NEW ZEALAND GRASSLANDS ASSOCIATION.

Oct. 1938.

THE RELATION OF PASTURE SPECIES TO QUANTITY AND QUALITY OF MILK

By Wm. Riddet, Director, Dairy Research Institute (N.Z.)
Massey Agricultural College.

It is remarkable, in fact tragic, that although wonderful strides have been made by plant breeding, plant selection, manuring, soil management and pasture management to substitute two blades of grass for one, little constructive or organiscd effort has been made to-relate the production of pasture to it-s true- feeding value-as measured by the quantity and quality of animal products derived from it. In other words, emphasis had been placed on improving production from the grasslands worker's conception of what the animal should eat rather than from the viewpoint of what the animal will eat and best turn into its own product, This state of affairs is made all the more acute in New Zealand by the fact that animal products are our only means of selling pasture, and that our national revenue is largely dependent on both the quantity and the quality of those animal products that our pastures can render. The true feedingvalue, then, of pasture associations, pasture species and even pasture strains is of overwhelming interest to New Zealand. Long standing deficiency diseases such as Bush sickness, Morton Mains Disease &c. and more recent widespread, thoughspasmodic, outbreaks of diseases such as facial eczema', grass staggers and the like have caused to be brought under review the relation of pasture to the health of the animal. Other speakers will deal with this matter.
I desire to stress the necessity for increasing our store of knowledge respecting "normal" pasture feeds in the interests of maintaining the quantity and quality of our products and obviously also as a starting point for determining the causes of abnormal conditions amongst stock.

Within recent years material progress has been made in defining the conditions under which pasture produces its maximum food value and maximum yield. The Hohenheim method of rotational grazing, the classical experiments carried out at Cambridge by Woodman and his co-workers, and the oecological, plant growth, species and strain studies made-by Stapledon and his team at Aberystwyth laid the foundation of new methods of pasture utilisztion. The yeoman work started in this country by Cockayne, and ably followed up by Levy and others in relating pasture associations to soil type and carrying capacity, and in drawing attention to the place of the animal in, improving pastures has had far-reaching effects both in the Dominion and elsewhere. Intensive and extensive studies in many parts of the world, and in New Zealand particularly by Rigg, Askew, Hudson, Doak and others, on the relation-of types and quantities of fertiliser to the yield and composition of pasture have considerably added to our store of knowledge. Watson at Jeallott's Hill and others have demonstrated the high food value of dried grass and pasture ensilage. Wright and Morris at Auchencruive have proved that the protein of pasture has a very high biological food value and that spring pasture has a higher food value then autumn pasture of similar stage of growth. Norman at Rothamsted has drawn attention to the high availability of carbohydrates in leafy ryegrass. Orr and his co-workers

at Aberdeen have clearly shown the extent and importance Of variability in the mineral content of pasture. Underwood and Filmer in Australia, Rigg, Askew, and Dixon Of the Cawthron Institute and Aston, Grimmett, Hopkirk and others of the Department of Agriculture have clearly demonstrated the important relationship of trace elements in tho soil and pasture to the health of stock. Throughout the whole world, research workers are becoming exceedingly conscious of the need for obtaining more definite knowledge of the true feeding value of pasture.. Yet the surface has only been scratched. Comparatively little research work has been carried out on the objective feeding of domestic animals, measuring their production and observing the effects of pasture on the health of the animal, Most results have been expressed in terms of accepted and traditional methods of chemical analysis: Food values have been then deduced by the application of conversion factors, mostly worked out from the use of meals and cakes. Further, little attempt has been made to relate closely the amount and quality of feed grown day by day to the needs of the animal. The live beast requires daily a relatively constant amount of feed for maintenance throughout the whole year. The quantity and quality of feed it needs for production varies gradually during the season. On the other hand, the quality of pasture varies rapidly with season and weather and its volume of production is even more variable. Unfortunately there is no definite information on the conditions under which grazing animals are underfed or overfed when the demand for feed is relatively constant and the supply is very variable. Underfeeding is not generally observed till there is an obvious reduction. in production or in the condition of the animals; yet physiological underfeeding may then have been in progress for some time and have done almost irreparable damage. The repercussions on the quantity and quality of the animal's production are unknown. Again there is even a greater dearth of knowledge on the effect of pasture species and strains on the quantity and quality of the animal's production or even on its health. Babcock's early work on the maize plant as a sole source of diet led his followers to their discoveries on the differences between the feeding value of maize, wheat and oats and incidentally paved the way for far-reachin, discoveries with regard to vitamins and minerals. Is it too much to expect that our different pasture grasses and clovers and other plants we meantime class as weeds may have virtues and drawbacks that we do not realize? Yet this information is the basis of our existence and future. With regard to the quality of animal products, it has long been known that some plants affect the flavour of milk and cream. It has also been known that the composition and firmness of butterfat (not the test of' the cream) is greatly influenced by the nature of the cow's feed. This plays an exceedingly important part in determining the body of butter. Yet what definite knowledge have we of the effects of our pasture species on the quality of our dairy products? All we know is that better quality butter is made an3 is easier to make in some districts than others. The relationship of the quality of cheese to feed is not so clear cut, but there is considerable evidence that feed exerts a material influence, Several factors are probably operating but these need not be discussed in detail in the absence Of precise data.

