into the channels of the Agricultural Extension Service. Any impediment to that must depreciate the value of research, and no one knows that better than A.H.C. On the other hand, time may tell that Cockayne was right in divorcing extension from research.

A.H.C. left the service somewhat prematurely in 1943 but for 3 years still fathered the Plant Research Bureau Committee until that committee was dissolved in 1946. For 2 post-service years also he was chairman of the School of Agriculture and was a member of the University Senate. During these years he saw enthroned, in at least one of the Agricultural Colleges, the great science of Horticulture, a science where truly the plant, and the plant alone, reigns supreme.

In 1946 Cockayne's public life ended; may his retirement midst the plants he first tendered as a boy and still his first love be long and still fruitful. His influence has been great: his vision open, frank and wide, his talents rare; as an agricultural critic always sound; his administrative ability mediocre but this does not detract from his personal greatness in the field of research, in which field, had the State the sense to have retained him and to have given him a free hand, with ample remuneration, research would have profited and from it profited the whole of the Nation.

PASTURE AND ANIMAL PRODUCTION

by

Dr. C. P. McMeekan, Ruakura Animal Research Station.

This paper is presented with a certain amount of apprehension. There are three reasons for this. The first - some of you will have heard it before since most of the material was presented in a similar form to the Veterinary Association conference some months ago. The second - a comment from one of our members on the conference programme, that "the series of papers sounded a little dull and threatened to consist of too much talk and too little science". The third - that it seems hardly necessary to emphasise the obvious importance of pasture-animal associations to a society whose members are so directly and intimately concerned with such relationships.

Nevertheless, despite the disadvantages of repetition, the grave paucity of scientific material, and the danger of boring you all, it was considered desirable by your executive that the opening paper on the conference theme of Pasture and the Animal, should aim at providing a general background against which subsequent more scientific and more specialised reports might be examined. My only qualification for the honour of thus leading off appears to be that no one else was prepared to take the obvious risks. With these apologies, might I present the views of an animal husbandman on the relationship of grass to the farm animal in New Zealand.

The Efficiency of Grassland Farming:

From the outset it is desirable to make quite clear the basis of the animal husbandman's attitude to New Zealand pasture as a stock-feed, since this conditions very materially his approach to New Zealand animal problems. It can be asserted, as a fact, that the basis of New Zealand animal production is grass, the efficient conversion of which is responsible for the greater part of our animal products. Now, pastoral farming is essentially a labour-saving type of farming, and this reliance on grass has permitted New Zealand to develop a farming system characterised by an extraordinary high output per unit of labour. The relative efficiency of this output can be gauged from Table I summarising Colin Clarke's estimates of net productivity of primary production in various countries(1).

TABLE I.

Efficiency of Production.

Country	Male Workers per 1,000 ac.	N.P. per Head
New Zealand	8.1	2,444
United States	10.0	661
Great Britain	28.0	475
Denmark	59.0	642

It will be observed that New Zealand shows a net productivity index nearly four times greater than that of United States, five times greater than that of Great Britain and four times greater than that of Denmark.

In more specific animal terms reliable surveys of production levels over a representative sample of dairy herds have shown a return of from 4,500 lbs. to 6,700 lbs. butterfat per male labour unit. Individual productions as high as 12,600 lbs. have been recorded. Under fat lamb production an annual yield of from 16,000 lbs. to 25,000 lbs. fat lamb per labour unit are common on typical fat lamb pastures, while yields of up to 34,000 lbs. have been attained under highly efficient management.(4).

It is reasonably argued that any modification or refinement in farming technique in New Zealand, that increases the labour required per unit of output, threatens not merely the whole economic structure of farming, but of the country as a whole and the standard of living of the people. If it is agreed, and it surely must be, that this high output per labour unit is a direct reflection of our reliance on pasture, then it must also be agreed that any modification of methods of animal production away from pasture toward more orthodox nutritive practices must be carefully examined as to their effect on output per labour unit. This test, rather than that of animal welfare alone, is the ultimate test to which any modification must and will be submitted by the farming industry. The animal research worker in New Zealand therefore must of necessity, be a student of animal behaviour in a grassland environment. This is perhaps the most important point I have to make.

The Adequacy of Pasture as a Diet:

The adequacy of any diet for livestock must take into consideration both qualitative and quantitative aspects. Despite the classical work of Woodman and co-workers in determining the high nutritive value of well-managed pasture, the work of Wright and Morris as to the high biological value of grass proteins, the measurement of the high availability of carbohydrates in rye-grass by Rothamsted workers, and the demonstration at Rowatt and elsewhere throughout the world as to the adequacy of well-managed topdressed pasture in respect of minerals, very little attention is devoted in standard nutritional text-books to grass as a stock feed. In one of the most recent authoritative volumes on feeding farm animals, Halnan and Garner of the Cambridge Nutrition School devote but seventeen pages of some three hundred to a description of the specific characteristics of pasture.

This situation is more understandable when one examines the quantitative aspects of pasture production in Britain whence most of our nutritional ideas and instruction have come: equally the merits of pasture in New Zealand should become more understandable. Striking difference in annual yield of dry matter from pasture is apparent from published data. (4), (5).

TABLE II.

Dry Matter Yields from Pasture.

New Zealand	Winton	6,269	England	Temporary grass	2,050
	Karamu	10,412		Permanent grass	1,670
	Marton	11,071		Improved grassland	5,600
	Palmerston North	13,675		Unimproved "	1,576

Thus, from Table II, it will be observed that well-managed New Zealand pasture gives an annual dry matter yield per acre equivalent to a 60 ton mangold crop and that this yield is 6-7 times greater than the recorded yields of English pasture and twice as great as that from specially treated and improved English grass, obtained under the stimulation of war emergency conditions. Though these yields for New Zealand pastures are probably higher than those obtained under average farm conditions, the production levels of typical dairy and fat lamb pastures in terms of animal products permit an estimate of from 6,000 to 8,000 lb. of dry matter per acre on such farms.

There are, of course, many reasons for these great differences. Basically the climatic factor governs the situation the short growing period and the lower growth potential in Britain being largely responsible for the lower yields. It might also be suggested that grass culture in Britain lagged behind arable crop production because of the attitude of mind which regarded it as a natural product, incapable of the spectacular improvements early demonstrated with crops by control of cultivation, manuring, variety and strain. In contrast, the special suitability of New Zealand soil, climate, topography and labour supply focussed attention on grass as a crop and the early recognition of this viewpoint by Cockayne, followed by Levy led to their splendid improvement work in this field.

