NUTRITION OF GRAZING CATTLE

5. A Survey of the Nutrition of Dairy Cattle in South-eastern Queensland

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SUMMARY

A survey was made of the nutrition of dairy cattle on 68 farms in south-eastern Queensland.

The protein, phosphorus and calcium levels in selectively grazed pasture were related to the class of country, the overall appearance of pastures and the predominant pasture species grazed.

On only two farms was the concentration of protein and phosphorus in selectively grazed pasture below the maintenance requirements of cattle. On other properties a deficiency of protein, phosphorus or calcium was related to a low intake of pasture and thus an associated deficiency of other nutrients.

The decline in milk production in winter was due primarily to low feed intakes.

Total production of milk was related to initial production. Inadequate nutrition of dry cows was a major cause of low total production.

I. INTRODUCTION

In south-eastern Queensland, the growing season for the main pasture species extends from the time of the early summer rains, usually in November, through the hot, wet months of December and January when pasture growth rate is maximum, until late February, when the grasses which have not been heavily grazed reach maturity. During winter, there is often little effective rainfall, and varying degrees of drought are encountered in the late winter months. To obtain winter production, cattle on unimproved pasture must be fed a supplement from late autumn until the pasture comes away following the early summer rains. Supplementary feeding is provided by fodder conservation, the growing of winter crops, the use of irrigated pasture or the purchase of concentrates and hays. The efficient utilization of the summer pasture and the winter feeds requires a knowledge of the nutritional factors which limit production in the different seasons.

The purpose of this survey was to determine the major nutritional factors limiting production of dairy cattle in south-eastern Queensland. Farms were classified on the basis of class of country to determine whether recommendations could be made which would overcome nutritional problems within each classification.

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II. MATERIALS AND METHODS

(a) Area Investigated

The area investigated extended 60 miles north and south and 40 miles west of Brisbane. Sixty-eight properties were included in the survey. The area was surveyed from February 1956 to February 1957.

(b) Seasonal Conditions

Seasonal conditions during the summer in early 1956 were good in the area, except in some districts which missed much of the summer rainfall. Heavy cyclonic rains fell throughout the area in March and April and provided a good carry-over of feed and a good green "pick" throughout most of the winter. From April, no effective rainfall was recorded and by November some districts were affected by drought. Late and only moderate rainfall in the following summer preceded a severe drought in 1957.

(c) Classification of Farms

Farms were classified according to the predominant class of country on which they were situated. The class of country is connoted by original vegetation, soil type and predominant pasture species. These classes were:

(1) *Rain-forest*

(*a*) Heavy rain-forest, occurring where annual rainfall is 45–80 in.; better soils such as the deep red loams of moderate fertility and good structure; after clearing the introduced grasses kikuyu grass (*Pennisetum clandestinum*) and paspalum (*Paspalum dilatatum*) predominant, usually associated with Rhodes grass (*Chloris gayana*) on the slopes.

(*b*) Medium rain-forest on black soils; after clearing, paspalum and Rhodes grass predominant.

(*c*) Light rain-forest on shallow soils; after clearing, self-established blue couch grass (*Digitaria didactyla*) predominant, with some paspalum and native forest grasses such as wire grasses (species of *Aristida*).

(*d*) Marginal rain-forest, usually fringing heavy rain-forest on plateau edges; some eucalypts; kikuyu grass and paspalum degenerating into carpet grass (*Axonopus affinis*).

(2) *Open Forest*

(*a*) Heavy soils merging into the black soils of medium rain-forest; forest blue grass (*Bothriochloa intermedia*) and pitted blue grass (*Bothriochloa decipiens*) predominant, associated with paspalum and Rhodes grass.

(*b*) Light and heavy soils of blue-gum and apple-tree flats; paspalum and blue couch grass predominant; wire grasses on the ridges.

(*c*) Podsolized and sandy ridge soils or stony shallow ridges; poor forest grasses, such as wire grasses, kangaroo grass (*Themeda australis*) and bunch spear grass (*Heteropogon contortus*), predominant.

(*d*) Podsolized and sandy ridge soils or stony shallow ridges associated with heavy soils merging into the black soils of medium rain-forest.

(*e*) Podsolized and sandy ridge soils or stony shallow ridges associated with light and heavy soils; paspalum degenerating into carpet grass on the flats.

(*f*) Wallum-type country; eucalypts and tea-trees; wire grasses, kangaroo grass and bunch spear grass predominant.

(3) *Eucalypt Forest/Bastard Scrub*

High-rainfall areas; podsolized soils; paspalum sown after clearing degenerating into carpet grass.

(4) *Lowlands*

Soils with high water-table in summer and restricted drainage; swamp oak and some tea-tree; blue couch, green couch (*Cynodon dactylon*), water couch (*Paspalum distichum*) and carpet grass predominant.

(d) Classification on Overall Appearance of Pasture

The overall appearance of the pasture on each farm was described as:

(1) *Lush green.*—A uniform lush green sward.

(2) *Green.*—An overall appearance of greenness but some drier areas evident.

(3) *Green to dry.*—The overall appearance not easily defined as either green or dry. Thus, there may be an overall tinge of green or scattered areas of green and dry pastures.

(4) *Dry.*—An overall appearance of dryness, but green growth evident at the base of mature grasses when inspected more closely.

(5) *Very dry.*—Little or no evidence of green growth on close inspection.

(e) Sampling

The procedures used for sampling pasture and faeces were those described by Moir (1960*a*).