A few moments reflection will explain why these problems have not been tackled in the past. In the first instance, animal production experiments are exceedingly

costly t o carry out. Experiments carried out on laboratory animals are not quite satisfactory. In many cases the domestic ruminant has to be used, Even more than pasture species, the animal is variable in its needs for maintenance and production and its prodution is very variable, not only from animal to animal but in the same animal from day to. day. Thus comparatively large numbers of animals need to be used or alternatively exceedingly carefully planned small scale experiments need to be carried out. In the -- second place, the growth and composition of the plant is very variable. Its growth rate and composition cannot readily be standardized. Yet in feeding trials this drawback needs to be overcome because the first effect of a feed is not properly reflected till several days after it has been given and its full effect can only be gauged in long period feoding trials.

In the third place, rapid methods of analysis have not yet been evolved for estimating chemical constituents of known importance so that analytical results can be kept abreast of production results. Difficulty is even experienced in preserving for later analyses the composition of plants that undergo very rapid change after cutting. Finally, knowledge of nutrition has not advanced far enough for chemical analysis to state the cause of a condition. In many cases the condition has to be reproduced experimenatlly in the animal and it remains with the investigator by analytical procedure or trial and error to trace the responsible factor. In other words, the animal hcs first to prove the plant or stage of growth of the plant guilty before the investigator can determine the reason for the guilt.

I may have tried the patience of many with the above long introduction, but if I have stirred up some enthusiasm for the importance of ths broad subject I hope I may be pardoned.

I propose to divide this address into the following parts : (a) The relationship of the growth of pasture to the needs of the milking animal; (b) The influence of the quality of feed; (c) Influence of plane of nutrition ; (d) Influencc of spread of pasture production; (e)Influence of pasture on the flavour and composition of milk,.

THE RELATIONSHIP OF GROWTH OF PASTURE TO THE NEEDS OF THE MILKING COW.

It is well known thrt the production of nutrients by a pasture vcrios enormously with the period of the year and with weather conditions in each period. It is not generally recognized, however, that the needs of the cow vary much loss widely. The animal needs the same nourishment for bodily maintenance throughout the whole gear; whilst producing, the cow needs additional nourishment in amount roughly proportional to her milk production; while dry but in calf, she needs nourishment for her foetus in addition to a reserve store from which she may draw normally at the peak of production and in case of cmergcncy. (A very deep milking cow at the height of production cannot generally digest and assimilate sufficient nutrients for the milk she produces unless she is given a special diet - in grassland practice in New Zealand this is not usually economically possible). The maintenance need of the cow is an unavoidable overhead expense. In the case of a cow of 1,000 lbs. live weight producing 300 lbs. fat per year from milk with a 4% test, the ratio of maintenance to production feed, taking the year as a whole, is approximately 22 : 19, while in the case of a cow producing 500 lbs. fat the ratio is approximately 22 : 31.

The ratio of need by the former milking cow at the period of greatest demand for both maintenance and production to that at the lowest period of demand is approximately 6 : 16. On the other hand, the ratio of dry matter production per acre per day in the period of maximum production to that of the lowest is possibly over 40 : less than 1.

