GRASSLAND FERTILITY AND CROPPING

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INTRODUCTION

Most of New Zealand's soils are inherently infertile and fertility has had to be built up per medium of clovers, pasture and grazing animals.

On the pastoral land, nitrogen deficiency is the main limiting factor to increased production. The key to improvement lies in the clover plant which has the capacity to supply enough nitrogen for itself and the requirements of the associated grasses. At Palmerston North Sears (1952) found the nitrogen fixed was equivalent to 15 cwt sulphate of ammonia; in Canterbury, 100 lb, equivalent to 5 cwt of sulphate of ammonia, would probably be a reasonable annual average.

To utilize the high dry matter produced under favourable conditions, high stock numbers are required which, in association with all-year grazing, favours a rapid build-up of soil fertility.

In turn, high soil fertility enables high-yielding crops to be grown and this situation exists in most parts of New Zealand.

REGIONAL CROPPING POTENTIAL

On non-irrigated, light stony soils (for example Lismore, Eyre, Steward and Paparua silt loams), although fertility can soon reach a level high enough to warrant cropping, dry summer conditions limit their cropping intensity. In most cases, cropping is restricted to forage crops such as soft turnips or rape. Cash crops are infrequently grown because they are too variable in yield and quality.

Because of its drought resistance and versatility in terms of hay and grazing, lucerne is the most important crop on this class of land.

With irrigation the problem of drought on light land is overcome and a very wide range of crops can be grown.

Typical regional rotations would be:

(1) Light land (the light stony soils)
Five- to seven-year grass → soft turnips (winter feed) → rape (fat lamb feed) → new grass or lucerne.

(2) ***Drier 24 to* 30 *in. downs*** (for example, Timaru and Claremont silt loams)
Five- to seven-year grass → swedes and choumoellier (winter feed) → rape (fat lamb feed) → wheat → wheat or barley → new grass.

(3) ***Heavy alluvial soils*** (for example, Templeton, Wakanui and Willowbridge silt loams)
Three-year grass → wheat → wheat → barley → peas → new grass.

Regardless of whether soils are naturally fertile or whether the fertility has been raised by artificial means, the rotation will need to include several years in pasture to maintain and restore fertility.

The number of years required will vary according to such factors as soil type, rainfall, previous fertility, and previous cropping history.

The type of pasture cultivated for cropping also depends on a wide range of circumstances such as need to provide winter feed, grass grub damage, and economic factors. It may be a first-class pasture or one which is the very opposite because of weeds or pests.

As a general rule, the best crops will be those which follow a high-nroducing well-balanced grass and clover sward. On the other hand, cropping during development — that is, during the fertility build-up period — can be very detrimental to fertility raising and can result in reduced crop yields, lower grass production and lower stock carrying capacity.

After a period in grass, organic matter has accumulated, particularly in the top 3 in. and much of the nitrogen, sulphur and phosphate has become largely immobilized. These unavailable nutrients may be effectively released by cultivation, shallow ploughing generallv not initiating as much of their release as will deeper ploughing.

For best results, cultivation should be thorough to prepare a suitable seedbed and give a complete kill of all existing vegetation so that there is no induced nitrogen deficiency or weed competition from old turf. Although cultivation should be sufficient to release soil nutrients, ground should not be over-cultivated or fallowed too long as these operations can result in loss of soil structure and the leaching of soil nutrients, What is the effect of grassland fertility on the various crops?

Cultivation of high-producing pasture should result in high yields of brassica crops such as rape, choumoellier, swedes and soft turnips, as high nitrogen levels encourage dense, leafy crops.

However, regardless of fertility, it has been found that brassica responses to phosphatic fertilizer can be expected. Under Canterbury conditions, the recommended rate is approximately 2 cwt per acre of reverted or serpentine superphosphate (see Table 1).

TABLE 1: BRASSICA RESPONSES TO REVERTED SUPERPHOSPHATE

(Yields in tons greenweight per acre)

(a) SOFT TURNIPS

Reverted super.	*Timaru Silt Loam* (Medium to high fertility)	*Lismore Silt Loam* (Medium fertility)
Nil	17.1	9.8
1 cwt	26.5	13.6
2 cwt	31.8	15.2

(b) CHOUMOELLIER

Reverted super.	*Timaru Silt Loam*	*Claremont Silt Loam*
	(Medium to high fertility soils)	
Nil	12.7	21.4
1 cwt	20.4	28.5
2 cwt	21.3	30.5

In most cropping districts after cultivating grass for the provision of forage crops or because of pasture deterioration, the growing of at least one grain crop is practised. The reasons for this are:

(1) The growing of a grain crop enables a farmer to cash in on the fertility built up while in grass.