Equally important as the total annual yield of nutrients from pasture from the viewpoint of adequacy is the distribution of yield throughout the year. Figure 1 (see last page of this paper) built up from measured yields from typical North Island areas over several years, illustrates the seasonal variability in pasture growth (6). While considerable individual departures from this occur, the curve is fairly typical of North Island pasture distribution in an average season. Grass commences to grow vigorously in the spring, rising to a peak in November in most areas. It falls sharply in December-January, with the onset of dry weather, to rise again with the autumn rains. A low level is maintained in the winter months, growth seldom being entirely dormant.

Superimposed on this curve of nutrient yield are the annual food requirements of a dairy cow and a breeding ewe and lamb. Herein lies the additional strength of the New Zealand pasture. It will be observed that a very close correlation of feed supply and feed needs applies in the case of fat lamb production, while even in dairy production the fit is fairly good. Both classes of stock tend to be inadequately provided for in early spring, growth quickly overtakes requirements leading soon to a large surplus in the peak period. Supply tends to be inadequate in summer for the milking cow but sufficient for the ewe which is now dry. Both classes of stock are under-supplied in winter. It will be observed, however, that the deficiencies at any time are never so great as to be incapable of being met by conservation of surplus grass from peak growth periods. Herein lies the New Zealand farmer's major management problem and the success with which he meets it is the measure of his efficiency as a grassland farmer. I would suggest that most of the apparent weaknesses of pasture and its products in practice are due to our failure to meet this situation effectively and not to any inherent irremediable defects in pasture as a food. Data to support this view will be presented.

Pasture and Dairy Production:

Perhaps in no field of stock raising have orthodox feeding methods based on concentrates, balanced rations and so on persisted so long in New Zealand as in calf raising. A high percentage of farmers still employ concentrates to supplement a skim milk diet for dairy calves; a high proportion of animal advisors still recommend this. No basis to the method or recommendation exists save overseas practice and text-book tradition. The work of the Dairy Research Institute has shown clearly that the feeding of concentrates to calves on good pasture confers no benefit in rate of growth or health (2). Work at Ruakura fully supports the contention as to the adequacy of a good pasture diet for the growth of dairy stock. Figure 2 (see last page of this paper) shows the growth rate of Jerseys from birth to 20 months under

two methods of grazing management. For comparison the data available from Missouri for U.S.A. Jerseys are also shown, since in that country standard rations with a concentrate base are systematically employed. The excellent growth of Ruakura Jerseys under rotational grazing is clearly apparent. It is interesting to observe that the rates obtained exceed those of these U.S.A. stock. At the same time, the variations in the rate of growth with seasonal supply of pasture in the Ruakura cattle may be contrasted with the more uniform rates of growth, obtained under systematic rationing of the overseas system. These results are more interesting since they tend to cut across well-established nutritional concepts, particularly that of nutritive ratio.

In a leafy stage of growth, New Zealand pasture has a very high protein content. With skim milk with a N.R. of 1:1 the ration of a dairy calf on milk and grass is much less wide than considered optimal by most authorities. I would suggest, however, that in adopting that standard concept of N.R. to New Zealand we fail to realise that this concept is largely economic and not nutritional in origin. Protein is a relatively expensive nutrient in Europe and U.S.A. and as wide a ratio as is compatible with stock needs has always been essential. A high protein intake is both expensive and wasteful and it is not improbable that this situation has been responsible for the frequent belief that a high protein intake is harmful to the animal. While abnormally high levels of intake at some particular physiological state may have specific harmful effects, it is clear from well-established New Zealand feeding practice that the narrow nutritive ratio of characteristic feeding methods here is associated with very high performance insofar as the animal is concerned.

Reverting again to pasture, Figure 3 (see last page of this paper) emphasises the importance of management in meeting seasonal variations in supply. While it has not been possible to eliminate the effects completely the performance of the rotational grazed animals is so superior as to be worth emphasis. Over several years, work at Ruakura has been designed to provide information on the cause of poor growth and mortality in calves in the Waikato. The results are summarised in Table III.

TABLE III.

Grazing Management and Growth of Calves.
(0 - 9 Months)

Year	Rotational Weight (lb.)	Set-Stocked Weight (lb.)	Difference (lb.)
1940/1	416	354	62
1941/2	423	360	63
1942/3	439	374	65
1943/4	385	334	51
1944/5	405	279	126
1945/6	332	262	70

Calves reared in a calf paddock and thereafter set-stocked in a field with ample cover grew more slowly than calves rotated daily around the dairy pastures ahead of the milking herd. Entering their first winter with a deficiency in weight of 60 lb. set-stocked calves suffered mortality ranging from 5 to 50% depending upon the severity of the winter, the survivors reaching the yearling stage with a weight deficiency of 140 lb. Rotated calves suffered no mortality. No dosing against internal parasites has been necessary with these despite a degree of infestation generally as high as that of the set-stocked animals. We believe that the highly selective grazing habits of the dairy calf are responsible for the difference. Close observation suggests that calves graze only the short leafy patches of pasture and since under set-stocking, these continuously decline in area and output due to constant defoliation, soiling and colder temperatures, set-stocked calves virtually starve themselves to a point where the effect of parasitic infection becomes important and mortality may ensue. Taylor's concept of the relationship of the grazing animal to parasitic infestation effects as being one of "calories per larvae" receives considerable support from this work. Whatever the reason, it is

quite clear that by the adoption of orderly grazing techniques under high carrying capacity conditions, it is necessary, neither to dose calves against worms, nor to lose calves from the effects of worms; on the contrary, excellently grown dairy calves can be produced by rotational grazing management. Table IV illustrates the persistence of these effects right through to the milking stage with maintenance of the management methods employed.

T A B L E IV.

Grazing Management and Growth of Yearlings.

