PASTURE GROWTH AT MODERATE STOCKING RATES

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IN APRIL, 1961, the writer was invited by I. McQueen, Dairy Farm Supervisor, Massey University of Manawatu, to assist in investigating two systems for the wintering of dry dairy cows. The need for this occurred on the No. 3 (Bourke) Dairy Farm, where wet soil was unstable in winter and spring. It was difficult to utilize pasture growth and avoid treading damage (Edmond, 1963), a problem common to most dairy farms.

Much of the area used was level and all soil was Tokomaru silt loam (Cowie, 1964). From 1950–60, all pastures were resown with certified seed, notably perennial ryegrass, while 8 to 10 hay or silage crops were carted off and only 25 to 35 cwt per acre of phosphate (serpentine and superphosphate) were returned. The area had not been intensively farmed and, latterly, was used to provide summer and autumn grazing for dry stock. Mole and tile drains were installed throughout.

The Treatments

By assuming that 50 to 60% of a hypothetical farm (stocked at one cow per acre per annum) would be rested through the winter to provide spring feed, two systems of winter management of the remainder were planned :

(1) Dry cows uniformly set-stocked (split herd), with hay supplement fed to appetite.

(2) Dry cows grazed on breaks of fresh pasture for two hours each day, given access to self-feed silage for a further two hours and then restricted to the first paddock eaten out (holding paddock) for the remaining twenty hours. When the soil was judged to be wetter than field capacity, the cows were kept on a concrete platform with free access to the self-feed silage.

Winter 1961

The effective stocking rates were: split herd = 2.4 cows per acre; platform herd = 2.1 cows per acre. The cows used were grouped by age and calving date, all being over two years old and calving in July and August. During the 72-day period of the investigation, 8.5 in. of rain fell on 34 days (0.75 in. on July 6). Approximate soil moisture contents, (field capacity approximately 40 g water/100 g dry soil) were: May 15, 35 g/100; June 19, 41 g/100; July 11, 46 g/100; July 28, 45 g/100. The concrete platform was used for over twenty hours on 21 consecutive July days and on 12 other days, with shorter periods on a further 11 days. Table 1 indicates the type of pasture used.

Cow weights at calving were not influenced by treatment. In the beginning, the split herd cows ate pasture herbage almost to appetite, so that within two weeks most herbage had been eaten. Hay feeding increased to 10 to 12 lb per cow per day in early July. The scanty herbage which remained was almost untouched, due to inaccessibility, contamination and outright unpalatability. When soil moisture exceeded field capacity, severe pugging developed. Water lay continuously in many hoof marks, while hay, pasture and dung were trodden in.

The platform cows had an assured but rationed feed supply throughout. Indeed, the two-hour daily restriction on pasture grazing resulted in a surplus of saved pasture. These pastures (in later years also) were closed in early April and as a result suffered from overshading and rotting of the bottom leaves. In the circumstances, white clover and the ryegrasses could not thrive and Yorkshire fog, bents and *Poa* spp. persisted in quantity. The feeding platform received a large transfer of fertility, as did the holding paddock, which was not seriously damaged. This caused ryegrass to increase relatively, as did *Poa* spp. and to a lesser extent timothy, while Yorkshire fog thrived in an area where there was no defoliation and limited treading. At any one time, there were twice as many heaps of dung on the split-herd pastures as on the others, despite extensive trampling in the former.

Subsequently, all pastures were spelled into September when the break-fed pastures produced 28 lb dry herbage per acre per day, while the best sites in damaged split-herd (set-stocked) pastures produced 18 lb dry herbage per acre per day. This result was in spite of the transfer of fertility

TABLE 1: BOTANICAL COMPOSITION (%) OF TWO CONTIGUOUS PASTURES, No. 3 FARM, MASSEY UNIVERSITY OF MANAWATU -CUT TO M-in. HEIGHT

Sampling Date	*May, 1961*		*Jun., 1962*		*Jul., 1963*		*May, 1964*		*Jul., 1965*		*Jul., 1963*	*Nov., 1963*
Pasture No.	*10*	*11*	*10*	*11*	*10*	*11*	*10*	*11*	*10*	*11*	*10*	
SPECIES												
Ryegrass	20	38	not	47	55	54	39	37		47		
Poa spp.	11	5	taken	7	7	3	7	31	37	7	37	
Yorkshire fog	20	17		34	18	14	11	16	44		9	
Agrostis spp.	9	9		3	6	1	3	7	10	34	19	
Sweet vernal and goose-grass	3	4		—	1	—	—	2	6	3	6	
White clover	12	17		6	10	17	28	4	—	—	2	
Other species		2		—	—	2	1	1	2	6	18	
Dead	2:	7		3	3	9	11	2	1	—	—	
										3	9	

and appeared to be because of the gross damage to the set-stocked pastures. Long-term evaluation of treatment effects was not possible.