Everyone recognizes the drawbacks of the differences in these ratios but the implications of them are possibly not sufficiently realized in respect of two separate considerations, viz. the need of the cow and farm management.,

With respect to the former, it must be realised that lactation is a normal physiological process and the dairy cow's ability to produce milk on the average follows a general law. Properly fed, the average cow should continue in milk for 10 months - 305 to 310 days, and produce a calf again in 12 months. During lactation her milk production follows a normal trend. It increases rapidly in the first 30 days, then reaching a maximum which should be approximately sustained for the next 3 to 4 months. Thereafter, it falls Off slowly till the cow is nbout 20 weeks in gestation, when it drops markedly till the cow is finally dried off. There may of course be exceptions to this rule because milk production is governed by inheritance as well as feeding and management. Some animals persistently yield a more level production of milk throughout the year than others; some also have inherently short lactations. It is a comparatively simple matter to show a cow's manthly prodution expressed as a total for the year in normal lactations and to show for the same periods the monthly % need of her annual requirement. When this is contrasted with the monthly supply of nutrients available in a year from an area of land to support the cow and her milk yield, the results are very striking. At once enormous disparities a re observed. Attention is directed to the accompanying charts. It is obvious that the extent of period deficiencies and surpluses depends both upon seasonal growth and the period at which the cow calves. Nevertheless the diagrams show clearly the difficulties attendant on grassland farming and these are reflected in everyday practice. The normal lactational curve is seldom achieved in practice in New Zealand though it is common overseas where animals are housed and rationed. New Zealand farmers try to achieve it by bringing their cows into profit early in the season. This is a sound practice because although the farm is short of feed, the cow at the outset of lactation puts every unce of available feed into the bucket and she increases in yield as grass supply increases. Also the high daily yield permits the use of relatively expensive grass because the high yield per day decreases the nctt cost of the feed, including that needed for keep. But the weakness lies in the fact that the cow'maximum yield should not be delayed till abundant feed grows. A flush followed by a falling off of 'her production indicates that the cow is drawing on her body reserves - often needlessly and with attendant risks of many kinds. Sufficient feed and feed of the right type should be available to the cow. The next period of departure from the normal lactation curve is in late summer. Milk yields fall off unduly rapidly due to insufficient feed. The cow has to draw on her already depleted reserves and tends to dry off. Lactation is now well advanced and with it has been lost the stimulus to respond quickly to any sort of feed, with the consequence that hand feeding does not always give the results expected and the cow frequently drics off before there is an autumn flush of grass, and she refuses to resp nd to this flush. These latational reactions to feed are well illustrated by comparing ordinary herd test records with C.O.R. records of the same duration.

I shall presently deal with the relation of surpluses anddeficiencies to farm management.

THE QUALITY OF FEED,

The lactating cow needs both a certain bulk of feed and certain quality of feed. The amount she can digest is limited by the dry matter she can physically consume. This is exceedingly important, When dry, the cow can get all the nutrients, expressed in starch equivalent and digestible protein, that she-needs from -good quality hay or silage, but even then if these foods are very fibrous or, through weathering in harvesting, deficient in available nutrients, they are insufficient. In lactation the feed requirement is quite different. The animal then needs more available nutrients as a whole and much more digestible protein, because milk is a product rich in protein. If the feed is fibrous or rank, the cow cannot get sufficient nutrients from the dry matter that her digestive capacity can deal with. This is well illustrated in dairy cow feeding trials carried out by the Dairy Research Institute, where cows are fed ad lib supplies of freshly cut pasture and the amount actually ingested is recorded. It has been clearly shown that cows on a positive balance of starch equivalent and digestible protein in September and early October, later experienced a negative balance first of digestible protein as grass increased in fibre and finally a negative balance of starch equivalent although the ingestion of dry matter did not fall off. This has bad effects. The same is clearly shown when milking cows are turned into a field ready for making ensilage; milk production generally falls off in spite of abundant feed. Yet strangely this same ensilage is made to supplement hay, and even less available diet, in periods of low feed supply and not infrequently, as in spring, and late winter, during the period of maximum milk flow, A practice even worse is employed by some producing milk in winter for city supply. Large amounts of hay are fed - even bought for the purpose - in the hope that milk production will be increased or at least sustained. In point of fact the hay supply should then be limited and a much more nutritious diet fed to produce the nourishment the cow needs within the limits of her capacity to absorb, Silage from short pasture is an infinitely better diet or better still, fresh pasture grown in advance of winter and "cold-stored" by prevailing atmospheric conditions tillrequired. Dairy Research Institute results show that when pasture provides ample nutrients in respect of starch value and digestible protein, the necessary mineral supply is generally available. When however the latter areinsufficient, the mineral supply as indicated by self feeding trials seems to be insufficient.

