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## PROSPECTS FOR HIGH PRODUCTION FROM CANTERBURY PLAINS PASTURES

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### SUMMARY

Limitations of traditional grass-clover pasture in Canterbury are demonstrated. Research has shown that, on non-irrigated plains soils of widely different texture, grazed lucerne-grass pasture produces much more herbage than clover-grass pasture sown with improved varieties of pasture plants bred for high year-round productivity. Very high levels of herbage production in winter have been obtained from a new cool-season-active tetraploid Western Wolths ryegrass sown on cultivated high fertility soil. The association obtained by overdrilling such a grass into established lucerne may offer considerable potential for year-round increases in pasture productivity.

How much pastures grow on the predominantly shallow stony soils of the Canterbury Plains has traditionally been unpredictable. Frequent drought can be expected, but how severe this will be remains uncertain until it is over. Prudent farm managers always keep generous reserves of fodder for such periods. This paper considers, briefly, what limits present pastures from yielding more herbage more assuredly, the prospect of changed use of some of the present herbage plants and the potential which may be achieved from such change and from the introduction of other plants.

Features of the Canterbury Plains environment are recorded in the bulletin, "Soils of the Downs and Plains, Canterbury and North Otago, New Zealand" (Kear *et al.*, 1967). About 33% of the 2.25 million acres of plains are well-drained to excessively-drained soils, 68% of these being stony and shallow. A mere 2.5% of the plains are first-class cropping soils with minor limitations to intensive use. Rainfall is chiefly between 25 and 30 in. annually, moderately-well distributed, but, on average, three dry spells of average duration of six weeks can be expected every two years. Wind is particularly important in spring and summer months causing much drier conditions than temperatures or rainfall indicate. Mean winter temperatures are in the low 40s and days of ground frost range from 94 to 140.

It has been estimated that 75,000 to 100,000 acres of the 1,150,000 acres of light lands could be partially or fully irrigated (Dingwall, 1963). Considerable potential for supplemental irrigation also exists on heavier soils. In this paper, achievements and prospects in herbage production without irrigation are considered. Examples are quoted from a range of soils in the vicinity of Lincoln.

An experiment at Lincoln on Wakanui silt loam over the four years 1956-7 to 1959-60 showed that, under periodic hard grazing, mean annual herbage production from clover-based pastures of Prairie grass, S170 tall fescue, Yorkshire fog, 'Grasslands Kahu' timothy, 'Grasslands Ruanui' ryegrass or 'Grasslands Manawa' ryegrass ranged from 7,770 lb dry matter (D.M.) per acre to 9,180 lb D.M. per acre. In the same experiment, two pure lucerne varieties produced mean annual yields of 12,360 lb and 12,040 lb D.M. per acre. Lucerne outyielded the grass-clover mixtures, especially in the last two of the four years, when, following low winter rainfall (June-August, 4.36 in. and 2.39 in.), spring rainfall was low (September-November, 3.06 in. and 2.71 in.), and summer rainfall moderate (December-February, 5.28 in. and 4.41 in.). Clover-grass pastures may exceed 10,000 lb D.M. per acre in years of good rainfall. However, unless a sufficiently soaking rain falls in early spring, and winter recharge of soil moisture has been satisfactory, annual yields of clover-grass pastures seldom exceed 6,500 lb. About double this yield may be obtained from lucerne and more when good summer rains occur. Such rains are of little immediate benefit to most grass-clover pasture if drought conditions have preceded them.

Although autumn-sown grass has served Canterbury Plains farmers well, particularly for provision of lambing greenfeed and a subsequent crop of grass seed, in the pasture phase clover yield has been insufficient to provide adequate nitrogen input for sustained high yields of grass. This position may be even more serious in pastures sown with newer, denser tillering varieties of grasses. For example, 'Grasslands Ariki' ryegrass with either 'Grasslands Huia' or 'Grasslands 4700' white clover, sown in February, 1967, following a summer fallow, gave three grazings in the winter and produced 5,200 lb D.M. per acre under frequent grazing and 6,900 lb under infrequent grazing in spring. Clover contributed 2 to 4% of those yields. Under present dry summer conditions, prospects for continued high production from the pasture do not appear bright and the situation would probably have been worse were

the ryegrass shut for a seed crop. A measure of potential yields of legumes is given from an experiment at Lincoln. Under frequent periodic mowing for a period of three years, with moderate fertilizer, pure stands of Huia white clover produced a mean annual yield of 4,200 lb D.M. per acre, 'Grasslands Turoa' red clover (late type) 4,500 lb, while lucerne produced 12,600 lb. Similar performance of these legumes was observed under intermittent grazing.