Long Term Investigation

It was decided to study the effects of the treatments outlined above on a year-long basis, over a period of years. Plot measurements indicated that, after 30 days, in August and early September, urea at 4 cwt per acre increased pasture growth to a rate of 90 lb dry leaf per acre per day, whereas 50% muriate of potash at 3 cwt per acre, superphosphate and ground limestone did not give significant responses.

Thirteen paddocks (total area 52.6 acres) were then fenced into halves, one half being allotted to a farm to feature split-herd wintering, the other half to a farm to feature the use of pasture protection during the winter and a feeding platform. Both farms were to run on similar lines, save during the winter period, when the two systems as outlined would be used. The platform system was amended to permit longer periods at grazing and occasional continuous use of the platform with complete reliance on silage. Cow numbers were to increase each year until production declined on either farm. Results since winter 1962 are shown in Table 2.

TABLE 2: STOCKING RATES AND BUTTERFAT PRODUCTION (LB/AC/YR) FOR No. 3 FARM
(McQueen, 1965)

Season	1962-3	1963-4	1964-5	1965-6
Milking cows/ ac.	0.95	1.03	1.22	1.33
Butterfat:				
Split-herd	360	425	515	—
Platform herd	350	450	500	—

Pattern of Events

During each winter period the events have been similar to those of 1961. In the spring, calving has preceded the period of rapid pasture growth, and this has necessitated the grazing of large areas of both farms between July and September, when the soil is wet and easily damaged. The resultant damage has been increased by giving the milking cows access to as much pasture herbage as they can eat, at all times, but particularly in the spring. This has meant that

all of each farm has been damaged once and possibly twice each spring. Even so, it has been possible to harvest earlier silage crops from the platform farm pastures, which, as a result, have gone into the summer with more carry-over herbage. This difference has disappeared during the summer, since pasture growth slumps on the droughty clay rich soil. White clover becomes prominent in the summer, without achieving dominance.

Once or twice, winter-damaged pastures have been oversown with short-rotation ryegrass. Otherwise, plants from hay seed and survivors from original pasture gradually occupy the area. The first grazings during recovery smooth the soil surface and within several months a pasture develops which is similar to the original. The affected areas produce poorly for months, and, in the writer's opinion, should be over-sown with short-rotation or mixed ryegrass seed, and smoothed using the cows or machinery.

Pasture Composition

The split-herd pastures have mostly been damaged and have recovered as above, but all pastures have suffered spring damage. Hence, it is probably not surprising that their composition has changed relatively little during the investigation. Table **1** shows botanical composition data for Paddock 10 (a platform farm pasture) and for Paddock 11 (its split-herd twin). These have been a little better than average. High variability and sampling difficulties prevented statistical treatment of the data. Data for Paddock 10 in 1963 gives an idea of the relatively small seasonal change in pasture composition. Although botanical composition has changed only little, over the years dead material has generally become less and plant vigour does appear to have increased.

Fertility and Growth

Urine and dung patches have been poorly utilized throughout, while, latterly, the "in between' areas have tended to be overgrazed. Last July, when Paddock 10 had been spelled for about 8 weeks, 69% (± 6) of its area supported growth which reached to 3-in. height or less. High spots yielded at the rate of 2,200 lb dry leaf per acre, while some low spots gave 600 lb dry leaf per acre. They differed importantly and significantly in botanical composition, in ryegrass (high $=52\%$, low $=35\%$), in bent grasses (high= 3%, low $=9\%$) and in white clover (high= trace, low $=5\%$).

This is a fresh reminder of the need to secure even distribution of fertility and to utilize pasture efficiently. One sound method for doing this is to increase stocking rates.

In most years, serpentine superphosphate at 2 to 3 cwt per acre has been applied. In 1963, a number of paddocks received one ton ground limestone per acre, while in 1964 and 1965 there has been restricted seasonal use of sulphate of ammonia. DDT was used widely in 1962. Each year, Rukuhia Soil Research Station tests soil samples from each paddock. Levels of pH have been 5.8 to 6.2, and for calcium 8 to 11. Phosphorus figures have increased from 4 to 6 up to 9 to 12, while potassium figures are still low, having increased from 3 to 5 up to 4 to 7.

Clover growth has lacked vigour and in the spring, 1964, gave cause for serious concern when, for the first time, demand equalled supply of herbage. Part of Paddock 10 was enclosed, rolled and mown, and fertilizer treatments applied as in Table 3.

TABLE 3: FERTILIZER TREATMENTS ON PADDOCK 10, No. 3 FARM. ALL APPLIED WITH OR WITHOUT SULPHATE OF AMMONIA (N) 4 CWT/AC.