The question of providing a high quality feed is of increasing importance in our farm economy because the productive ability of dairy herds is increasing fairly rapidly through herd testing and breeding from high producing strains of stock. The size of animals is not increasing with productive ability and accordingly pasture, providing more immediately available nutrients must be furnished to enable the animal to express her producing ability. There is reason to believe indeed that the inherent capacity of the highly bred cow to produce is so great that she draws on her reserves to the uttermost in the absence of sufficient feed and so doing makes her susceptible to illnesses and diseases from which she would be free if properly fed,

It has also been pointed out by Dr. Hammond that a.

protein rich diet, fed particularly to heifers, for 6-8 weeks prior to parturition (at a season when pasture is 'scarce in New Zealand and little protein rich diet is available) stimulates the growth of the mammary gland tissue and increases production in the subsequent lactation,

PLANE OF NUTRITION.

This may most conveniently be described as the relation of the needs of the animal to nutrients actually assimilated by it. The plane may be high as in over feeding, normal as in correct feeding, or low as in under feeding, The importance of plane of nutrition has not received the attention it deserves. Problems arising from it do not arise where animals are stalled for a considerable part of the year because it is customary to ration the feed given according to their size and production. Under grazing conditions, however, the position is quite different. We assume that animals are getting enough nourishment when their appetites are satisfied by bulk. Frequently also we find difficulty in even providing this bulk, In the course of investigating the cause of low solids-not-fat in milk, particularly the casein fraction, the Dairy Research Institute has conducted two trials, one in the winter and the other in the summer, on the influence of the plane of nutrition. Using 6 cows on each occasion, the double-reversal method of animal feeding experimentation was employed. All animals were fed sufficient maintenance diet according to accepted feeding standards. After a preliminary period (30 - 40 days) on a diet fed proportional to milk production, one lot of cows received only as much feed as was required for half of the milk they produced while the other lot were fully fed. At the end of 30 days, the feeding of the lots was reversed and at the end of a further period of 30 days, the feeds given in the first period were fed. Finally all were full fed in a fourth 30 day period. An accurate record was kept of all feed given, milk produced and composition of the milk. The results are most impressive, They were more clear cut in the first trial than in the second because in the former case the experimental cows were at the height of lactation while in the latter they were 6 months in milk at the outset of the experiment and the results are somewhat affected by normal lactation effects towards the close of the milking period. Yet the two lots of results coincide in the main. When the cow's production feed was reduced by a half, the milk yield dropped in most cases in the first 3 to 5 days, then it kept fairly steady with a falling tendency for the remainder of the 30 day period. In no case, over 30 days, did the milk yield fall to the level of that supported by the feed supply. The cows obviously lost weight. while drawing on their reserves but after 60 days under-feeding out of a total of 90, the animals were in better condition than many seen in herds. One cow in high condition responded more slowly than the others to the effects of under feoding. The solids-not-fat in the milk, especially the protein and casein fractions, dropped markedly in the period of under nutrition - to the extent of 6- 10% of the total - but it is to be observed that there was a lag period of 3 - 10 days in this occurring and a corresponding lag period in the solids-not-fat and casein returning to normal. In a few cases the lactose content of the milk was depressed. The fat content (test) of the milk was not greatly affected. In some Cases i-c increased slightly in the first fen days and then returned to its normal. The iodine value of the fat (indicative of hardness) however rose markedly in the poriods ofsub-nutrition.