On light lands, the superiority of lucerne over clover has likewise been shown. Iversen and Calder (1956) record that average annual herbage production from subterranean clover-low density grass mixtures was 3,500 lb D.M. per acre (range 900 to 6,000 lb), best results being obtained where the density of grass was kept low to allow maximum germination in autumn of the annual legume. Inclusion of lucerne in such mixtures raised annual herbage yields to an average of 5,000 lb D.M. per acre with reduced variability (3,500 to 10,000 lb), but as Iversen (1965) commented, ". . . such swards were more productive as long as the lucerne component remained strong. Retention of the lucerne has required very careful grazing management."

The realization that lucerne grazed at the appropriate growth stage could be both productive and persistent has been widely recognized only in the past few years. Grazed at the pre-flowering stage, lucerne-dominant pastures produced 7,250 lb D.M. per acre per annum over four years on a very shallow Eyre soil and 11,260 lb D.M. per acre per annum in the same period on a shallow Wakanui soil at Ashley Dene (Iversen, 1965). During six years on a deep, rich, moisture-retentive soil at Lincoln College, the best varieties under similar treatment averaged about 16,000 lb D.M. per acre per annum (Iversen, 1968).

Thus, on the Canterbury plains, lucerne appears to have greater potential as a base for non-irrigated pasture than other presently available perennial or annual legumes.

Lucerne-grass mixtures have in the past found little continued favour in Canterbury because maintenance of lucerne growth in the face of increasing grass dominance has proved difficult. The problem has arisen primarily in the establishment phase, through difference in the rates of legume and grass establishment, and has later been accentuated by differing acceptability of these components, particularly cocksfoot, to the grazing animal. To obtain better compatibility of the species at sowing, low grass seeding rates and alternate row-sowing of the legume and grass have been tried with no great success. An ex-

ample from a Lincoln experiment demonstrates this. On Wakanui silt loam, cocksfoot at 3 lb per acre and lucerne at 14 lb per acre, sown in alternate seven-inch spaced rows, produced 6,300 lb D.M. per acre, 10,300 lb, 16,100 lb and 12,500 lb in successive years under grazing, with cocksfoot dominant throughout (W. G. Thurston pers. comm.). Thus, although the association was high producing, the problem of species compatibility was not solved.

A new approach has been provided by the practice of overdrilling grass into established lucerne. From Taitapu silt loam at Cashmere, O'Connor (1968) has reported annual yields of 15,500 to 17,700 lb D.M. per acre from four or five mowings of lucerne-grass mixtures established in this way in 1962.

Winter temperatures in Canterbury average 42.5°F. Thus choice of productive materials is restricted to those with some degree of cool-season activity. Among non-annual grasses, both Ariki and Manawa ryegrasses may be considered. However, if spring-summer herbage production is increased from a lucerne base rather than a clover base, this must be matched with reciprocal grass production in cool seasons. Only in this way can sufficient stock be carried to graze the lucerne *in situ*. Otherwise, the spring-summer production "peak" from lucerne would have to be stored as additional hay for winter feeding.

Greater cool-season-activity than from perennials may be obtained from the greenfeed grasses, 'Grasslands Paroa' ryegrass or a new tetraploid variety of Western Wolths ryegrass, as yet designated 'Grasslands 4707'. Sown on cultivated high-fertility soil at Lincoln, 'Grasslands 4707' ryegrass produced 5,700 lb D.M. per acre and 8,800 lb over a six-month period from April, in successive cold and mild winters (Barclay and Vartha, 1966). The combination of lucerne with 'Grasslands 4707' ryegrass appears to offer the best prospect for increased herbage production in Canterbury.