(9-21 months)

1945 Month	Rotational Weight (lb.)	Set-Stocked Weight (lb.)	Difference (lb.)
March	405	279	126
June	472	317	155
September	538	368	170
December	664	532	132
March	703	564	139

These results explain much of the variation in the field, in the growth and development of our dairy stock. Dairy farmers may be classified broadly into two main groups: those who allow their stock to be subjected to the ups and downs of seasonal food supply under uncontrolled grazing management; those who attempt to provide their stock with a high even level of feed by controlled grazing - through the use of close sub-division, autumn-saved pastures, maximum conservation hay and silage and so on. The former secure growth in their cattle typical of our set-stocked animals; the latter approach the standard of our rotationally grazed groups.

It should be conceded from this data that New Zealand pasture is capable of supporting highly satisfactory growth rates in dairy stock. What now of the production side? On a total nutrient basis it should be clear from the data on Table II that high per acre production yields of dairy produce are possible. Assuming complete utilisation, the pasture yield figures quoted will support a butterfat yield of from 285 to 620 lb. per acre. Complete utilisation is never possible, but with a Dominion average of 100-120 lb. butterfat per acre from all dairying land, from the fact that a yield of 200 lb. butterfat per acre is by no means uncommon from good dairy pasture under reasonable management; and from the fact that yields of 400 lb. butterfat per acre have been attained and maintained under highly efficient management, it should also be conceded that New Zealand pasture is capable of supporting highly efficient dairy production.

From the qualitative angle it is often assumed and frequently stated, that pasture is not capable of supplying the needs of a high producing dairy cow, and ideally, needs to be supplemented with suitable concentrates. Is this true? New Zealand work indicates that a Jersey cow of average mature weight can consume readily 125-140 lb. fresh grass daily. This will contain more than sufficient S.E. and D.P.E. to maintain a four gallon yield of high test Jersey milk, provided the pasture concerned is of reasonable quality. On the pasture product side, the Dairy Research Institute has shown that grass silage is capable of supporting a yield of 2-2½ gallons daily without the aid of any grazing. It is not to be wondered at, therefore, that the per cow Dominion average is approximately 230 lb. fat; that herd averages of the 300-350 lb. level are common; that individual herd yields of from 400 to 500 lb. fat per cow on grass alone have been recorded; and that individual cows have put up lactational performances up to 700 lb. butterfat, and lifetime production records of 5,000 lb. fat without the aid of concentrates. This does not mean that the addition of concentrates may not aid a high producing cow on pasture in reaching still higher yields, the bulkiness factor of pasture being a limiting one to maximum performance. The economy of such a practice, however, is extremely questionable under the peculiar economic conditions of New Zealand dairying.

TABLE V.

Production and Grazing Management.

Management	Milk (lb.)	Test	Fat (lb.)	Days.
Controlled	4938	5.7	279	275
Uncontrolled	4033	5.5	221	260
Difference	905	0.2	58	15

That high productive efficiency per cow and per acre is, like growth, conditioned by management is clear from Table V. This illustrates the combined effect of early poor growth and subsequent uncontrolled grazing management, upon per cow yields. Well-reared heifers under controlled grazing management designed to maintain a high even level of feed supply, show a superiority of yield of nearly 60 lb. of fat per cow.

At Ruakura we are in the process of attempting to measure the effects on lifetime production of the four major variables in grassland management found in the field: a uniform high level of feeding throughout life; a high even level from birth to calving followed by an uneven level thereafter; a low level from birth to calving followed by a high even level thereafter; and a low level to calving followed by an uneven level for the rest of the milking life. From this work we hope to obtain more specific evidence of the strengths and weaknesses of pasture in relation to the lifetime efficiency of the cow, and to test some of the theories that have been advanced as to the cause of specific types of herd wastage in New Zealand.

Before leaving the dairy side, a word should be said about the incidence of disease in our dairy cattle on pasture. It is commonly believed that herd wastage in New Zealand is unduly high and increasing. This view is at least open to question. Dominion herd wastage figures give the New Zealand cow a milking life as long as, and in most cases longer, than that of the cow of any specialised dairying country. Again, the major causes of herd wastage, mastitis, sterility and abortion, accounting for an average of 75% of the total loss due to disease have not been shown to be due to pasture nutrition, though theories in this connection have been advanced. Efforts to demonstrate such a linkage have failed so far, while the world-wide incidence of these troubles under all combinations of nutritive conditions gives one little confidence in attacking pasture as such, as a major cause. Many of the other diseases, accounting for 25% of the total, do appear to have some relation to pasture nutrition. We will no doubt hear something of them from speakers dealing specifically with the disease aspect.

PASTURE AND MEAT PRODUCTION:

The most important form of meat production in New Zealand is our fat lamb industry. Figure 1 illustrated the adequacy of growth of pasture insofar as the feed requirements of the ewe and her lamb are concerned, while, as in the case of dairy production, Table II provides measure of the yields potentially attainable. Taking a ewe of 150 lb. live-weight producing one lamb 35 lb. carcase as standard, the measured yields of Table II permit a potential output of from 170-400 lb. of lamb per acre. Here again full utilisation has been assumed but is not possible. Recorded yields of up to 300 lb. of fat lamb per acre, however, have been made. It is reasonable to suggest that good class fat lamb pasture under good management produces from 100-175 lb. of lamb per acre.

That pasture is capable of supporting a high milk yield in the ewe and high growth rate in the lamb is clear from Figure 4 (see last page of this paper). The rate of growth obtained - in this case in Canterbury where pastures are not of the best and lambs grow more slowly than in the North - compares more than favourably with published English and U.S.A. data for lambs where the nutrition of the ewe and lamb is under much more effective supplementary feed control.

In sheep, even more than in cattle, there is a lack of factual data as to the precise relationships of pasture to performance. That comparable problems exist, and that these are probably amenable to treatment in a similar manner to methods being evolved in dairying, is a reasonable contention from field evidence. The hogget growth and mortality problem is one to which attention might be drawn. While normal pastures and pasture management methods permit excellent growth of the sheep to the weaning stage, all is not well thereafter, Figure 5 (see last page of this paper) illustrating the rate of growth of hoggets at Ruakura on good grassland emphasises the decline in weight in the winter months of short supply and the drop during drought conditions. I would suggest, however, that as in the case of similar big fluctuations in cattle growth under uncontrolled grazing management, hogget growth fluctuations may yield to comparable grazing control techniques; that the weakness lies not so much in the pasture as in the methods of use thereof. Support for this view appears likely from the work of Filmer and Simpson at Manutuke on hogget growth.