These trials were mainly carried out with hay and concentrates, but in one trial half of the production ration Of 2 cows was provided by pasture. An attempt was made to follow them up with animals grazing pastures badly affected by dry weather last summer and fed ad lib quantities of ensilage (16 months old) made from Italian ryegrass and red, clover, The animals consumed from 25 lbs. silage per day when there was some available pasture to 80 lbs. per day when the pasture supply had almost entirely vanished. The moisture content of the pasture was abnormally high. The silage was of fairly good quality. The feeding of silage did not prevent an abnormal falling off in milk production but it stemmed the drop - those groups receiving no 'silage, at any one period fell off more than did the others receivingsilage. The solids-not-fat content of the milk dropped in all cases, but to a greater extent in the no silage groups than in the silage, Again there was a lag period in the silage and no silage showing their effects. The: effect on the constituents of thesolids-not--fat was not So clear cut as with the cows fed indoors on rationed feed. In most cases, the feeding of silage prevented continued falling off in protein and casein. In a few these constituents actually increased during the period of "no-silage" feeding, In some cases, notably the latter, the lactose content of the milk fell off markedly in the no silage periods and even was low in the silagc feeding oeriod. In all cases, the iodine value of the fat was materially higher when no silagc was fed. This experiment clearly points to physiological disturbance during the periods of subnormal nutrition. This was quite evident from the apparent falling off in condition of the animals. The feeding of silage did not entirely avoid the disturbance, possibly because it was not of sufficiently good quality for the animals to get sufficient nourishment from it, but it must 'be emphasized that it was typical of most silagc used in farms. It is also possible that prevailing atmospheric temperatures exerted an influence because it has been recently shown overseas that exposure of animals to temperatures exceeding 80° F. results in a reduction in milk yield and lowering of solids-not-fat . The latter observation emphasizes the need for protection from the sun in summer by abundant shade shelter - 'A need oven greater than protection from cold in winter.

Several lessons are to be learnt f rom this trial. A falling off in milk yield does not adequately express under-feeding. Gross under-feeding can occur before its full effects arc expressed in milk output or outward appearance of the animal,, We have no data on its long continued effect but it can be expectad to have sorious results. The composition of the milk is affected by under nutrition. The solids-not-fat fraction is dopressed and cheese yield is dccrcased. It is well known that the cheese yielding capacity of milk falls off in dry weather and is frequently low in' early spring, This is a possible explanation. It is also well known that the casein content of milk for any one fat test varies in mixed milk from one form to another. With the knowledge that the feeding value of pasture varies with swards and management , it is possible that tho plane of nutrition is responsible for these differences. These are matters of great importance to cheese producing districts. The fact that the iodine value of fat is raised in periods of under-feeding suggests that the keeping quality of butter made from it will be depressed.

Sufficient has probably been said to emphasize the need for study of plane of nutrition in our dairy cattle. Much is said about imbalance of nutrients in the diet. This

is undoubtedly important and must be closely investigated. But as indicated at the outset we must learn more about the normal state of our dairy cattle under grazing conditions in New Zealand. In particular, we must ascertain when they are properly and when 'not adequately nourished.. The latter undoubtedly happens' and probably more extensively than we realize. In this connection, it is most unfortunate 'that we have no record of the changes in weight ofmilking animals on even well managed pastures in New Zealand.

SPREAD OF PASTURE PRODUCTION.

As pointed out above, seasonal demands of our dairy herds vary much less than the seasonal supply of pasture and it.. is suggested. that. under-feeding of dairy stock is a nett result . This is. aggravated by. the economic necessity of reducing labour needs to an absolute minimum, indeed closely approximating that required only for milking by machinery. Given adequate labour, we are harvesting as ensilage and hay sufficient surplus at periods of peak production to make up for periods of, scarcity. In efforts to secure enough bulk, we are largely making ensilage suitable essentially as a maintenance, diet rather than a production diet. More at tention needs urgently to be given to the making of more nutritious silage and hay. I t is notoriousthat in grassland farming we are relying on these on most farms for about one-third of the year at least and yet we are giving them no attention. Losses in making are considerable, probably not less than 20% in the case of silage and even more in hay-making, probably of the order, of 50%. In most dairying districts, where good rainfall and high humidity are necessary and generally obtained, it is probable that these losses in food value will be greatly exceeded. There is great need'for study 'of improved methods of hay and. silage making. In this connection, grass drying cannot be 'dismissed. lightly, It is too frequently stated that it is uneconomic. This statement is based on overseas experience and costs., But have the returns in New Zealand really been studied? An adequate answer cannot be obtained till both costs and returns arc considered. We cannot accept present production as ideal because, as above indicated, our so-balled lactation curves 'arc essentially abnormal. In the first, place let us try to adjust the curve by trying various -means , including dried grass. Thereafter we can proceed to the economics side of the study, but do not lot us prejudge the result.