A comparison of lucerne and clover as legume bases for pasture was established at Lincoln in 1964. Among the materials were Wairau lucerne and a new variety of white clover, designated 'Grasslands 4700' bred to provide greater cool-season-activity than that obtained from the standard variety 'Grasslands Huia'. Both these legumes were established in late autumn 1964. At the time of grass overdrilling in February, 1965, 'Grasslands 4707' ryegrass was not available. Ariki ryegrass was chosen on the basis of its demonstrated compatibility with lucerne in experiments

TABLE 1: HERBAGE PRODUCTION OF 'GRASSLANDS ARIKI' RYE-GRASS OVERDRILLED IN LEGUME BASES AT LINCOLN  
SEPTEMBER 1965 - AUGUST 1966  
(lb D.M./acre)

	<i>Wairau Lucerne</i>	<i>'Grasslands 4700' Clover</i>
Total herbage	19,040	16,180
Legume	9,890	6,860
Sown grass	6,350	8,220
Unsown grass	460	610
Other unsown species	2,340 (1,300)*	490

\*Clover in parentheses.

both at Lincoln and Cashmere. Production for the first year of measurement from September, 1965 to August, 1966 is shown in Table 1. The lucerne-grass was grazed with up to 500 sheep per acre for two days whenever lucerne was at the 10% flowering stage. Grazing was deferred to late autumn and grazing of young lucerne avoided in very early spring. The clover-grass was grazed intermittently, from 3 or 4 in. down to 1 in. throughout. Technique of pasture measurement was not identical for the two associations. Clover-grass production was measured by a "rate of growth" technique in which caged areas were harvested each month and the cages then re-located to a pre-trimmed area. Harvesting was then not coincident with grazing and production of the pasture by this method is probably over-estimated. The lucerne-grass pasture was sampled before animals were admitted, then grazed down to sampling height, any growth during the short grazing periods being ignored. The lucerne-based sward produced 2,000 lb D.M. per acre in excess of that from the clover-based sward which in turn was the highest ryegrass-white clover yield ever recorded at the Grasslands Division, Lincoln. Winter production of ryegrass with lucerne (1,090 lb) was comparatively low in relation to total annual herbage production from the mixture, so that, in effect, combination with the lucerne increased the disparity between the peak and trough of production, compared with combination with clover.

In the following year, the lucerne-grass swards were put under either of two managements:

- (1) The same as in the previous year ("lucerne" grazing);
- (2) Grazed whenever herbage height was 5 to 7 in. ("grass" grazing).

TABLE 2: HERBAGE PRODUCTION OF 'GRASSLANDS ARIKI' RYE-GRASS OVERDRILLED IN LEGUME BASES AT LINCOLN  
SEPTEMBER 1966 - AUGUST 1967  
(lb D.M./acre)

	Wairau Lucerne		'Grasslands 4700' Clover
	"Lucerne" Grazing	"Grass" Grazing	
Total herbage	20,900	19,730	16,280
Legume	14,960	12,930	5,710
Sown grass	4,300	4,280	9,770
Unsown grass	—	220	200
Other unsown species	230 (1,410)*	460 (1,840)*	600

\*Clover in parentheses.

The results from September, 1966 to August, 1967 are shown in Table 2. Total herbage yield from lucerne-grass was similar to the previous year, outyielding clover-grass by 4,620 lb. The weather in 1966-7 probably had considerable influence on the behaviour of lucerne and Arika ryegrass. Rainfall in the preceding winter was moderate (4.71 in.), low in early spring (1.04 in. in September), but high in late spring (3.65 in. in November). Total rainfall for the growth year 1966-7 (22.45 in.) was exceeded in seven of the last ten years. Summer rainfall was particularly low (4.79 in.—30-year average 6.70 in.). Drought and the suppression by lucerne (5,800 lb D.M.) reduced ryegrass density to such an extent that its subsequent yield was negligible. Argentine stem weevil (*Hyperodes bonariensis* Kusch) damaged ryegrass to an unknown degree. High production from lucerne has been continued in spring 1967. "Grass" grazing reduced potential total herbage yield by almost 3,500 lb D.M. per acre in 1966-7, and, in spring 1967 alone, by almost 2,700 lb D.M.

Herbage yields so much higher than previous data call for comment. First, part may be explained by grazing method. The interval between grazing was longer than in previous Grasslands Lincoln experiments with lucerne, which in general were grazed at about 7 to 10 in. height compared with 12 to 18 in. in the present experiments. Frequent grazing reduces lucerne production as illustrated in Tables 2 and 3. Secondly, mob-stocking rates of about 500 sheep per acre for 24 to 36 hr had not previously been used. Such mob-stocking involves massive and probably more even return of nutrients than at lower stocking rates for a more prolonged grazing period. Thirdly, in the specific instance of spring 1965, Arika ryegrass maintained

TABLE 3: HERBAGE PRODUCTION OF 'GRASSLANDS ARIKI' RYE-GRASS OVERDRILLED IN LEGUME BASES AT LINCOLN  
SEPTEMBER 1967 - NOVEMBER 1967  
(lb D.M./acre)

