AN ABSTRACT OF THE THESIS OF

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(Name of student) (Degree)

in Animal Science (Dairy Production) presented on January 9, 1968
(Major) (Date)

Title: PERFORMANCE OF DAIRY CATTLE UNDER TWO FEEDING REGIMES, DRY LOT AND IRRIGATED PASTURE

Abstract approved: [redacted]
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Four experiments were conducted (1961-1964) for the primary purpose of studying the milk and milk constituent yields of dairy cows under dry lot and pasture systems of management. The secondary purpose was to compare the health and breeding performance of cows under these two systems.

Ninety-eight cows of the Holstein and Jersey breeds were used. These cows were paired on the basis of breed, age, current milk production, previous lactation yields, days in milk, days in gestation and udder health and were assigned randomly to the two experimental groups.

Cows in the dry lot groups were fed grass silage and alfalfa hay (periods I-III) or haylage (period IV) whereas, cows in the pasture group were strip-grazing irrigated grass-legume pastures. Both groups were also fed the same concentrate mixture twice daily.

Differences in performance between the two systems were not

significant statistically ($P < 0.05$) for the following criteria: (1) age at calving (periods I, III and IV), (2) days in milk prior to experimentation (periods I, II, and IV), (3) projected milk and milk fat records (305 day, 2X) for all periods, (4) age adjusted (M. E.) milk records (periods I, II and IV), (5) age adjusted milk fat records (periods I-IV), (6) complete records (periods I, II and IV), (7) complete lactation protein records (periods II-IV) and (8) differences between complete and incomplete projected milk and milk fat records of all 98 cows. Differences in performance were significant for the above criteria for any of those periods not given in parentheses.

Data collected during the four experimental feeding periods (84, 150, 150 and 68 days, respectively) on milk, PLM, protein and milk fat yields, mastitis and reproduction showed no significant differences ($P < 0.05$) between the two systems except for milk fat yield which favored the pasture group during period III and number of A.I. services for conception which was higher in the dry lot group during period II. Higher levels of concentrate feeding resulted in higher milk and milk constituent yields.

The results of these studies indicate that milk cows will perform equally well when subjected to dry lot or irrigated grass-legume pastures under the conditions of these experiments.

Performance of Dairy Cattle Under Two Feeding Regimes, Dry Lot and Irrigated Pasture

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1968

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Date thesis is presented January 9, 1968

Typed by Opal Grossnicklaus for Aloysius Lloyd Kyeyune-Sendagi

ACKNOWLEDGMENTS

Acknowledgment is extended to the United States and the Uganda governments for the joint scholarship that made my studies in this country possible.

I am indebted to Professor Ray Kliewer, Assistant Professor of Animal Science, for his continued guidance and assistance during my training and preparation for this thesis.

My thanks are also extended to Dr. J. C. Miller, former Head, Department of Animal Science and Dr. C. W. Fox, Associate Professor of Animal Science, for their guidance in the first few months of my program. Appreciation is also extended to Professor F. B. Wolberg, Associate Professor of Animal Science, for collecting and making available the data on which this thesis was based.

I wish to express my gratitude to Mr. Ronald Lind for his advice and constructive criticism of the manuscript. My sincere thanks are extended to Miss Jan Kerr and Mrs. Glyna Morris for the typing of the first draft of the thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (CONTINUED)

PERFORMANCE OF DAIRY CATTLE UNDER TWO FEEDING REGIMES, DRY LOT AND IRRIGATED PASTURE

INTRODUCTION

Pasturing has been a standard method of feeding and managing dairy cattle and other farm livestock for centuries. As dairy cattle have been selected for greater milk yields their nutrient requirements have increased proportionately. In parallel with this, methods have also been devised to increase the productivity of pasture by application of fertilizers, irrigation, intensive grazing, or a combination of all three practices. In countries like New Zealand, at least 90% of their milk production depends on pasture and is closely related to the growth curve of pasture grasses. Cooper (1955) reported that the Netherlands rely to the extent of 80% on grass in its various forms for milk production as opposed to less than 55% in Great Britain. Whereas, in the United States pasture is playing an ever decreasing role in milk production.