Another aspect of the question is the spreading of "green" product ion. This can conveniently be achieved already in districts where ryegrass, white clover and paspalum occur. The reservation of autumn grown ryegrass' and clover can ' provide, by rational grazing, green feed in winter to supplement hay even for milk production. Paspalum provides for late summer and autumn. In less favoured districts there is a greater problem. For some years this winter production green feed problem has been approached at Massey College by shutting up pastures about April 1st. after topdressing, them in February/ March and accumulating as much green feed as possible' before growth has. stopped. A certain number of cows (20 - 25% of the herd) have been brought into profit in May and with strippers grazed in' these pastures by the off and on system during winter: These cows were grazed on reserve pasture only for about 1 - 1½ hours per day. They re cc ived hay and silage in separate paddocks. A few fields (light land) have been regularly reserved for this purpose, as many of the remainder as possible being spelled for spring and early summer use, The holding paddocks naturally. became father foul,

but following cleaning up and harrowing in spring they were cut later for silage. This treatment, did not harm the holding paddocks., indeed it raised their fertility. The method gave fairly good results in respect of production; no difficulty Was experienced in maintaining milk yield, cows did well, and continued in production till the following February or March. Their records compare very favourably with early spring calvers. The drawbacks to the method were (a) time taken up in moving the herd from one field to another; (b) poaching of gateways; (c) loss of valuable feed and (d) loss of manurial residues to the field carrying the Winter feed. During the past winter, the use of an electric fence has removed most of these difficulties. Daily there was fenced off a sufficient amount of reserved pasture to provide the "production ration" for the milk herd. Hay formaintenance needs was fed after the morning milking in the previous day's break, at about 8.30 - 9 a.m., then the cows were allowed access to a fresh break which they consumed almost completely by night. The amount allowed per animal Was calculated approximately as follows :- It was assumed from appearance of the pasture that it would produdo a certain weight of silage per acre. It was further assumed that this silage would have a starch value of about 60 lbs. S.E. per 100 lbs. dry matter ± 12 per 100 lbs. silage. An allowance of about 2½ lhs. starch value was allowed per gallon of milk produced and from this a rough calculation was made of the area necessary. Hay Was fed to the cows at night. No silage was fed for 23 days. Obviously no attempt was made to make this calculation daily; in fact it was made only once and thereafter the area was modified slightly to meet the needs and numbers of the cows,. The results wore very good. As contrasted with a period of random grazing, when 34 cows consumed 3½ acres in 7 days, on rationed grazing from June 25th. till August 13th. an average of 36 cows per day were grazed on 14 acres of "cold stored" grass, supplemented by hay during all of the time and by silage also from July 25th. Their milk production was quite good though slightly below normal. The animals grazed the fields as evenly as sheep and the fields recovered quickly. Consolidation of the land and distribution of droppings were very even. The animals did not attempt to get over the electric fence to fresh feed though only a single strand of barb and later of' light plain wire were used. This method of grazing opens up great possibilities. It makes the rationing of grass fairly practicable, it introduces another scientific approach to grassland management, it makes possible avoidance of losses in silage and hay-making and reduces labour and time in feeding out supplementary feed. No doubt there is much room for improvement in the technique of grazing etc. It must also be realized that the scheme radically influences the pasture. It encourages grasses and keeps clovcrs in check - a most useful thing in certain pastures. It tends to open up the sole of pasture; present indications are however that hard grazing in late September encourages the closing up of these blank spaces.

Other methods of speeding production of pasture feed need to be exploited. In particular a search should be made for pasture (grass) species that will suit, in summer, areas where paspalum does not grow. It is well known that ryegrass tends to become dormant especially on light soils between December and March. Indoor feeding trials demonstrate that on ryegrass milking animals arc sometimes - especially in a dry period - on a negative protein and even starch equivalent balance in December even though they are eating to capacity. This continues in January and February. The effects of a low plane of nutrition then become evident. Admittedly, when ryegrass is grown in mixture with No. 1 white clover growth is sustained, but evon then it is less than required and clover