(f) Analysis

The methods used for determining protein, phosphorus, calcium and ash were those described by Moir (1960*a*, 1960*b*).

(g) Estimation of Chemical Composition in Selectively Grazed Pasture

For herds in which there were cows not supplemented, the regressions of Moir (1960*a*, 1960*b*) were used to relate protein, phosphorus and calcium in faeces to the percentages of these constituents in the selectively grazed pasture.

For herds in which all cows were supplemented, protein, phosphorus and calcium were determined from analysis of pasture samples only.

(h) Estimation of Chemical Composition in the Diets of Supplemented Herds

The regressions relating faecal and pasture phosphorus and calcium, shown by Moir (1960*c*) to be applicable to mixed diets, were used to estimate phosphorus and calcium. Protein was estimated by the methods of Moir (1960*c*), which were based on the calculated approximate proportion of each feed in the diet and the estimated protein level in each feed, and on adjustments to the regression relating faecal and pasture protein.

(i) Milk Production Records

Milk production records were obtained where possible from the Herd Recording Section of the Queensland Department of Agriculture and Stock. The average milk production of cows lactating for 2, 4 and 6 months in each herd at the time of sampling was calculated. Cows which had dried off before 6 months were not included in calculating these averages.

In herds which were not regularly recorded, the farmers' estimates of the production of cows in the middle of their lactations were taken.

III. RESULTS

A summary of survey results of farms in each classification is given in Tables 1–11. The data recorded on each farm are:

(1) Locality of the farm.

(2) Date of sampling.

(3) Overall appearance of the pasture at the time of sampling.

(4) Predominant pasture species grazed at the time of sampling.

(5) Supplements used at the time of sampling.

TABLE 1

Summary of Survey Results of Farms on Heavy Rain-Forest, Red Soils. (Classification 1a)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Tamborine Mountain	Apr., 1956	Lush green ..	Kikuyu ..	Nil	18·0	0·43	0·36	..	..	..		30	
		Feb., 1957	Green ..	Kikuyu ..	Nil	13·9	0·31	0·27	..	..	..		25	
		Oct., 1956	Green to dry	Kikuyu ..	Nil	12·9	0·25	0·35	..	..	..		20	
2	Maleny ..	Apr., 1956	Green to lush	Kikuyu ..	2 lb	15·3	0·38	0·27	..	..	..	20	16	11
		Jan., 1957	Green ..	Kikuyu ..	Meat-and-bone-meal	14·0	0·29	0·34	..	..	..	24	21	19
		Nov., 1956	Green to dry	Paspalum ..	to the highest	12·0	0·26	0·30	..	..	..	24	18	15
		Oct., 1956	Green to dry	Paspalum ..	producing cows	12·0	0·23	0·37	..	..	..	21	16	14
		Aug., 1956	Green to dry	Paspalum ..	in all months	11·5	0·28	0·45	..	..	..	19	16	10
3	Beechmont ..	Jan., 1957	Green ..	Paspalum ..	Nil	14·8	0·27	0·34	..	..	..	23	21	18
4	Maleny ..	Jan., 1957	Green ..	Paspalum ..	Nil	14·4	0·29	0·46	..	..	..	18	15	11
		Sept., 1956	Green to dry	Paspalum and carpet	Nil	11·7	0·20	0·42	..	..	..	15	12	10
5	Maleny ..	Jan., 1957	Green ..	Kikuyu ..	Nil	14·1	0·36	0·30	..	..	..	25	24	22
		Sept., 1956	Green to dry	Paspalum ..	5 lb conc. to top cows	11·4	0·26	0·88	13·0	0·51	0·73	26	21	17
6	Beechmont ..	Jan., 1957	Green ..	Kikuyu ..	Nil	13·4	0·38	0·28	..	..	..		15	

(6) Percentages of protein, phosphorus and calcium in selectively grazed pasture.

(7) Percentages of protein, phosphorus and calcium in the diets of supplemented herds.

(8) Average milk yields of cows lactating for 2, 4 and 6 months at the time of sampling in recorded herds and estimates of production of cows at about 4 months in lactation for non-recorded herds.

In Table 12 are recorded the percentages of protein, phosphorus and calcium in selectively grazed pasture on podsolized and sandy ridge soils or stony shallow ridges (Classification 2C) used widely for dry cows and heifers.

Table 13 is assembled from data in Tables 1–12. This table records the means and the maximum variation from the means of protein, phosphorus and calcium contents of selectively grazed pasture when there are two or more analyses of pastures with similar attributes in each classification of class of country.

In Table 14 are shown minimum percentages of protein required in pasture for maintenance plus milk production. Using the relationship between apparent protein digestibility and protein percentage in pasture calculated by Moir (1960*a*), these minimum percentages are calculated from the amounts of digestible protein recommended by the National Research Council (1956) for maintenance and production of a 1,000 lb cow. These percentages have been calculated for dry-matter intakes ranging from 15 to 30 lb daily. The minimum percentages of protein required in mixed diets are dependent upon the apparent protein digestibilities for each feed comprising a diet. The general relationship of apparent protein digestibility and protein percentage in different classes of feedstuffs shown by Glover, Duthie, and French (1957) indicates that the data in Table 14 may be used generally with little error for mixed diets, particularly when roughage constitutes the principal part of a diet.

In Tables 15 and 16 are minimum percentages of phosphorus and calcium in a diet required for maintenance plus milk production at dry-matter intakes of 15–30 lb. These percentages are calculated from the amounts of phosphorus and calcium for maintenance and milk production recommended for a 1,000 lb cow by the National Research Council (1956).