The Inadequacy of Pasture:

This survey would be incomplete without some brief reference to the other side of the picture - to the weaknesses of pasture as a dairy and meat producing feedstuff. The seasonal quantitative inadequacies have already been stressed. They are further emphasised by comparison of Figure 1 and Figure 6, (see last page of this paper).

The qualitative deficiencies of pasture are also wellknown, but it seems fair to say that insofar as New Zealandis concerned, these are not general in their incidence but are definitely limited in their occurrence in time and place. Thus,facial eczema occurs only in such places and at such times as when highly abnormal growth conditions result in pasture toxic to the animal. Bush-sickness and peat scours are specific deficiency troubles inherent in the type of soil of the localities concerned, and yield to appropriate topdressing treatment. Transient deficiencies have been postulated as being responsible for certain other animal disorders as grass-staggers in cattle, while undefined composition changes are sometimes believed to cause other stock troubles.

In this connection there is one characteristic of New Zealand pasture to which it is worth drawing attention. The growth potential of our pasture is so high that the feed is frequently characterised by abnormally large changes in rate of growth (Fig. 6). It is postulated that such changes may be responsible for the production of toxins as in eczema. We know that rapid growth alters the physical condition of the feed, affecting the fibre, water relationships. We have observed the difficulty with which stock often adjust themselves to these rapid changes. Might one suggest, therefore, that at least one major weakness of New Zealandpasture is associated with this rapid change complex and its effect upon the normal digestive and physiological processes of the animal. It seems to me more than a coincidence that much of the stock trouble of which we still know little, seem to occur at periods of rapid change in pasture growth; change from poverty to plenty, from high fibre to low fibre, from slow growing to rapid growing feed. The need for adequate management techniques in this connection is an obvious line of attack.

A reasonable reply to many of the views advanced herein as to the virtues of New Zealand pasture for milk and meat, is that much of the quantitative inadequacy of pasture could be met by the use of supplementary fodder crops and/or concentrate feeds. This is probably true, but taking the latter first, cost rules out the use of concentrates as stock food for commercial dairy and meat production. Due to short supply - a situation unlikely to be remedied without drastic alteration in the whole economy of New Zealand agriculture - grains will not return their cost in animal products. Since it is a fairly sound rule in farming, that the feed bill should not exceed one third of the value of an animal product, there is no place for their us except under specialised conditions, where the normal price relationships do not exist. Insofar as crops are concerned the problem of costs, of output per labour unit, of pasture replacement, etc., weigh

heavily against their use where a good quality productive pasture has to be broken up for their growth. While I am not normally one who believes that 100,000 farmers can't be wrong, it is significant that the growing of supplementary fodder crops has fallen steadily for many years. Between 1920-40 the drop was 85% in the area sown per 1,000 cows (4).

In general, I believe that the reverse of the old English saying: "To make pasture breaks a man, to break a pasture makes a man" applies to animal production in New Zealand.

References:

(1) Clark, Colin (1940) - "The Conditions of Economic Progress". MacMillan, London.

(2) Cook, M.K. (1946) - Proc. N.Z. Soc. An. Prod.: 110-111.

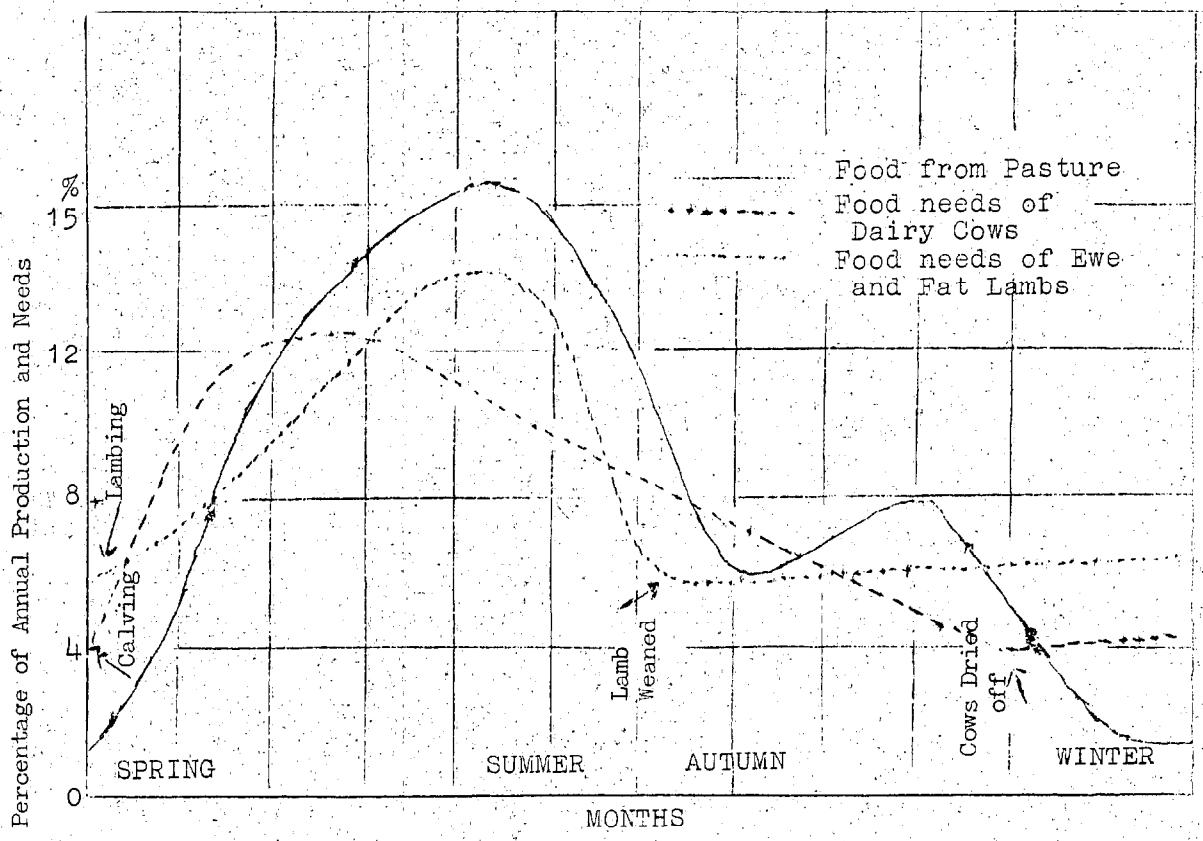
(3) Filmer, J.F. (1946) - Proc. N.Z. Soc. An. Prod.: 111.