Spring 1964 Applications (per acre)	*Autumn 1965 Applications*
(1) No fertilizer	(1) No fertilizer
(2) Superphosphate (P), 10 cwt	(2) As for spring treatment 4
(3) 60% Muriate of potash (K), 4 cwt	(3) P+K (as for spring series)
(4) Superphosphate, 10 cwt 60% Muriate of potash, 4 cwt Ground limestone (L), 10 cwt Magnesium sulphate, 3 cwt Manganese sulphate (Mn), 40 lb Copper sulphate (Cu), 10 lb Boric acid (B), 8 lb Zinc sulphate, 5 lb Ammonium molybdate, 2½ oz	(4) P+K+L (as for sprmg series) (5) P+K+Cu+Mn+B (as for spring series) (6) Cu+Mn+B (as for spring series)

Spring treatment (4)="mixture".

Fertilizer Experiments

Sulphate of ammonia produced rapid responses ; initially the largest was in the superphosphate plots. Yorkshire fog responded to straight super-phosphate (Table 4), while ryegrass responded to potash and the mixture. Without nitrogen, there were a number of early changes which

TABLE 4: YIELDS FROM FERTILIZED PLOTS, PADDOCK 10, No. 3 FARM, TREATED OCTOBER 29, 1964

Harvest Date	19.11.64			4.2.65	
Species	*Ryegrass*	*York. Fog*	*Total*	*Ryegrass*	*White Clover*
TREATMENT					
N	61			85	10
N+P	55	49	210 180	140	15
N+K	82	28	165	100	10
N+ "mixture"	89	19	215	125	15
Sig. diff 5%	23	17	28	39	—
No fertilizer			110	20	35
P					
K			100 120	40 35	40 50
"Mixture"			135	35	85
		Sig. diff. 5%	—	21	22

failed to reach significance level, *e.g.*, ryegrass responded to the fertilizer mixture (control = 53, mixture = 83). Three months later (February), the fog had declined under the repeated mowing, the ryegrasses had been stimulated by super-phosphate and the mixture, while white clover was markedly most vigorous where the mixture had been applied (not the result of overshading).

This result caused a further set of plots to be laid out on another freshly enclosed part of Paddock 10, the treatments (Table 3) being related to those used earlier.

Responses from March 17, 1965, may be seen in Table 5. The complex mixture again stimulated ryegrass, and also *Poa* spp. Where the nitrogen stimulus persisted, superphosphate and potash stimulated ryegrass growth. There was little real effect on Yorkshire fog or white clover, but the latter grows slowly in the winter.

While the longer-term effects recorded in Tables 4 and 5 do indicate fertilizer responses of importance, the early responses are of particular interest since the influence of dung and urine would be operating then.

Results in Brief

Superphosphate and muriate of potash applied together promoted ryegrass growth, but the complex fertilizer mixture was much more effective. It has almost doubled

TABLE 5: YIELDS FROM FERTILIZED PLOTS, PADDOCK 10, No. 3 FAKM, TREATED MARCH 17, 1965

Harvest date	14.4.65		5.6.65 and N+29.5.65	
Species	Total	Ryegrass	Total	Ryegrass
TREATMENT				
No fertilizer	85	2.5	85	35
"Mixture"	155	75	160	110
P+K	90	30	110	45
P+K+L	105	25	115	45
P+K+Cu+Mn+B	85	25	115	55
Cu+Mn+B	95	25	100	40
Sig. diff. 5%	22	25	17	17
N	145	65	100	50
N+"Mixture"	145	55	175	125
N+P+K	150	70	145	95
N+P+K+L	140	55	130	90
N+P+K+Cu+Mn+B	155	80	140	100
N+Cu+Mn+B	140	60	105	65
Sig. diff. 5%	22	25	17	19

the production of pasture herbage, and, possibly most important of all, it has stimulated white clover growth — an effect which appears to be persisting. Further investigation may show that smaller quantities of all or some of the mixture components will be sufficient to stimulate growth.

Outlook for the Future

These results have obvious practical implications. Last season's production of 509 lb butterfat per acre, secured with 64 milking cows from the 52.6 acres of No. 3 Farm, was equivalent to a farmer's production of approximately 410 lb butterfat per acre per annum "at pail" or 390 lb "at factory" secured with 5.5 cows plus 12 "in-calf" heifers plus 14 yearlings on 55.6 acres (almost one cow per acre per annum). This was taken from pastures of only moderate agronomic merit, a situation similar to that found at Waimate West (Smith, 1965). In the future, it is possible that the pastures will improve and that bred species and strains of pasture plants will become dominant. Once this has come to pass, the butterfat production on the No. 3 Farm may have reached 600 to 800 lb per acre per annum on a "normal farm" basis.