Although some of the dry-matter intakes given in Tables 14, 15 and 16 may be rarely encountered, they are included to emphasize the concentrations of protein, phosphorus and calcium which would be required for an extreme range of conditions.

TABLE 2

Summary of Survey Results of Farms on Medium Rain-Forest, Black Soils (Classification 1b)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Gleneagle ..	Jan., 1957	Green to lush	Paspalum ..	Nil	15·4	0·30	0·34	..	..	..	21	19	17
		June, 1956	Green ..	Paspalum ..	Irrigated white clover	13·7	0·32	0·40	18·0	0·33	0·75	22	18	15
2	Veresdale ..	Jan., 1957	Green ..	Paspalum ..	Nil	14·1	0·29	0·38	..	..	..	22	20	15
		Feb., 1956	Green ..	Paspalum and Rhodes	Nil	13·4	0·30	0·28	..	..	..	19	18	15
		Sept., 1956	Green to dry	Paspalum ..	3 lb concentrates, roughage and bonemeal to top cows	11·1	0·27	0·47	13·0	0·39	0·60	19	17	10
3	Veresdale ..	Jan., 1957	Green ..	Paspalum and Rhodes	Nil	12·7	0·33	0·38	..	..	..	25	21	17
		Apr., 1956	Green ..	Paspalum and Rhodes	Nil	12·2	0·31	0·30	..	..	..	19	17	12
		Feb., 1957	Green to dry	Paspalum and Rhodes	Nil	9·8	0·22	0·28	..	..	..	25	22	17
		Mar., 1956	Green to dry	Paspalum and Rhodes	Nil	9·6	0·23	0·35	..	..	..	23	19	15
		Nov., 1956	Dry	Paspalum and Rhodes	Silage and meatmeal	..	..	..	13·0	0·27	0·68	21	16	12
4	Lamington ..	June, 1956	Green to dry	Paspalum ..	Nil	11·4	0·27	0·38	..	..	..		15	

TABLE 3

Summary of Survey Results of Farms on Light Rain-Forest, Shallow Soils (Classification 1c)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Whiteside ..	Jan., 1957	Green ..	Blue couch ..	Grazing panicum and irrigated pasture	11·9	0·26	0·33	12·0	0·31	0·44	20	17	16
		Mar., 1956	Green ..	Blue couch ..	Nil	11·4	0·28	0·31	..	..	..	18	16	14
2	Lacey's Creek	Apr., 1956	Green ..	Blue couch ..	Nil	10·7	0·24	0·35	..	..	..	22	19	15
3	Narangba ..	Jan., 1957	Green ..	Blue couch and carpet	Nil	10·3	0·20	0·28	..	..	..		15	
4	Bald Hills ..	June, 1956	Green to dry	Blue couch ..	Entirely hand-feeding	..	..	..	19·0	..	..	30	24	18
5	Upper Caboolture	Dec., 1956	Green to dry	Blue couch and forest grass	3 lb concentrates and bonemeal	9·0	0·23	0·51	10·0	0·30	0·70	16	11	8
6	Kilcoy ..	Feb., 1957	Green to dry	Blue couch and forest grass	Nil	8·9	0·21	0·34	..	..	..		15	
7	Moggill ..	Dec., 1956	Green ..	Blue couch ..	Up to 10 lb concentrates; grazing crops	..	..	..	14·0	0·53	1·15	48	33	29
		Feb., 1957	Green ..	Blue couch ..		..	..	..	13·0	0·44	0·51	44	36	24
8	Highvale ..	Sept., 1956	Dry	Blue couch ..	5 lb concentrates and roughage	..	..	..	12·5	0·35	0·60	18	15	12
9	Upper Caboolture	Oct., 1956	Dry	Blue couch ..	Irrigated pasture — little outside grazing	..	..	..	18·0	0·46	0·68	17	16	13

TABLE 4

Summary of Survey Results of Farms on Marginal Rain-Forest on Plateau Edges (Classification 1d)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Reesville ..	Jan., 1957	Green ..	Carpet and kikuyu	Nil	13·2	0·25	0·28	..	..	..		12	
		Oct., 1956	Green to dry	Carpet and kikuyu	Nil	10·3	0·19	0·30	..	..	..		10	
2	Mount Mee ..	Feb., 1957	Green to dry	Carpet ..	Nil	9·0	0·16	0·25	..	..	..		8	
3	Witta ..	Jan., 1959	Green to dry	Carpet ..	Nil	8·5	0·17	0·29	..	..	..		8	