Systems of pasture utilization that are commonly used include rotational and strip grazing. It is under these systems that the full potentialities of pastures for milk production are realized. This is so because less intensive grazing results in pastures getting ahead of the grazing cows, particularly during the period of most rapid growth, with the consequent accumulation of varying amounts of coarse and dead material intermingled with the young growth. The nutritive value of such pastures gradually declines in the summer months unless irrigation and intensive management are applied.

Where the availability of pasture land is limited, new methods of pasture utilization have been studied. These methods include the feeding of soilage, silage and hay produced from these lands. But despite these efforts to utilize pasture land more efficiently, dairymen are still looking for alternative methods of feeding and managing of dairy cattle in an effort to maximize milk output from minimum inputs and on limited acreage.

At the present time, the question of overriding importance is to determine whether the age-old practice of pasturing cows in the spring and summer is equal to or better than the dry lot system in terms of dairy cattle performance. Dry lot systems of dairy cattle feeding and management have been widely adopted. It has been suggested that under this system it is possible to carefully control the type, quality, and amount of diet fed, thus influencing the level of milk production obtained. It has also been claimed that under the dry lot system of managing dairy cows, the health and breeding performance of such herds can be improved because of closer observation and handling. However, such claims need further elucidation.

Mastitis and poor reproductive performance continue to be the two leading management problems of dairymen. Therefore, research should reveal whether or not it is advantageous to keep cows in the dry lot, as opposed to pasturing, as a means of reducing the incidence of mastitis and reducing the problems associated with reproduction.

A large amount of work has been carried out to determine the influence of levels of feeding and feeding methods on milk yield and milk constituents. Of particular interest to research workers and producers is the influence of nutrients on the protein-lactose-mineral (PLM) complex of milk. Further research should make clear whether or not there are true differences in the production of these milk constituents when cows are fed and managed in the dry lot or when cows are pastured.

The primary purpose of this four-year study (1961-1964) was to determine the comparative milk yields, and the PLM, protein, and fat content of milk from cows fed grass silage and alfalfa hay in the dry lot and cows strip-grazing irrigated grass-legume pasture. A secondary purpose was to compare the incidence of mastitis, reproductive diseases and irregularities, and other diseases incidental to both management systems.

REVIEW OF LITERATURE

Nutritional Factors Influencing Milk Yield

Milk yield as an economic trait in dairy cattle is greatly influenced by feeding and management. In order to obtain maximum milk yields, adequate energy must be provided in the feedstuffs. This supply of energy is usually accomplished by supplementing succulent (pasture) and stored (hay and silage) roughages with liberal amounts of high energy concentrates. Work by Nordfeldt et al. (1964) showed that the highest milk production occurred when the roughage to concentrate ratio was 40% roughage and 60% concentrate. When only hay was used the lowest yield was found when the ratio was 70% hay and 30% concentrates. When silage was the sole roughage, the lowest yield occurred when 25% silage and 75% concentrate was fed. Stone et al. (1966) reported that changes in concentrate feeding were one of the most important factors causing changes in milk production. McCoy et al. (1966) reported that feeding high levels of concentrates to dairy cattle stimulated milk production and he attributed this phenomenon to greater energy intake. Feeding of pelleted concentrates was shown by Bishop et al. (1963) to greatly increase milk yield over that obtained with the same concentrate in meal form.

