on nodulation was obtained by adding molybdenum although this trace element did slightly increase plant vigour.

It would appear from this trial that the same fertilisers which give optimum plant growth also affect directly and/or indirectly the ability of the Rhizobia to form effective nodules. The application of fertiliser with inoculated seed presents several problems, e.g., the acid in superphosphate kills the inoculum unless it is neutralised with lime. The best method of mixing the lime and superphosphate to neutralise this acid, the time the mixture should be allowed to

stand and the proportions to mix the fertilisers, are some of the number of problems which have yet to be solved before the best conditions for effective nodulation can be satisfactorily determined.

Establishment Trials

Several aspects of pasture establishment were tested in autumn 1954 and autumn 1955. The trials discussed above were all established on prepared seedbeds. The good establishment obtained in most of these trials often under adverse conditions is proof of the worth of preparing a good seedbed before the sowing of the pasture. This is perhaps, the most expensive method of establishment but it is the safest and it is quite economic. Other methods and practices were tested in separate trials and these are now discussed.

Lucerne Establishment Trial: This was established at Schofields in autumn 1954. The aim of this trial was to test the effect of deep ripping the ground as an aid to water penetration and retention before the sowing of lucerne on a prepared seedbed. There exists on this area a clay subsoil under 12 inches of clay loam surface soil and it was hoped that the deep ripping would open up this clay subsoil and allow the soil moisture and lucerne roots to penetrate through this clay to a satisfactory depth. In this the treatments were not effective and even under irrigation the lucerne stand began to deteriorate as soon as the roots reached the clay although good initial growth was made in the clay loam surface soil.

Sod-Seeding Trials: Two trials to test the value of sod-seeding were commenced in autumn 1955. One was at Marsden Park and the other at Pitt Town. Fertiliser treatments consisting of various rates of lime, molybdenum, superphosphate and sulphate of ammonia were also included in these trials. Results to date indicate that this method although cheaper is not as satisfactory for pasture establishment as the prepared seedbed under County of Cumberland conditions. However, the method is of value when additional species have to be introduced into an already well-established pasture. It may also be of value for working in particular spots (e.g., timbered hillsides), where it is difficult to operate more conventional machinery. Wherever the method is used it appears that little feed can be expected from the sod-seeded areas in the first year but that they can build up quite satisfactorily in the second and succeeding years. The sulphate of ammonia treatments in these trials gave a valuable initial boost to the sown pasture while the molybdenum, superphosphate, and lime also showed their value again just as in the fertiliser trials already described.

These sod-seeding tests were made on a comparatively limited scale and in the one season. Before the worth of the method can be truly estimated it must be tested again under different seasonal conditions and in comparison with other established methods. It is hoped in the near future to carry out these more comprehensive trials and to extend the scope of the trials to

cover management aspects, e.g., time and rate of grazing.

Glasshouse Work

The College Plant Nutrition Officer has undertaken some work on County soils under closely controlled conditions in the glasshouse. These pot tests have been carried out on soils from both the Pitt Town and the Camden areas, and have verified the results of the field trials. The most notable response has been to phosphate. Lime has again proved to be of value and the two together are better than each individually. Best results to date in the glasshouse, have been obtained with four cwt. per acre of each. Molybdenum has again been shown to be deficient. Agricultural lime has proved better than hydrated lime because of the latter's tendency to "tie-up" phosphorus and other elements in the early stages of plant growth. Increasing rates of hydrated lime gave an increasing "tie-up" effect.

Future Work

While much of the information already obtained from these trials can be applied immediately with some reservations to farming practice in the County, there is still a great deal of work to be done before definite recommendations can be made. The next stage in this research programme is the investigation of particular aspects which have been highlighted by the general programme undertaken over the past two years. The more important have been selected and the following tentative trials have been drafted to cover them. These

trials will be established in spring 1955 and autumn 1956.

Fertiliser :

- (a) Trials to determine the optimum economic rate of superphosphate application on various County soils, e.g., whether a single high dressing is more satisfactory than a number of smaller dressings.
- (b) The economics of using heavy applications of lime and dolomite which appear to aid tremendously the establishment and persistence of legume species on County soils.
- (c) The use of sulphate of ammonia or other nitrogenous fertilisers as an aid to initial establishment of all species and the subsequent productivity of particular grass species.
- (d) More minor element trials of a general nature on new trial sites.

Species :

- (a) Trials under grazing conditions of the outstanding species in various combinations for both irrigated and dry land farming.
- (b) Larger plantings under sward conditions of some of the more promising of the new species.
- (c) Continued testing of new introductions in both the nursery and the field.

Inoculum :

- (a) A trial to find the best method of mixing and distributing the necessary fertilisers to provide optimum growth conditions for the various recommended strains of inoculum.

Establishment and Management :

- (a) A trial to compare methods of establishment, e.g., sod-seeding, clean seed-bed, over-seeding, chisel plough, bog-and-bush.

Irrigation :

- (a) A trial to determine the most economic method of spray irrigation, e.g., whether a single high application is as effective as several small applications.

In addition to this trial on irrigation methods it is hoped that sufficient irrigation equipment can be obtained to carry out some of the above fertiliser, species, inoculum, and establishment trials under irrigation conditions on different soils in the County.

A number of those trials established in 1953, 1954 and 1955 are still yielding valuable information and it is planned to continue these in the coming year's programme.

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