(2) It enables him to recoup the costs of cultivation, supplementary feed production and pasture renewal.

(3) After a period of cereal growing, there is often less evidence of stock scouring and ill-thrift and overall better stock performance.

(4) After cereal cropping, white clover seed production is frequently more reliable and higher yields are obtained.

(5) With lower nitrogen levels following cropping, grass dominance is reduced and a better balance of grass and clover is achieved.

TYPE OF CROP

AUTUMN-SOWN WHEAT

Frequently soil fertility after grass is too high for the first autumn-sown wheat crop. High nitrogen levels can cause very vigorous plant growth with too much leaf and straw, lodging, severe mildew and reduced yields (Table 2). Various attempts to overcome these first wheat crop yield reductions are often made. They are: not having too long a fallow and too large a release of soil nutrients between ploughing and drilling; sowing autumn wheat at reduced seeding rates and without manure; grazing autumn-sown wheat crops in the spring; and sowing, as a first crop, the variety Arawa instead of the mildew: susceptible varieties Aotea and Hilgendorf. Because of high soil nitrogen levels, these attempts to reduce crop vigour and mildew frequently meet with limited success.

Because soil nitrogen levels are usually high and phosphate can stimulate plant vigour, lodging or mildew, neither phosphatic nor nitrogenous fertilizers are recommended for first autumn-sown wheat crops which follow grass.

One effect of the first wheat crop is to reduce‘ this’ high. soil nitrogen to a level which is more suitable for wheat, and consequently sowing a second wheat crop often enhances yields.

On many cropping soils, existing phosphate and nitrogen levels are sufficiently high for the second wheat crop and little response to either is obtained. (Table 2).

To date little work has been done on the, manurial requirements of three successive wheat crops, mainly’ because few farmers have grown wheat so intensively. South Canterbury trials carried out in 1967, however, indicated that third successive autumn-sown wheat crops will respond to both phosphatic and nitrogenous manures (Table 2).

For the reasons mentioned, in many wheat-growing localities it is recommended that two successive -wheat crops be taken, and on good, cropping soils a third crop can be harvested.

TABLE 2: AUTUMN-SOWN WHEAT RESPONSES TO SUPER-PHOSPHATE AND NITROGEN

(Yields in bushels per acre. Soil type: Claremont silt loam)

(a) SUPERPHOSPHATE RESPONSES			
Superphosphate	*1st Crop*	*2nd Crop*	*3rd Crop*
Nil	48.0	59.1	60.8
2cwt	48.7	62.5	69.5
(b) NITROGEN RESPONSES			
Nitrate of Lime	*1st Crop*	*2nd Crop*	*3rd Crop*
Nil	73.1	53.6	59.4
3 cwt	67.6	55.6	10.2

Note: Although on the same soil type, the trials were on different farms in different seasons.

SPRINGSOWN WHEAT, OATS AND BARLEY

With spring wheat, oats and barley sown after grass, good responses to phosphate are usually obtained (Table 3). Nitrogen applied to these spring-sown crops frequently causes lodging and usually gives little yield response and may affect the malting quality of the barley.

TABLE 3: SPRING-SOWN CEREAL RESPONSES TO SUPERPHOSPHATE

(Yields in bushels per acre. Soil type: Templeton silt loam-high fertility.)

Superphosphate	*Wheat*	*Oats*	*Barley*
Nil	69.3	94.5	76.1
2cwt	79.3	105.5	87.2

It has frequently been suggested that with intensive wheat growing there is the danger of lowering fertility to the stage where low-yielding crops would result. This is most unlikely where two or three cash crops are followed by, say, 5 to 7 years in grass. From both trial and field observation, it would appear that, after three to four years in good pasture, soil fertility can be restored to its pre-cropping level.

The inclusion of a lengthy period in grass allows the saving of ryegrass and clover for seed to be made in the first and second year. Even after saving grass and clover seed, there is still a sufficient time interval for fertility build-up before cropping recommences.

On some medium to high, or high fertility cropping soils, intensive cereal growing can be carried out with the period in grass reduced to two or three years. Whether this tempo can be maintained depends largely on a quick build-up in fertility while in pasture. The short-term pasture must be high producing and intensively stocked to build up fertility 'quickly and restore soil structure. This may necessitate the use of artificial nitrogen to stimulate grass production in addition to the correction of lime, molybdenum, phosphate and sulphur nutrient deficiencies. On some soils it may also mean that a fallow will be needed between the last cereal crop and pasture sowing.