Coppock and Tyrrell (1966) observed that level of grain feeding has much bearing on forage intake and therefore milk yield. The effect of high-level grain feeding on milk production was studied by Brown et al. (1962) using three levels of grain. The ratios of concentrate to milk in their study were 1:2.5, 1:3.5, and ad libitum. Their results showed that cows fed the two higher levels of grain produced considerably more milk than expected whereas cows fed the low level of grain produced slightly less milk than expected. Murdock and Hodgson (1967) reported that feeding high levels of concentrates (1.3 lb concentrates/2.2 lb of 4% FCM produced over 20 lb) resulted in the production of significantly more 4% FCM ($P < 0.01$) than produced when the lower level of concentrate (0.6 lb) was fed.

Burt (1957) reported that management plays an important part in eliciting the full response to additional feed. Milk yields were significantly higher at the highest level of feeding in his work. Likewise, Larsen and Eskedal (1952) reported phenomenal increases in milk yield when very high levels of feeding were combined with close individual attention.

Myron and Plum (1963) studied the effect of feeding extra grain-concentrate mixtures to dairy cows. They fed the control group according to the Morrison standards. An attempt was made to feed the other group 50% more than amounts suggested by Morrison. The results indicated that on the average the group fed more concentrates produced slightly more 4% FCM than the control group. However, the difference was not significant.

At the Wisconsin Station (1961) a study of summer feeding of dairy cattle was conducted using the following management systems: strip grazing, green feeding, and stored feeding. No significant differences in milk production among the three methods were found. In a follow-up report in 1965 results were given for an experiment conducted in Central Wisconsin for seven grazing seasons (Larsen and Johannes, 1965). In this experiment utilization of alfalfa-brome-grass forage by lactating dairy cows under three systems of forage management were compared. They concluded that under well managed stored feeding, green feeding, or strip grazing systems, dairy cows averaged 40 pounds of 4% milk per day and produced as high as 70 to 80 pounds per day. No advantage could be shown for any system in terms of milk per cow per day. According to work done at South Dakota State University (Kurtz, 1962) a 15% increase in milk yield can be expected from rotational and strip grazing as compared to continuous grazing.

Feeding of corn silage with or without concentrates has been studied by several workers. Muller _et al._ (1967) found that lactating dairy cows can utilize a group fed complete ration consisting of corn silage and concentrates as efficiently as an individually fed ration. They also found that feeding concentrates separararately did not apparently stimulate greater milk production. On the other hand, work reported by Davidov (1965) and Mamaev (1964) indicated that prolonged (up to a year) corn-silage feeding resulted in less milk production as compared to control groups. In Davidov's study there was a 12.8% difference whereas in Mamaev's study the difference ranged from 10.3% to 13%. However, Saito et al. (1965) made an 18-day study whereby he fed 66-77 lbs. of corn silage to lactating cows during the experimental period. They did not find any significant change in milk yield and milk composition. Their work is supported by that of Brown et al. (1966) who studied the effect of feeding corn silage or hay as the sole roughage to lactating dairy cows. Their data strongly indicated that lactating dairy cows could be fed corn silage as the sole roughage without sacrificing milk production.

The effect of feeding dried sugar-beet pulp on the intake and production of dairy cows was studied by Castle et al. (1966). Using three rations in a 15-week winter feeding experiment they found that the mean daily milk yield increased as the amount of the beet pulp was increased in the diet. There was a decrease in silage intake as the amount of beet pulp intake increased. On physical form of the diet, Magill et al. (1967) studied the effect of feeding baled, wafered, and pelleted alfalfa hay for milk production and growth. They supplemented hay with 25% concentrates. They reported that treatment differences for all trials were nonsignificant for 4% FCM.

Protein-Lactose-Mineral (PLM) and Protein Yield and Content in Milk

Several workers have shown that quantity as well as quality and consistency of the feed have a profound effect on milk composition. It is a well established fact that lack of sufficient fiber in the diet leads to a depression of fat content and that insufficient feeding of energy will affect the PLM portion of milk. Bailey (1952d) studied variations in PLM content of milk due to winter feeding practices. He found that the PLM percentage of milk varied directly with the amount of starch equivalent (S. E.) and inversely with the dry matter (D. M.) content of the diet. Holmes (1956) found that while keeping the protein portion constant and varying the starch equivalents (59, 67, 75) of three rations there was a slight increase in yield and percentage of PLM. By feeding a ration containing 25% less S. E. than normal, Rowland (1946) lowered the PLM from 8.68 to 8.34%.