tends to become dominant with the consequent risk of bloat on dewy mornings. Farm management is made exceedingly difficult by starting to feed silage or other supplements in early January or possibly December, in attempts to balance feed and production supply. The growing of roots introduces management and husbandry difficulties, while the provision of lucerne has drawbacks though some advantages. There is great need for the breeding of perennial strains of grasses or the introduction of species that will suit this period. An annual heavy yield need not be essential, There is no reason why we should not have fields on the farm for different grazing periods. Bearing in mind difficulties in farm management, difficulties in procuring seasonal labour for ensilage and hay, high cost of casual labour, losses in ensilage and hay making;, it is quite possible that some stands of low producing grasses and clovers with maximum production in low periods of pasture production may actually be more profitable than pasture exclusively of high productivity, throwing all their feed in a relatively short period.

THE INFLUENCE OF PASTURE ON THE FLAVOUR AND COMPOSITION OF MILK.

It has long been known that certain foods and weeds cause taints in milk. The flavouring substances are absorbed by the fat portion of the milk and thus abnormal flavours are much more noticeable in cream than in skim milk or even whole milk. Unlike flavours due to bacterial causes, other than udder pathological infections, feed taints are present in freshly drawn milk. Cruciferous plants, notably turnips and swedes, impart, a characteristic flavour to cream. Similarly does lucerne, as has been shown in the United States of America, Some weeds, particularly Land Cress and Pennyroyal, cause obnoxious flavours. Within recent years attention has been focussed on the role played by clovers in the production of a taint, very similar to if not identical with that caused by lucerne. This taint is especially marked in the Waikato district and particularly in the spring and early summer months. It was first brought to the writer's attention in 1926 by the late A.M. Stirling, then manager of Morrinsville Dairy Company, and was attributed by the late T.H. Patterson, at that time Fields Instructor in the Auckland Province, who investigated the problem in the field, to Lotus Major in certain pastures. Dr. Annett in 1929 drew attention to its production by clover. Intensification and spread of the taint led in 1934 to joint organized action by the Dairy Research Institute and Grasslands Division of the Plant Research Bureau with the assistance of the Fields Division of the Department of Agriculture. Mr. Levy showed by field observations that the taint was closely related to the leguminous composition of the pasture; he showed that it was very intense in the night cream and present only to a limited extent. in the morning cream and he related this to the feeding habits of the cows, showing that as with other tainting plants the avoidance of ingesting clovers within 4 hours of milking greatly mitigated the flavour in the cream. This work led to objective feeding trials carried out at Palmerston North under the joint auspices of the Grasslands Division of the Plant Research Bureau, and the Dairy Research Institute, which laid the foundation of the wider study of the influence of pasture plants on the production and composition of milk. progress results have already been discuesed at a Grasslands Conference and more details have been published. It is necessary then only to refer briefly to them. Perennial and Italian ryegrass do not impart a strong feedy flavour to cream - at flush of growth, freshly drawn milk and cream from cows fed on these has frequently a slight odour but it is not so intense as that caused by clover. All clovers cause taint but they vary in the following descending order - Suckling, Subterranean, white and red (the lotuses have not been tested at Palmerston North). Even a small percentage of suckling will at the height of its growth cause taint The taint in cream caused by white clover is influenced by period of year, interval between ingestion and time of milking, and amount of feed. District (possibly soil) also apparently exerts an influence. The most intense taint coincides with the period

of most active growth of the plant, it is most intense about 1 hour after ingestion and the greater the percentage in the pasture the more intense the taint, Careful feeding trials show that 30% clover in a spring pasture causes only a faint taint while 70% causes a strong taint, As the season advances the percentage of clover can be increased without any material incidence of taint. Farm and butter factory methods of controlling the taint have been tried, A method of pasture management by periodic grazing and spelling, as demonstrated by Mr. Marryatt at Ruakura, to encourage growth of grasses in autumn, winter and spring offers one line of practical approach to the solution of the problem, Nitrogenous topdressing of pastures is another. Removing stock to taint free or bare pastures four hours before milking is still another, In trials at Palmerston North this tid not decrease milk yields, and this result was confirmed last season at the Manaia Experimental Farm, Increasing soil fertility by topdressing and stock and pasture management to raise the ryegrass content of the pasture as advised by Mr, Levy is still another mode of approach to the problem, Aeration of affected cream on the farm tends to reduce intensity in the cream, Deodorisation in the factory removes nearly all the taint, but this should be viewed as a last resort or for removing traces, rather than a permanent and sole cure. The mechanism of t ho cause of clover taint is not understood, The tainting substance has not been isolated. It is commonly believed that all food taints are caused by essential oils. This is not necessarily the case. Odoriforous gases may cause taints, The fact that taints arise within a few hours of ingestion suggests that. the taint is not absorbed from the cow's gut. Mr. Campbell has reproduced a taint in milk within ix short time by causing a cow to inhale turpentine fumes. Efforts are now being made to isolate the tainting substance. For some reasen not yet adequately explained, clover taint is more pronounced in some districts than in others.