TABLE 5

Summary of Survey Results of Farms on Open Forest, Heavy Soils (Classification 2a)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Veresdale ..	Jan., 1957	Green to dry	Forest grass and paspalum	Improved pasture	12·3	0·30	0·34	14·0	0·29	0·51	24	22	19
		Feb., 1957	Green to dry	Forest grass and paspalum	Lucerne and Sudan grass	..	..	..	11·0	0·20	0·47	25	21	17
		Nov., 1956	Dry	Forest grass ..	Silage and meatmeal	..	..	..	12·0	0·29	0·71	20	16	15
2	Gleneagle ..	Jan., 1957	Green to dry	Forest grass and paspalum	Improved pasture	11·6	0·26	0·29	15·0	0·34	0·54	32	25	15
		Mar., 1956	Green to dry	Forest grass and paspalum	Irrigated pasture	11·6	0·34	0·39	14·0	0·33	0·45	25	23	20
3	Jimboomba ..	Jan., 1957	Green to dry	Forest grass and paspalum	Improved pasture and chaffed maize	11·0	0·30	0·28	12·0	0·31	0·38		17	
		Apr., 1956	Green to dry	Forest grass and paspalum	Chaffed maize	..	..	..	7·5	0·23	0·29		12	
4	Woolmar ..	Jan., 1957	Green to dry	Rhodes and forest grass	2 lb corn-and-cob to top cows	10·6	0·30	0·34	..	..	..		17	
		Oct., 1956	Dry	Rhodes and forest grass	5 lb corn-and-cob to top cows	7·7	0·25	0·37	..	..	..		12	
5	Veresdale ..	Jan., 1957	Green to dry	Forest grass ..	Chaffed maize and lucerne hay	10·0	0·26	0·32	12·0	0·33	0·56		17	
		Apr., 1956	Dry	Forest grass ..	Chaffed maize	..	..	..	7·6	0·27	0·36		12	

TABLE 6

Summary of Survey Results of Farms on Open Forest, Light and Heavy Soils (Classification 2b)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Yatala ..	Jan., 1957	Green ..	Paspalum ..	2 lb grain to top cows	14·4	0·30	0·27	..	..	..	18	16	16
		July, 1956	Green to dry	Paspalum ..	Irrigated clover	..	..	..	16·0	0·36	0·68	17	14	11
2	Yatala ..	Jan., 1957	Green ..	Paspalum and blue couch	Nil	13·1	0·25	0·23	..	..	..		15	
		July, 1956	Dry	Paspalum and blue couch	3 lb concentrates to top cows	9·1	0·25	0·26	10·0	0·23	0·36		12	
3	Amberley ..	Feb., 1957	Green ..	Paspalum and blue couch	3 lb lucerne hay	12·1	0·28	0·28	13·0	0·26	0·41	18	15	11
4	Waterford ..	Feb., 1956	Green ..	Paspalum and blue couch	Nil	12·0	0·39	0·26	..	..	..	14	12	10
		Apr., 1956	Green ..	Paspalum and blue couch	Nil	11·9	0·30	0·30	..	..	..	14	10	9
5	Amberley ..	Feb., 1957	Green ..	Paspalum and blue couch	Nil	12·0	0·27	0·53	..	..	..		12	
6	Waterford ..	Apr., 1956	Green ..	Paspalum and blue couch	Nil	11·7	0·32	0·29	..	..	..		12	
7	Upper Caboolture	Dec., 1956	Green ..	Paspalum and blue couch	Nil	11·7	0·28	0·33	..	..	..		15	
8	Upper Caboolture	Dec., 1956	Green ..	Paspalum and blue couch	Irrigated pasture	11·7	0·24	0·36	13·0	0·30	0·47	22	16	14
9	Amberley ..	Feb., 1957	Green to dry	Paspalum ..	2 lb concentrates and bonemeal	10·4	0·33	0·31	12·0	0·39	0·60		15	

TABLE 7

Summary of Survey Results of Farms on Open Forest, Podsolized and Sandy Ridge Soils or Stony Shallow Ridges Associated with Heavy Soils Merging into the Black Soils of Medium Rain-Forest (Classification 2d)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Veresdale ..	Jan., 1957	Green to dry	Paspalum ..	Nil	12·9	0·23	0·28	..	..	..		15	
		Oct., 1956	Dry	Paspalum and forest grass	3 lb meal to top cows	10·7	0·17	0·24	..	..	..		12	
2	Rosevale ..	Dec., 1956	Green to dry	Paspalum ..	Irrigated pasture	12·3	0·26	0·36	14·0	0·29	0·62	24	19	16
3	Mount Beppo	Feb., 1957	Green to dry	Paspalum and forest grass	Irrigated pasture	10·5	0·20	0·21	13·0	0·27	0·48	25	22	19
		Sept., 1956	Dry	Paspalum and forest grass	Irrigated pasture	9·2	0·16	0·16	16·0	0·22	0·58	28	23	22
4	Kilcoy ..	Nov., 1956	Green to dry	Rhodes following burning	Nil	8·9	0·22	0·25	..	..	..		15	
5	Mount Beppo	Sept., 1956	Dry	Paspalum and forest grass	Nil	9·0	0·17	0·37	..	..	..		7	

TABLE 8

Summary of Survey Results of Farms on Open Forest, Podsolized and Sandy Ridge Soils or Stony Shallow Ridges Merging into Light and Heavy Soils (Classification 2e)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Tamborine Village	Feb., 1957	Green to dry	Paspalum and carpet	Nil	9·9	0·21	0·24	..	..	..		12	
2	Tamborine Village	Apr., 1956	Green to dry	Paspalum and carpet	Nil	10·3	0·20	0·26	..	..	..		12	

TABLE 9

Summary of Survey Results of Farms on Wallum Type Country (Classification 2f)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Elimbah ..	Jan., 1957	Dry	Forest grass ..	Improved pasture	6·1	0·08	0·13	9·0	0·76	0·26		<5	
		July, 1956	Very dry ..	Forest grass ..	Nil	5·7	0·07	0·10	..	..	..		<5	
2	Deception Bay	Sept., 1956	Very dry ..	Forest grass ..	Elephant grass	5·4	0·05	0·10	8·0	0·13	0·19		<5	