(4) Hamilton, W.M. (1944)- "The Dairy Industry in New Zealand". Government Printer.

(5) Menzies-Kitchin, A.W. (1945)- "The Future of British Farming", Pilot Press, London.

(6) McMeekan, C.P. et al. (1944)- "Principles of Animal Production." Whitcombe & Tombs.

Fig. 1: PASTURE AS A BASIC FOOD



Curve of pasture growth in relation to curves of feed requirements of milking-cow and fat-lamb ewe.

Fig. 2.

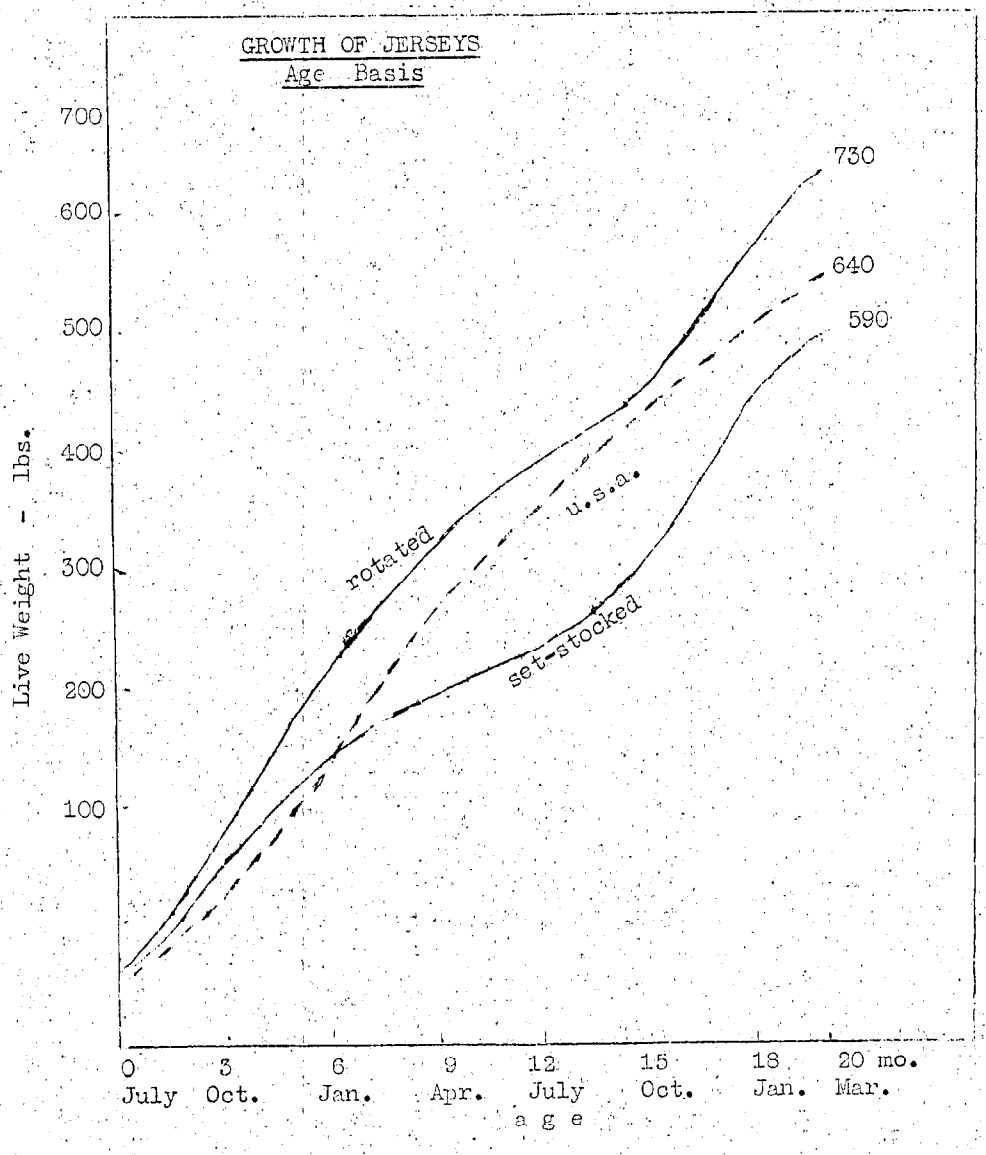

GROWTH OF JERSEYS
Age Basis
Live Weight - lbs.
700
600
500
400
300
200
100
730
640
590
rotated
u.s.a.
set-stocked
0 July
3 Oct.
6 Jan.
9 Apr.
12 July
15 Oct.
18 Jan.
20 mo. Mar.
a g e

Fig. 3.