Much will depend upon the efficiency with which the greater growth of the improved species is utilized, and, also, on its quality as feed. Careful correction of soil deficiencies

should improve quality, while Sears (1953) and Watkin (1954) reported that dung and urine enhance herbage quality. Earlier, workers such as Stapledon (1926) and Levy (1934) recognized the importance of dung and urine, but it remained for Sears (1953) to highlight the matter. He urged constant consideration of the fertility cycle and the need for continued vigorous clover growth. In fertile conditions, such as dung and urine promote, Brougham (1959) measured the growth of ryegrass and white clover at annual yields of more than 15,000 lb dry herbage per acre. Sears (1949) presented data for similar pastures which indicated that 800 lb butterfat per acre per annum could be secured from annual herbage yields of approximately 13,000 lb dry herbage per acre. Hutton (1963) has recently confirmed this estimate. It is probable that present knowledge will need considerable expansion, e.g., there appear to be fewer earthworms under stocking of one-and-a-half cows per acre than under one cow per acre at Waimate West, but the prospect is plain for all to see.

Conclusion

Unsatisfactory pasture management, some of it inherent in the design, has prevented an objective evaluation of the two wintering systems used. However, both farms have demonstrated that relatively poor pastures can produce a lot of butterfat when the cows and the cowmen are above average (particularly the latter). It is concluded that when accumulated knowledge of pasture species and management is applied to this farm, or any other farm, stocking rates and production will rise to a level considerably above that currently accepted as being high.

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DISCUSSION

How does Mr Edmond reconcile the luck of difference in butterfat production obtained under each of these two wintering systems, with the difference he might have expected?

I do not.

Why?

In the paper, I said that "the resultant damage [on both farms] has been increased by giving the milking cows access to as much pasture herbage as they can eat . but particularly in the spring". I wonder if this is a really sound practice. Give the cows as much as they need rather than as much as they can eat. If cow intake is regulated, pastures may be grazed less frequently-of particular importance in the spring. In this investigation the normal farmer-approach to pasture management has given similar pastures on both farms and similar productivity from both.

An opinion in Taranaki is that the electric fence should not be used after calving. It is argued that cows should be fully fed at this time and the problem is how to get sufficient feed info them. Concentration of cows behind an electric fence in the spring may affect the pasture, particularly since cows eat more when behind a fence. Would Mr Edmond comment?

The first thing to consider is length of pasture. Too often, farmers rest their pastures from April-May to August. This causes severe damage by overshading, while the lax, yellowish herbage effectively has a low dry weight content. It would be better to feed green-leaf as it is grown, when it has on average about 20% dry weight content. The electric fence could then be used to ration cows without restricting intake, and would reduce the area liable to serious spring damage.

Another reason for throwing away the electric fence is based on D.S.I.R. results. Stock moving faster over a pasture gives more grass overall and more production with less work.

The way in which experimental results are put into practice is the source of much argument. We are not disagreeing and have each made our points.

Pasture growth on the No. 3 Farm has been influenced by soil fertility. The mixed fertilizer used in these trials is expensive, Since the nitrogenous fertilizer appears to have been quite effective, would Mr Edmond consider that, in practice, additions of nitrogen would have been just as beneficial, at lower cost?

I do not think so. The soil of No. 3 farm appears to lack more than nitrogen, and, basically, this deficiency needs correction.

COMMENT (R. A. CANDY) : Our aim as farmers is to *produce as much* grass as possible. Hence stock management is important. I come down on the side of Mr Edmond. We aim to see that our stock get a full intake, but without wastage of pasture.

COMMENT (R. PHILLIPS) : Concerning spring feed utilization, Mr Candy says that without the electric fence much spring feed is left

after grazing. I suggest that with higher fertility, better production of quality feed and higher stock numbers, farmers would get a better clean-off of pastures with less wastage.

The body weight *of* cows, early ***in*** lactation, ***must be maintained by*** *full* ***feeding. There must be a balance between feeding stock to capacity and maintaining pasture production. I think that early in the lactation the balance should be slightly on the cow side, and later in the season slightly on the feed side. Does Mr Edmond*** know the *herbage production* of ***the No. 3*** Farm pustures? ***There are many problems in an investigation such as on No. 3 Farm owing to experimental design, calving dates and so on. Does Mr Edmond think that later*** *calving* ***would alter the results in this in vestigation?***

A farmer's main asset, apart from his family, is his land, then come his plants and finally his animals. You say that animals must be fully fed, at the expense of pasture, before possible periods of feed shortage. I think that pastures must be carefully managed all the time! so that future growth is not prejudiced. If the improved, bred species are correctly managed there should be little risk of underfeeding where intake is regulated. I do not know the herbage production of the No. 3 Farm pastures. In the winter 1961, three of us put in a solid effort in measuring pasture growth on a few paddocks. Variability and sampling difficulties were such that a similar effort may be justified when the investigation is fully developed. I agree with the need for replanning; later calving could alter the results.