TABLE 10

Summary of Survey Results of Farms on Eucalypt Forest/Bastard Scrub Country (Classification 3)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Mooloolah ..	Apr., 1956	Green ..	Paspalum ..	4 lb corn-and-cob to some cows	11·8	0·27	0·19	..	..	..		10	
		Nov., 1956	Green to dry	Paspalum and carpet	4 lb meal ..	10·3	0·16	0·19	11·0	0·24	0·22		8	
2	Mooloolah ..	Apr., 1956	Green ..	Paspalum ..	Nil	11·3	0·25	0·28	..	..	..		7	
		Feb., 1957	Green ..	Paspalum and carpet	2 lb meal to some cows	10·6	0·20	0·23	..	..	..		10	
		Nov., 1956	Green to dry	Paspalum and carpet	2 lb meal to some cows	10·2	0·18	0·27	..	..	..		7	
3	Mount Cotton	Dec., 1956	Green to dry	Paspalum and carpet	Nil	9·9	0·15	0·16	..	..	..		10	
		Aug., 1956	Green to dry	Carpet ..	½ lb meatmeal	..	..	..	12·0	0·28	0·43		8	
4	Chevallum ..	Nov., 1956	Green to dry	Carpet ..	Nil	9·7	0·15	0·21	..	..	..		7	
		Feb., 1957	Green to dry	Carpet ..	Nil	8·7	0·16	0·20	..	..	..		8	
5	Buderim ..	Nov., 1956	Green to dry	Carpet ..	Nil	9·3	0·14	0·21	..	..	..		7	
		Feb., 1957	Green to dry	Carpet ..	Nil	8·9	0·14	0·16	..	..	..		8	
6	Mount Cotton	Dec., 1956	Green to dry	Carpet ..	Nil	9·3	0·14	0·22	..	..	..		8	
		Mar., 1956	Green to dry	Carpet ..	Nil	9·2	0·18	0·18	..	..	..		7	
7	Buderim ..	Feb., 1957	Green to dry	Carpet ..	Nil	8·4	0·16	0·16	..	..	..		7	
		Aug., 1956	Green to dry	Carpet ..	2 lb meal to some cows	8·1	0·12	0·19	..	..	..		7	

TABLE 11

Summary of Survey Results of Farms on Lowlands (Classification 4)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Supplementary Feeds	Chemical Composition of Pasture (Dry matter)			Chemical Composition of Diet (Dry matter)			Milk Yield (lb) for Lactation Period (months)		
						Protein (%)	P (%)	Ca (%)	Protein (%)	P (%)	Ca (%)	2	4	6
1	Tallebudgera	Oct., 1956	Green to dry	Couch and carpet	Nil	10·7	0·21	0·32	..	..	..	14	10	
2	Mudgeeraba	Nov., 1956	Green to dry	Couch and carpet	Nil	10·6	0·24	0·29	..	..	..	9	10	9
		Jan., 1957	Green to dry	Couch and carpet	Nil	9·5	0·19	0·29	..	..	..	15	12	9
3	Currumbin ..	Jan., 1957	Green to dry	Couch and carpet	Nil	9·6	0·19	0·26	..	..	..	18	15	11
		Aug., 1956	Green to dry	Couch and carpet	5 lb lucerne hay, 2 lb meal	..	..	..	14·0	0·30	0·45	19	16	16
4	Mudgeeraba	July, 1956	Green to dry	Couch and carpet	3 lb meal to some cows	9·6	0·19	0·26	..	..	..	12	11	9
		Nov., 1956	Dry	Couch and carpet	Nil	8·5	0·13	0·26	..	..	..	14	10	9
		Dec., 1956	Dry	Couch and carpet	Bonemeal ..	..	..	..	8·2	0·25	0·53	14	13	11

TABLE 12

Summary of Survey Results of Dry Cow and Heifer Paddocks on Open Forest, Podsolized and Sandy Ridge Soils or Stony Ridges (Classification 2C)

Herd No.	Locality	Month of Sampling	Overall Appearance of Pasture	Predominant Grasses Grazed	Chemical Composition of Pasture (Dry matter)		
					Protein (%)	P (%)	Ca (%)
1	Upper Caboolture	Oct., 1956	Dry	Forest grass, some paspalum	9·3	0·14	0·21
		Jan., 1957	Dry	Forest grass	8·0	0·13	0·28
2	Whiteside	Oct., 1956	Dry	Forest grass, some paspalum	9·3	0·13	0·30
3	Tamborine Village	Oct., 1956	Dry	Forest grass, some paspalum	9·1	0·12	0·27
4	Wonglepong	Sept., 1956	Dry	Forest grass, some paspalum	9·0	0·13	0·26
5	Kilcoy	Feb., 1957	Dry	Forest grass	8·7	0·12	0·17
6	Narangba	Sept., 1956	Dry	Forest grass, some paspalum	8·4	0·13	0·21
7	Benarkin	July, 1956	Dry	Forest grass	7·9	0·13	0·27
8	Moggill	Sept., 1956	Dry	Forest grass following burning	7·5	0·16	0·26
9	Palmview	Sept., 1956	Dry	Forest grass, some carpet	7·5	0·16	0·24
10	Veresdale	Oct., 1956	Dry	Forest grass	7·5	0·15	0·26
11	Veresdale	Nov., 1956	Dry	Forest grass, some Rhodes	7·4	0·19	0·34
12	Highvale	Sept., 1956	Very dry	Forest grass	7·7	0·14	0·36
13	Cedar Grove	Jan., 1957	Very dry	Forest grass	7·4	0·10	0·22
14	Gleneagle	Sept., 1956	Very dry	Forest grass	6·9	0·12	0·23