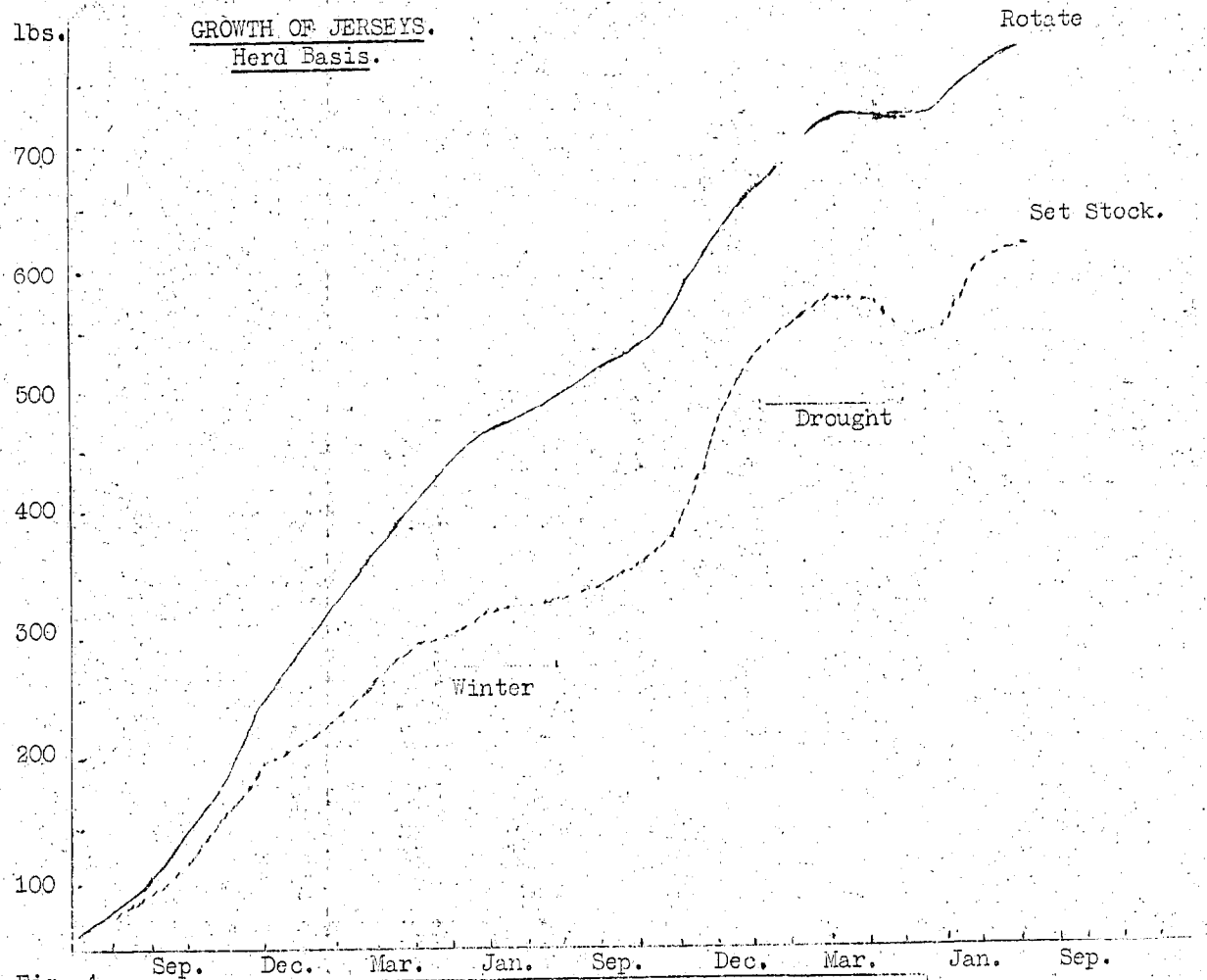
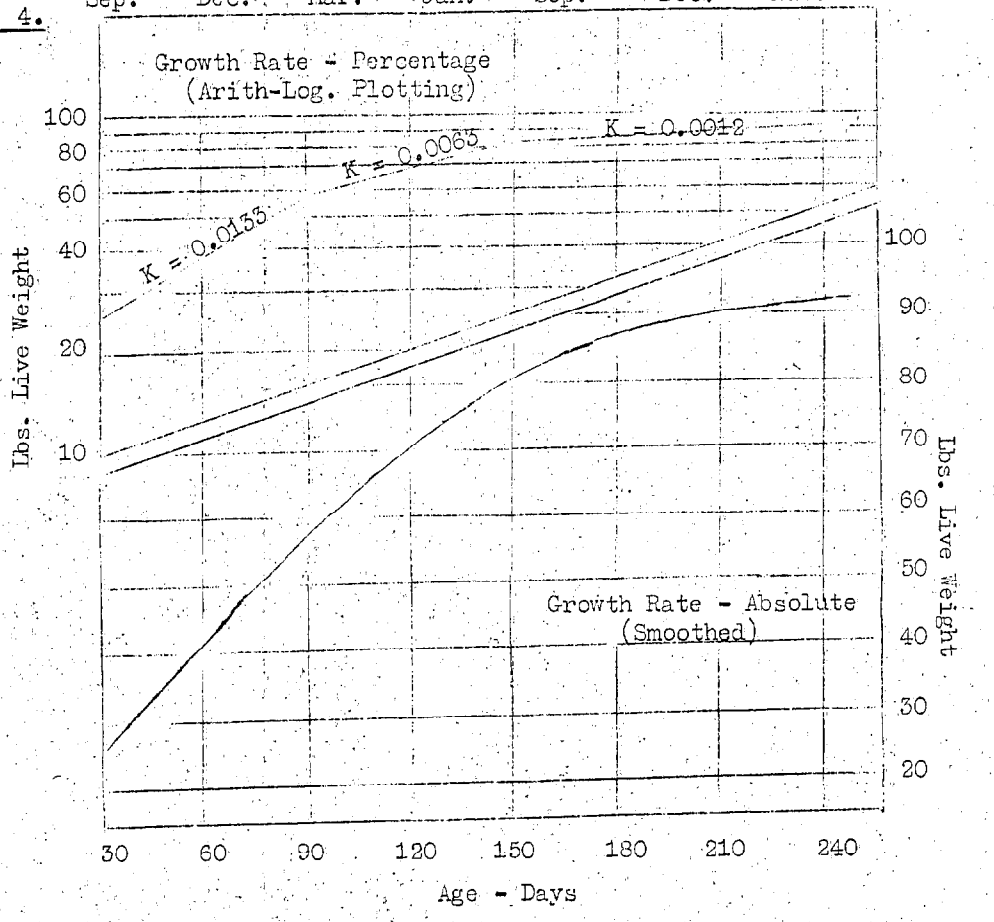


Fig. 4.



PLEASE NOTE - There is no page numbered 23.

Fig. 5.