As the practice of saving ryegrass for seed in the first year reduces the rate of fertiiity build-up, it may have to be avoided or used sparingly where a rapid lift in soil fertility is required.

GREENFEEDS

Most cereal greenfeeds are sown in the autumn as soon as the grain crop is harvested. Because maximum leaf growth is required, 1 cwt superphosphate per acre should be drilled with the seed. Greenfeeds sown after a grain cereal are one of the few crops which give large and consistent responses to nitrogen topdressing. In trials, best results have been obtained with 1½ to 2 cwt per acre of nitrogenous manure applied when the greenfeed is 1 to 2 in. high (Table 4).

TABLE 4: NITROGEN RESPONSES ON CEREAL GREENFEEDS (OATS)

(Yields in lb dry matter per acre)

Sulphate of Ammonia	*Period Mar. 19 to Aug. 5, 1964*
Nil	2,030
1 cwt topdressed	2,860
2 cwt topdressed	3,480

LINSEED

Linseed is usually sown in the spring immediately after grass. High soil fertility and good growing conditions can cause lodging, tangling and difficult harvesting. Low fertility, on the other hand, can restrict crop yields. Soil nitrogen levels are usually adequate for linseed which is unique in being the only spring-sown crop not requiring superphosphate.

PEAS

On high-fertility soils, peas tend to grow too vigorously and produce very dense, tall vines with widely spaced, low-yielding pods. On such soils, nitrogen levels frequently have to be reduced with one or two cereal crops before satisfactory pea yields can be obtained. Where soil nitrogen is not excessively high as on some medium fertility soils, artificial nitrogen can still stimulate vine development without increasing pea yields. Regardless of soil fertility, peas usually respond to phosphate, 2 cwt per acre of either reverted or serpentine super-phosphate being recommended.

POTATOES

Potatoes benefit from high soil nitrogen levels and good soil structure so this crop is usually sown immediately after grass. Although soil phosphate and nitrogen levels are frequently high after grass, potatoes still respond to superphosphate and artificial nitrogen, 3 to 4 cwt per acre of the 3 :1 superphosphate :sulphate of ammonia mixture at planting usually being an adequate rate of application.

LUCERNE

Although lucerne responds to high fertility.. this crop is usually not sown immediately after grass. Because of the danger of grass competition in both the establishing and mature growth stages, it usually follows one to two feed or cleaning crops. In trials, lucerne has given rather variable and inconsistent resnonses to fertilizer. In Canterbury, a satisfactory rate of superphosphate application appears to be 1 cwt per acre per annum. To date few responses to nitrogen have been obtained.

SUMMARY

In this paper, an indication has been given that grassland fertility and cropping are usually complementary, but there are problems particularly with too high soil nitrogen levels. However, with good pasture fertility, and sensible rotations, high yielding crops can be obtained. On most cropping farms, soil fertility has been brought up to a cropping standard rather than a crop being taken because the pasture has run out. Cashing in on' the high fertility built up by good grassland farming, by means of cropping, is sound practice.

REFERENCE

Sears, P. D., 1953: *N.Z. J. Sci. Tech.*, 35A: 221-36.

DISCUSSION

Asked how he reconciled the statements that the organic matter is in the top 3 in. and that deep cultivation gives best results. McLeod replied that he thought it was probably a combination of breakdown of nutrients and better aeration provided by deep cultivation. The fact was that the latter had given better crops than shallower working. To a comment that some trials had shown a phosphate response while his had not, McLeod stated that nationwide fertilizer trials on the response of wheat to phosphate had shown little increase in yield. Those in South Canterbury had followed this trend in contrast to those mentioned. No responses to potash had been obtained with crops, even on soils with low K tests. Actually, it had been found that paddock tests could vary from week to week. However, marginal responses had been recorded on pastures.

He was asked to reconcile his recommendation of having land in pasture for four years to build up high nitrogen levels before cropping, with work at Lincoln which showed a high nitrogen build-up in 18 months. McLeod could not agree that a period of 18 months was sufficient to restore nitrogen fertility-he had found three to four years a much more realistic time. This referred, of course, to pastures under grazing. Those saved for seed did not given such a good build-up in fertility.

O'Connor commented that the work at Lincoln did not give a measure cf nitrogen build-up for the first 18 months. It did show that pasture grazed intensively for one vear gave a build-up sufficient to maintain potato yields for four successive years.