TABLE 13

Means and Maximum Variations from the Means of Protein, Phosphorus and Calcium in Pasture with Similar Attributes on Each Class of Country

Class of Country	Overall Appearance of Pasture	Predominant Pasture Species Grazed	Mean and Maximum Variations from the Mean					
			Protein (%)		P (%)		Ca (%)	
			Mean	Maximum Variation	Mean	Maximum Variation	Mean	Maximum Variation
1a	Green	Paspalum	14·6	(0·2)	0·28	(0·01)	0·40	(0·06)
	Green	Kikuyu	13·9	(0·5)	0·34	(0·05)	0·30	(0·04)
	Green to dry	Paspalum	11·7	(0·3)	0·26	(0·03)	0·50	(0·38)
1b	Green	Paspalum	13·9	(0·2)	0·31	(0·02)	0·39	(0·01)
	Green	Paspalum and Rhodes	12·8	(0·6)	0·31	(0·02)	0·32	(0·06)
	Green to dry	Paspalum	11·3	(0·2)	0·27	(0)	0·43	(0·05)
	Green to dry	Paspalum and Rhodes	9·7	(0·1)	0·23	(0·01)	0·32	(0·04)
1c	Green	Blue couch grass	11·3	(0·6)	0·26	(0·02)	0·33	(0·02)
	Green to dry	Blue couch and forest grass	9·0	(0·1)	0·22	(0·01)	0·43	(0·09)
1d	Green to dry	Carpet	8·8	(0·3)	0·17	(0·01)	0·27	(0·02)
2a	Green to dry	Forest grass and paspalum	11·6	(0·7)	0·30	(0·04)	0·33	(0·06)
2b	Green	Paspalum and blue couch	12·0	(1·1)	0·29	(0·10)	0·32	(0·21)
2c	Dry	Forest grass and paspalum	9·0	(0·6)	0·13	(0·01)	0·25	(0·05)
	Dry	Forest grass	8·0	(0·7)	0·13	(0·02)	0·25	(0·08)
	Very dry	Forest grass	7·3	(0·4)	0·12	(0·02)	0·27	(0·09)
2d	Green to dry	Paspalum	12·6	(0·3)	0·25	(0·02)	0·32	(0·04)
	Dry	Paspalum and forest grass	9·7	(1·0)	0·17	(0·01)	0·26	(0·11)
2e	Green to dry	Paspalum and carpet grass	10·1	(0·2)	0·21	(0·01)	0·25	(0·01)
2f	Very dry	Forest grass	5·6	(0·2)	0·06	(0·01)	0·10	(0)
3	Green	Paspalum	11·6	(0·3)	0·26	(0·01)	0·24	(0·05)
	Green to dry	Paspalum and carpet	10·1	(0·2)	0·16	(0·02)	0·21	(0·06)
	Green to dry	Carpet	9·0	(0·9)	0·15	(0·03)	0·19	(0·03)
4	Green to dry	Blue couch and carpet	10·0	(0·7)	0·20	(0·04)	0·28	(0·04)

TABLE 14

Minimum Percentages of Protein Required in Pasture for Maintenance and Milk Production of a 1000 lb Cow

Dry-matter Intake (lb)	Minimum Protein Percentage Required in Pasture										
	Milk Production (lb)										
	0	5	10	15	20	25	30	35	40	45	50
15	7·5	9·2	11·0	12·7	14·4	15·8	..	..	..	..	..
20	6·5	7·7	9·0	10·3	11·5	12·7	14·0	..	..	..	..
25	..	7·0	7·7	8·7	9·8	10·8	11·8	12·8	13·8	..	..
30	..	..	7·2	7·9	8·7	9·5	10·3	11·2	12·1	12·9	13·7

TABLE 15

Minimum Percentages of Phosphorus Required in a Diet for Maintenance and Milk Production of a 1000 lb Cow

Dry-matter Intake (lb)	Minimum Phosphorus Percentage Required in a Diet										
	Milk Production (lb)										
	0	5	10	15	20	25	30	35	40	45	50
15	0·12	0·17	0·22	0·27	0·33	0·38	..	..	..	..	..
20	0·09	0·13	0·17	0·21	0·24	0·28	0·32	0·36	..	..	..
25	..	0·10	0·13	0·16	0·20	0·23	0·26	0·29	0·32	..	..
30	..	..	0·11	0·14	0·16	0·19	0·22	0·24	0·27	0·29	0·32

TABLE 16

Minimum Percentages of Calcium Required in a Diet for Maintenance and Milk Production of a 1000 lb Cow

Dry-matter Intake (lb)	Minimum Calcium Percentage Required in a Diet										
	Milk Production (lb)										
	0	5	10	15	20	25	30	35	40	45	50
15	0·12	0·19	0·27	0·34	0·41	0·49	..	..	..	..	..
20	0·09	0·14	0·20	0·26	0·31	0·37	0·42	0·48	..	..	..
25	..	0·12	0·16	0·20	0·25	0·29	0·34	0·38	0·43	..	..
30	..	..	0·13	0·17	0·21	0·24	0·28	0·32	0·36	0·39	0·43

IV. DISCUSSION

From the data in Tables 1 to 11, two major problems of the dairy farms examined are:—

(1.) *The fall in production during winter.*—In spite of supplementary feeding practices, the summer level of production is not maintained from autumn to spring.