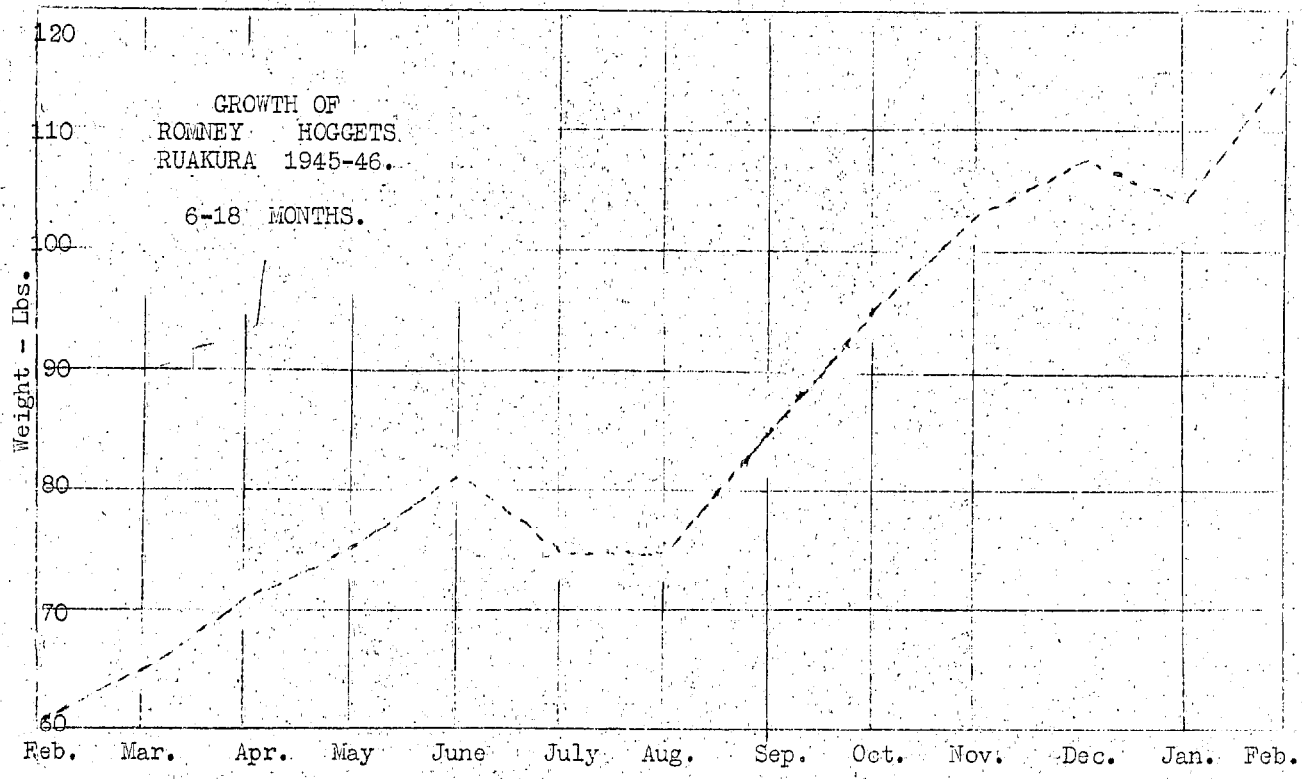
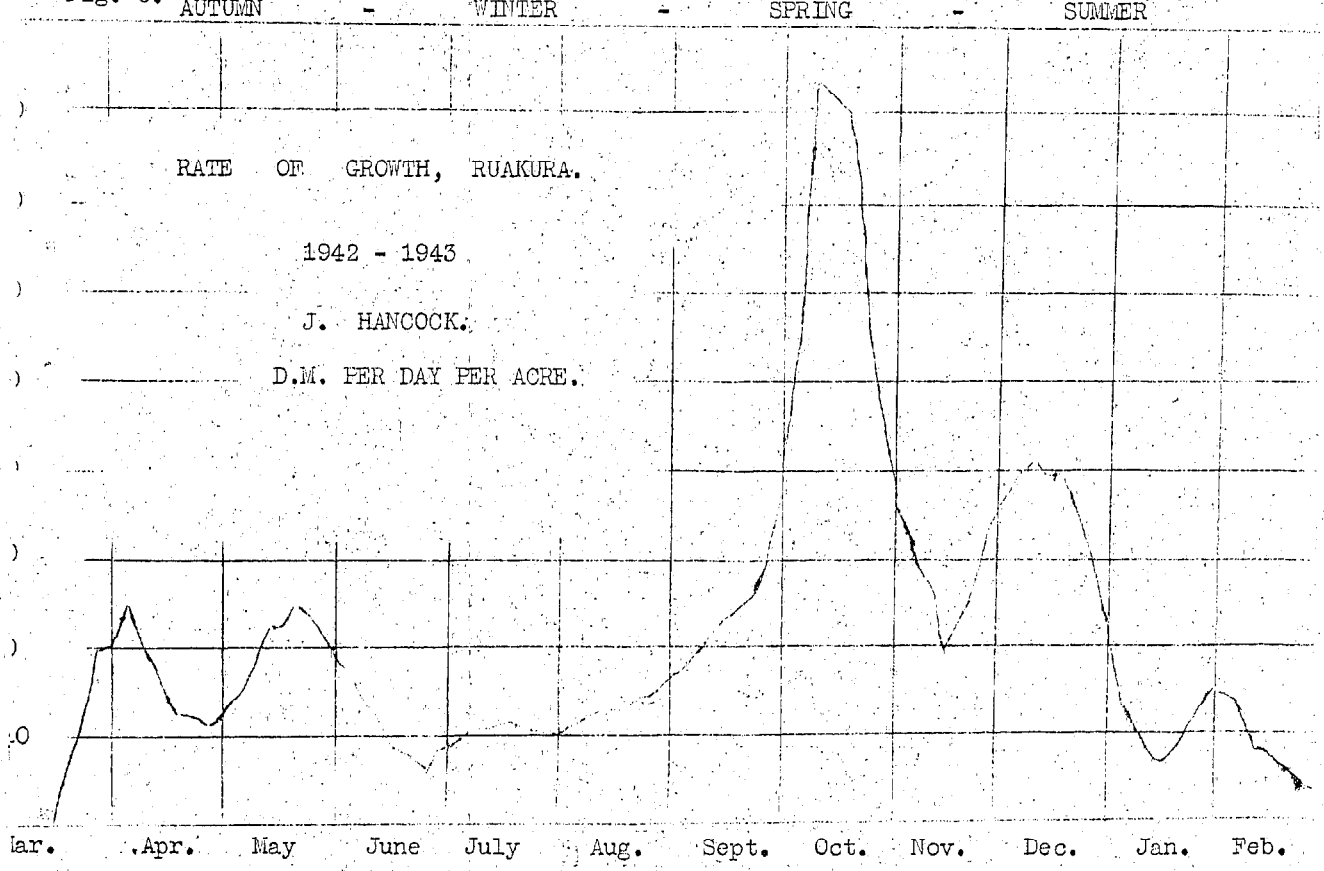

GROWTH OF
ROMNEY HOGGETS.
RUAKURA 1945-46.
6-18 MONTHS.
Weight - Lbs.
120
110
100
90
80
70
60
Reb.
Mar.
Apr.
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.