	<i>Wairau Lucerne</i>	
	<i>"Lucerne" Grazing</i>	<i>"Grass" Grazing</i>
Total herbage	10,600	7,950
Legume	9,660	5,920
Sown grass	90	530
Unsown grass	80	540
Other unsown species	370 (400)*	280 (680)*

\*Unsown clover in parentheses.

production at a high level when, after the first grazing of that season, recovery of lucerne was slow under cool weather conditions (Ariki ryegrass, 3,530 lb D.M. per acre; lucerne, 2,910 lb). In the following spring 1966, production was: Ariki ryegrass, 4,230 lb and lucerne 6,240 lb. Ryegrass, if present, contributes considerable spring yield. However, Ariki has not persisted satisfactorily under lucerne and overdrilling of the annual, cool-season-active ryegrass, 'Grasslands 4707', may provide better reciprocal grass growth than could be achieved with Ariki ryegrass. So far, marked winter growth of 'Grasslands 4707' ryegrass overdrilled into lucerne has not been obtained. Overdrilling on Templeton silt loam in 1966 was late, and, in 1967, establishment in dry autumn conditions was poor with subsequent severe reduction in yield from both grass and lucerne by Porina caterpillar, before this pest was controlled. There has been very good early spring production on the soil, on Kaiapoi sandy loam, Paparua sandy loam and Eyre very stony sandy loam, from 'Grasslands 4707' ryegrass overdrilled in lucerne.

Some success has resulted from 'Grasslands 4707' ryegrass overdrilled into lucerne on light land at Ashley Dene. In the period from February, 1966, to February, 1967, out of a total herbage yield of 10,320 lb D.M. per acre, lucerne and 'Grasslands 4707' ryegrass contributed 4,570 and 4,620 lb, respectively. The lucerne had been sown in 1959. Production up to 1964 ranged from 5,670 lb to 8,660 lb D.M. per acre (Iversen, 1968). In 1966, total herbage yield from these otherwise declining stands of lucerne was maintained by successfully overdrilling grass. Further work on the same site in 1967 was a failure because the grass did not establish sufficiently in the extremely dry weather

in autumn. It is still uncertain as to what extent cool-season production from the grass will be at the expense of subsequent lucerne growth.

In 1965, 'Grasslands 4707' ryegrass overdrilled into a clover-dominant Ariki ryegrass pasture on Wakanui silt loam at Lincoln, produced, under grazing, 1,450 lb D.M. per acre out of a total herbage yield of 2,370 lb D.M. for the period from April to August 27. Over the same period, the Ariki pasture produced 1,960 lb D.M., of which 690 lb was from Ariki ryegrass (E. W. Vartha, unpubl.).

The realization that grazed lucerne, with appropriate management, is both high producing and persistent on a wide range of plains soils could provide a major advance in Canterbury grassland practice. Through high stocking rates at infrequent intervals, a mass flow of nutrients may be cycled. The crop structure of lucerne enables large quantities of quality dry matter to be accumulated *in situ* (in spring and summer, yields of about 4,000 lb D.M. per acre before grazing have been obtained). Added to this, there is the prospect of combination with a cool-season-active grass such as 'Grasslands 4707' ryegrass that has been shown to accumulate 3,700 lb D.M. per acre of high quality greenfeed grass over 11 weeks in winter (Barciay and Vartha, 1966). Overdrilling may make possible satisfactory lucerne-grass mixtures. Specially-designed drills have overcome most of the technical problems associated with seeding. Successful establishment has largely been dependent on climatic conditions following overdrilling. This may be in terms of drought restricting seedling growth or of excessive growth of the established legume base suppressing establishing grass seedlings. If these difficulties can be resolved, then the prospect of reciprocal growth from a cool-season-active grass, such as 'Grasslands 4707' with lucerne, is a vast increase in potential herbage production. The most efficient method of harvesting this by grazing animals will involve some degree of rationed feeding. Such a system on Canterbury farms with their traditionally large-sized paddocks is novel. The degree to which the potential is realized will depend upon the system of management that best strikes a balance between production and utilization of herbage, while, at the same time, giving satisfactory production from all classes of stock. However, one should not neglect the potential indicated from Ariki ryegrass—'Grasslands 4700' clover pasture that produced in excess of 16,000 lb D.M. per acre in two successive years. The clover produced 5,700 and 6,860 lb of that total. Here, high clover

yields in association with grass point to the success of the method of introducing the grass by over-drilling into established clover.

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