(2.) *The low annual productivity in many herds.*—The average annual milk production per cow ranged from less than 200 gal to about 500 gal and the average for the recorded herds was 350 gal in 1956. Herds which were not recorded were in most cases low producing and the average for all herds could be expected to be less than 300 gal.

The survey sample was drawn from a total of 207 herds in nine dairying districts, classified for herd-recording purposes as Beaudesert, Brisbane, Beenleigh, Ipswich, Kilcoy, Landsborough-Caboolture, Maleny, Tamborine Mountain and Beechmont-Currumbin. The herd recording data for these districts (S. E. Pegg, personal communication) indicate that the problems of the dairy farms examined are general in south-eastern Queensland and even in the whole of Queensland's dairying areas.

Three of the districts (Beaudesert, Brisbane and Beenleigh) are on milk supply, which necessitates maximum endeavour to maintain milk production throughout the year. The monthly production averages for 79 herds in these districts for 1956 were:—

—	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Milk (lb) ..	524	494	432	380	382	400	422	454	440	472	438	450
Butterfat (lb) ..	21	21	18	17	17	17	17	17	17	18	17	17

In spite of supplementary feeding practices, a decline from the summer (January and February) level of production is evident. An even greater decline must be anticipated in cream-supply herds, as the economics of cream production are not dependent upon the maintenance of maximum production throughout the year.

The average annual milk production per cow in Moreton Statistical Division, which embraces the nine districts, and in the whole of Queensland for 1949 to 1959 was:—

—	Moreton (gal)	Queensland (gal)
1949–50	265	260
1950–51	272	272
1951–52	209	195
1952–53	276	273
1953–54	252	248
1954–55	267	261
1955–56	282	282
1956–57	256	256
1957–58	219	216
1958–59	278	276

The low average productivity in the herds surveyed was therefore typical of herds in Queensland in all years.

Because of the essentially summer rainfall, pasture reaches maturity in late summer with a resultant fall in digestible protein, total digestible nutrients and phosphorus. Pasture regrowth with a resultant rise in food value cannot be expected until the first effective spring or early summer rains. Thus the seasonal decline from the summer level of production in dairy cattle must be largely a nutritional problem. Adverse weather conditions such as cold winds and rain undoubtedly contribute to short-term depressions in milk production.

Productivity of herds in this survey is related to class of country and to supplementary feeding practices. Cows on the poorest classes of country, represented in Tables 4, 8, 9 and 10, produced less than 200 gal of milk annually. On the most fertile classes of country, represented in Tables 1 and 2, the production of cows in some herds receiving little or no supplement was above average. On the intermediate classes of country, a higher rate of supplementation was required to obtain production equivalent to the highest producing herds recorded in Tables 1 and 2. The relationship of productivity to class of country and to the level of supplementary feeding indicates that nutrition must be the most important single factor affecting productivity.

The influence of nutritional factors on productivity must be considered in relation to:—

(1) Summer (January and February) production.

(2) Autumn/spring production.

(3) Total productivity.

(1) *Summer Production.*—The highest producing herds on those classes of country with cows producing at least 2 gal of milk could be expected to consume

25 to 30 lb of dry matter per head daily. At feed intakes of 30 lb, herds in Tables 1 to 11 with cows producing 2 gal of milk in January or February would not be deficient in protein, phosphorus or calcium on the basis of the minimum requirements as set out in Tables 14, 15 and 16. At an intake of 25 lb dry matter, only the highest producing cows in Herd 3, Table 2, could be slightly deficient in protein, phosphorus and calcium. The highest producing cows in Herd 1, Table 5, could be slightly deficient in phosphorus, and some cows in Herd 1, Table 1, could be slightly deficient in calcium.

On the basis of digestibility data of Morrison (1937) and Schneider (1947) for grasses of protein content similar to that encountered in this survey, it could be expected that the total digestible nutrients in the summer pastures would be adequate for the production levels attained. Evidence that a deficiency of protein, phosphorus, calcium or total digestible nutrients was not specifically limiting the summer production in the lower producing herds on each class of country may be obtained by comparing the chemical composition of pasture selected by low and high producing herds. On each class of country, when the same pasture species are grazed and when the protein levels of the selectively grazed pastures are similar, the phosphorus and calcium levels in the selected pastures and the overall appearances of the pastures are also similar (Table 13). It could therefore be expected that under these conditions the percentages of total digestible nutrients in these pastures would be similar. The productivity of the lowest producing pasture-fed herds in summer is therefore not due to lack of total digestible nutrients, protein, phosphorus or calcium in the selected pasture, when there are higher producing herds on no greater bulk of pasture with similar or even lower levels of these nutrients.

Herds on poor classes of country (Tables 4, 8, 9 and 10), with cows producing less than 2 gal of milk, would not be deficient in protein, phosphorus or calcium at dry-matter intakes of 30 lb in the summer months. However, it is unlikely that the dry-matter intakes of low-producing herds would approach 30 lb, and varying degrees of protein, phosphorus or calcium deficiencies could occur at lower feed intake levels. Thus, at dry-matter intakes of 20 lb, a number of herds on the poorest classes of country could have been deficient in protein, phosphorus or calcium. These deficiencies cannot be regarded as specific deficiencies, but rather as deficiencies induced by low feed intakes.

For the area covered in this survey, there was an abundance of pasture in January and February of 1956 and 1957. Thus both field and analytical evidence support the conclusion that low productivity in summer is not a function of quantity or quality of the pasture available at that time.