The production and control of taints in general is not such a simple phenomenon as appears on the surface. For example, Land Cress taint can be produced by getting animals to ingest small quantities (less than 5% of feed) , yet cannot be removed from the cream by the same deodorizing procedure as for 'clover taint . Turnips do not always cause taint even when fed in large quantities . At the Dairy Research Institute large amounts per day have been fed without apparently affecting the cream. It is claimed by Orla Jensen that the glucoside responsible for the taint passes into milk where it is hydrolysed by certain organismsand taint is produced, Clean milking and careful cooling of cream keeps it in check. This may explain why no strong taint was produced *in* the. Palmerston North trials.

Fresh drawn milk may exhibit abnormal taints. Animal odour is one, and is removed by aeration of the milk while it is being cooled, An "oxidized" taint characterized by an oily or tallowy taste has been shown to be common in the United States of America. It is believed to be associated with diet and is reported to be avoided by including pasture in the feed. We have experienced at Palmerston North a peculiar oily taint in the fresh milk of cows receiving pasture but could not account for its occurrence. Cows affected with digestive disorders such as bloat produced milk with a disagreeable taste, Some cows continually produce cream with a cleaner flavour than others.

There is no extensive data on the effect of pasture grasses on the composition of milk. Some work has been in progress on this question for the last 2½ seasons at Palmerston North, but progress can only be made slowly because the composition of milk, especially the fat and casein fractions,

are subject to variation under the most carefully regulated conditions and t hc real influence on any ono diet cannot be observed in a few days, It generally tckcs at least 10 days for a diet to exert a permanent effect on milk and this period needs to be extended to study accumulative effects. Experiments have been carried out, both by the feeding of pasture to cows indoors and by grazing animals in specially seeded pastures, with pure perennial ryegrass and ryegrass and clover in the proportions of 70 :: 30 and 30:70. Experiments are now in progress with Iialian and perennial ryegrass. I have already indicated that pastures exert a material influence through their inability or otherwise to maintain the balance of nutrition of the animal. A lowering of t he plane reduces the milk yield, depresses solids-not-fat and raises the iodine value of the fat. It sometimes causes a sharp rise in the test for a few days but has not a lasting effect, This may explain the statement often made that the test of milk delivered to a factory rises when cows are put in certain fields, The results indicate that so long as the plane of nutrition is maintained, a high percentage grass and low percentage clover neither affects milk yield nor composition. Grass, however, more readily becomes fibrous than clover and accordingly a diet consisting of grass unless kept leafy and succulent more quickly reaches the danger level than one consisting of a proportion of clover. Clover produces fat with a higher iodine value than ryegrass. When the solids-not-fat arc depressed it is generally the casein fraction that drops,but the lactose fraction may also drop. Occasionally, as in the ensilage feeding trials, the casein rises and the lactose drops markedly. This happened in 3 cases out of 11 while in 8 the casein decreased markedly.

The above is only an exceedingly brief summary of the work a detailed account and results will be published in the near future. The surface of this wide field has only been scratched, much more must be undertaken to ensure that our pasture plants provide both quantity and good quality of dairy products. There must also be explained the reasons for butter and cheese quality varying with district and feed supply. It is also essential to study the long distance effect of the diet on production and health of the animal. This is in progress , with ryegrass and ryegrass and white clover.

I wish to acknowledge the hearty co-operation of Mr. Levy and his staff in the carrying out of the pasture feeding trials referred to in this address, the assistance o f Mr. Doak in carrying out the analyses of the pasture and of Dr. McDowall and Mr. Campb ell and their assistants of the Dairy Research Institute staff in carrying out detailed work connected with the pro jccts.

- - - - - - -