Fig. 6.


AUTUMN - WINTER - SPRING - SUMMER
RATE OF GROWTH, RUAKURA.
1942 - 1943
J. HANCOCK.
D.M. PER DAY PER ACRE.
0
lar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.

DISCUSSION ON DR. McMEEKAN'S PAPER:

MR. GRIMMETT: Could I ask Dr. McMeekan if he has come to any conclusion as to the ideal composition of pasture for dairy and meat production, particularly in respect to carbohydrates, protein and fat ratios?

Dr. McMEEKAN: I am afraid I have no idea. I think you will have gathered from the tenure of my remarks that personally I hold the view that the quantitative aspects are of primary importance. Once we get the quantitative aspects tied up it will be time to look at the qualitative side.

Dr. ANNETT: I was very interested in Dr. McMeekan's paper. There is just one aspect I would like to touch on. We are carrying enormous concentrations of stock on our pastures in the Waikato; if our pastures are so productive today I wonder what your ideas are regarding the marked increase in fertility which is going on? Are we justified in carrying on a heavy topdressing programme? Will the time come when it will be like having £20 in the bank and nothing on which to spend it?

Dr. McMEEKAN: The long term view, of course is difficult to do anything but argue about, but at least we would have this stored fertility in the bank if we did have to use it. Cropping requires extra labour. I do believe that New Zealand as a country owes its present high standard of living to the high output per labour unit of its agricultural industry and I do view with suspicion any form of farming that employs more labour units than normally necessary for the size of farm and type of farming in question. If you are going to be a farmer, farm the easy way, and not the hard way.

Dr. ANNETT: In answer to that, there are labour saving devices open to us now. I was very opposed to the use of tractors on small farms at one time but now it has the advantage of saving the employment of extra labour which is so hard to obtain.

MR. LYNCH: Could the improvement mentioned in Dr. McMeekan's paper be due to the development of better grass under the rotational grazing system?

Dr. McMEEKAN: There are some changes apparent in the species composition of the swards of the two farms described but to what extent I am not prepared to say at the present time. The effect of these changes is more likely to be quantitative than qualitative.

MR. GERRING: Has Dr. McMeekan taken into consideration in the table giving the dry matter per acre the losses due to making hay and silage?

Dr. McMEEKAN: The "grass used" table, based on figures obtained at various experimental centres, refers to grass production, that is, no hay or silage has been made at all. There are, as we know, very considerable losses in haymaking but it is not possible to utilise all grass grown on a farm without conservation of some of the surplus from the peak periods in the form of hay and silage, so that these surplus figures would need to be discounted somewhat. But until we know what those losses are it is difficult to account for them. The figures show a straight grass picture and assume complete utilisation.

MR. LONGWILL: I was particularly interested in Figure 6 which showed the very marked differences in rate of growth over short periods and it occurred to me to ask whether Dr. McMeekan feels that some form of supplement other than perhaps hay and silage might be desirable. Does he consider that grass drying might serve some useful function in our grassland industry in the provision of a highly concentrated type of feed to even out the fluctuations in pasture growth? More particularly I have in mind the two main periods of deficiencies - winter and the drought period.

Dr. McMEEKAN: I have no feeling about the matter at all. We have no data. One might assume that it would be possible to improve the general picture by methods such as you suggest. Grass drying as a method has been tried in New Zealand but with coal at its present price and in its present short supply I would hesitate to try it even as an experiment. Certainly grass drying, as a method, if it were practicable in terms of costs, would solve a tremendous number of grassland farming problems, including Mr. Gerring's of losses in hay and silage making.

Dr. ANNETT: There are enormous variations in dry matter production throughout the year. Have you thought what causes that? The answer is moisture in the soil. If you can keep your land irrigated you can keep up your production. We are doing trials at the Soil Fertility Station in which we have shown the enormous increase in production we can get by spray irrigation. The use of irrigation can be effective even if limited only to a small proportion of the farm.

Dr. HAMILTON: I do not agree with Dr. McMeekan's view that these changes in management of the pasture through grazing will have more effect on the quantitative production than on its qualitative production. I think there will be quite marked changes in the sward composition of his pastures. I do not see the point of Mr. Lynch's question because any changes in pasture composition and therefore any increase in production which accrues from them are as much a result of management as if the results were purely quantitative. We have ample evidence that changes in sward composition can be definitely attributed to the system of management.

Dr. McMEEKAN: I am afraid I disagree. One of the rather interesting observations that we made during this last season was that the quality of the sward as measured by standard nutritive methods was higher for the set-stocked pastures than for the rotated pastures. Unfortunately the cow is a rather selective grazer and has a very definite capacity for making a choice of the feed available and while the total amount of pasture in a set-stocked paddock might be of lower quality the grass eaten can be of higher quality. There have been species changes but the effects on the stock have been due so far to differences in amount of feed.

Dr. WALLACE: Dr. Annett suggested that irrigation would be an easier method of overcoming deficiencies in feed supply at particular times of the year. That might apply to the drought period but surely he is not suggesting irrigation during the winter period is going to improve the situation.

MR. CRAWFORD: There is the problem of the small dairy farms. When asked to advise these farmers how to rear better calves and one could tell them they can do so without drenching - and I have been prompted to do that since hearing Dr. McMeekan's paper - their retort would be a rude one. They have the one paddock on which they starve their cows at night and another one in which they gorge them in the daytime. I would like to know the difference in the capital costs of the two farms they are running at Ruakura and any practical suggestions whereby a farmer could economically change from one system to the other.

Dr. McMEEKAN: As far as the cost is concerned I can give you the answer to that in fifteen years. So far as practical methods of applying the principles that we are endeavouring to teach are concerned, I think that the problem can only be handled on the spot in relation to the particular farm. As a method it has been considerably criticised by farmers but it is being applied to an increasing degree by dairy farmers throughout the North Island with, I believe, good results. But it is extremely difficult to do anything with a man who has one paddock to starve the cows in at night and another to feed them in by day. The only suggestion I can make there is that he opens all his gates anduses his whole farm when the disadvantages of selective grazing will be reduced to some degree, but essentially, of course, you cannot effect any control over pasture growth without some degree of subdivision. That is the first essential to good grassland farming.