(2) *Autumn/Spring Production.*—For the higher producing pasture-fed herds in Tables 1 to 11, deficiencies of protein, phosphorus or calcium would not occur from autumn to spring in cows producing 2 gal of milk and consuming 30 lb of dry matter. At an intake of 25 lb, only Herd 3, Table 7, could be

deficient in phosphorus. As stated previously, within any class of country the level of total digestible nutrients in pasture selected by lower producing herds cannot be limiting when there are other herds giving higher production on pasture of similar chemical and botanical composition.

Similar deductions to those made for pasture-fed herds may be made for supplemented herds. For each classification, the lowest producing herd receiving a supplement had, with only two exceptions, a protein level in the diet at least equal to the protein level in the selected pasture. On the basis of digestibility data of Morrison (1937) and Schneider (1947), it could be expected that the total digestible nutrients in supplements would be at least equal to the total digestible nutrients in selected pasture. The two exceptions were Herds 3 and 5 in Table 5, where protein was low in the supplement and where low protein intake could have limited productivity.

For the majority of herds, irrespective of whether they are of high or low productivity, there is a decline in autumn/spring from the summer level of production. For lower producing herds in each class of country, this must be ascribed largely to low feed intakes, although high energy costs of grazing may be contributing. For higher producing herds in each class of country, this seasonal decline must be due primarily to insufficient total energy from limited dry-matter intake, an insufficient total digestible nutrient content of pasture, and/or high energy cost of grazing.

On most properties in winter there was an abundance of low quality, mature grass, but sparse, short, green pasture was preferentially grazed. On some properties of low productivity the only feed available was short pasture. Thus field evidence supports the analytical evidence of low feed intakes as well as the high energy costs of grazing which must be expected under such conditions. A high energy supplement could correct all major factors responsible for seasonal decline in production in the area covered by the survey but may be uneconomical on the poorer classes of country.

(3) *Total Productivity.*—In each recorded herd in Tables 1 to 11, the production levels of cows lactating for 4 and 6 months are highly correlated with the production levels of cows lactating for 2 months ($r = 0{\cdot}96$ and $r = 0{\cdot}86$ respectively). Hence factors which determined the productivity of the freshest cows also determined the production of cows at all stages of lactation. Within herds, this relationship is similar throughout the year irrespective of the seasonal decline in production from autumn to spring.

As low productivity is essentially a nutritional problem, having been related to class of country, a low production in fresh cows must be due primarily to inadequate nutrition of heifers and/or cows in late gestation.

The minimum percentages of protein, phosphorus and calcium calculated in a manner similar to that used for calculating values in Tables 14, 15 and 16, and based on the recommendations of the National Research Council (1956) for heifers and cows in late gestation, are—

—	Protein	P	Ca
	(%)	(%)	(%)
Heifers (400 lb weight)	11·5	0·30	0·26
Cows in late gestation	9·5	0·15	0·16

The classes of country represented in Tables 4, 8, 10 and 12 are typical of areas used for heifers and dry cows in south-eastern Queensland. Even the poorest class, Table 9, in which selected pasture will not meet the maintenance requirements of adult cattle, is used alone or in association with other types of country. The summarized data in Table 13 emphasize that class of country, overall appearance of pasture and predominant pasture species grazed largely define the protein, phosphorus and calcium levels in pasture selected by cattle in south-eastern Queensland. In dry seasons, these levels must be expected to fall to at least the lowest levels recorded during this survey for each class of country. Thus on the classes of country represented in Tables 4, 8, 10 and 12, the protein, phosphorus and calcium levels in selectively grazed pasture would be inadequate for long periods of the year for cows in late gestation and would almost never meet the optimum requirements for heifers.

On many properties neither dry cows nor heifers are supplemented. The higher productivity achieved on better classes of country has been due partly to a better plane of nutrition in the milking herd and partly due to better feeding of dry cows, if only by bringing them into milking cow paddocks for some weeks prior to calving. However, it is most evident from this survey that a major cause of low total productivity of herds in south-eastern Queensland is inadequate nutrition of heifers and dry cows.

V. CONCLUSIONS

On the basis of this survey, three broad conclusions are apparent with regard to the correction of the low productivity of dairy cattle in south-eastern Queensland. These are:

(1) The need for optimum feeding of dry cows and heifers.

(2) The importance of the selection of a type of supplement which with pasture will provide enough protein, minerals and energy to maintain production at the summer level. The farm classifications may be used to assess the protein, phosphorus and calcium levels in selected pasture; published tables on the chemical compositions of feeds may be used to assess the feeding value of supplements.

(3) The significance of the essentially agricultural classifications as a guide not only to the nutritive value of the selected pasture but also to extending to other properties agricultural practices which have proved both effective and economical in lifting production within a classification type.

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REFERENCES

GLOVER, J., DUTHIE, D. W., and FRENCH, M. H. (1957).—*J. Agric. Sci.* 48 : 373.

MOIR, K. W. (1960*a*).—*Qd J. Agric. Sci.* 17 : 361.

MOIR, K. W. (1960*b*).—*Qd J. Agric. Sci.* 17 : 373.

MOIR, K. W. (1960*c*).—*Qd J. Agric. Sci.* 17 : 385.

MORRISON, F. B. (1937).—"Feeds and Feeding." 20th Ed. (Morrison Publishing Co. : New York).

NATIONAL RESEARCH COUNCIL (1956).—"Nutrient Requirements of Domestic Animals. No. 3." (National Research Council : Washington).

SCHNEIDER, B. H. (1947).—"Feeds of the World." (West Virginia Agricultural Experiment Station : Morgantown).

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