Boyd et al. (1962) using six Holstein and three Jersey cows in a 12-week experiment studied the effect of feeding on yield and percent of protein. The three rations were: no grain (hay ad libitum); normal (1 lb grain per 3.5 lb of 4% FCM) plus hay ad libitum; and high grain (unlimited grain with 5 lb of hay daily). Their results showed that cows on the normal ration consumed slightly more hay than when they were fed the ration containing no grain. Daily grain consumption averaged 34.7 lb on the high grain ration. Dry matter intake was significantly different for all three rations averaging 23, 31, 36 lb daily for the no grain, normal, and high grain rations, respectively. Average percent PLM was 8.1 for the no grain, 8.3 for normal grain and 8.3 for high grain. Percent protein averaged 3.15, 3.29 and 3.38 on the no grain, normal, and high grain rations, respectively. Percentages of PLM and protein were significantly lower on the grain free ration.

In a study by Huber et al. (1966), cows grazing medium quality blue-grass pasture were supplemented with varying levels of corn and corn silage. The group receiving all the corn and corn silage they could eat produced more PLM than those on ad libitum corn. Milk from the group receiving corn ad libitum was higher in PLM content (9.16% as compared to 8.92%) and total protein (3.45% vs. 3.31%).

Burt (1957) worked on the influence of level of feeding during lactation upon the yield and composition of milk. He compared the studies of several research workers on this subject and developed the following table:

Table 1. Response of PLM content in milk to additional feeding

Source	Estimated intake of production S.E.	Lb production S.E. per 10 lb milk	PLM (%)	Response
Djikstra (1942)	6.9	1.8	8.32	
	9.6	2.3	8.52	+0.20
Bartlett and Rowland (1944)	1.9	1.0	8.40	
	5.9	2.7	8.69	+0.29
Holmes _et al._ (1956)	5.3	2.4	8.34	
	7.2	3.0	8.40	+0.06
	9.1	3.5	8.58	+0.18
	11.5	4.2	8.60	+0.02
Holmes _et al._ (1957)	12.2	3.1	8.62	
	13.8	3.4	8.75	+0.13
	14.8	3.6	8.77	+0.02
Burt (1957a) Expt. 4	5.9	2.7	8.59	
	7.3	3.2	8.62	+0.03
	8.8	3.8	8.71	+0.09
Expt. 5	6.0	2.2	8.26	
	7.7	2.7	8.26	+0.00
	9.5	3.2	8.34	+0.08

The data in Table 1 indicates that energy intake has an influence on PLM percentage. Responses were greater at the lower levels of feeding used (+0. 20 and +0. 29) in the experiments of Dijkstra (1942) and Bartlett and Rowland (1944) respectively, than in the other studies listed.

From their experiments, survey, and review of literature Becker et al. (1965) concluded that underfeeding reduces the protein and PLM contents of milk, the effect being greater on protein. On the other hand, some studies have shown that forage quality and quantity may affect PLM percent and yield. Large intakes of grass silage have been associated with marked decreases in milk yields and in the PLM content of milk. Some other workers have observed a depression in milk fat and some increase in PLM when pasture was supplemented with beet pulp or grain. Dijkstra (1959) found that excessive feeding of silage may adversely affect the PLM content of milk. However, Smith et al. (1966) found PLM content of milk to be the least variable fraction of the components of milk.

Milk Fat

Milk fat is the single milk constituent that has received the widest and most careful attention. Because of this unabating interest in milk fat, our present dairy cattle breeds have been characterized by and associated with it. Holsteins show the lowest milk fat percentage while Jerseys give the highest milk fat test. These breed differences are largely genetic while differences within breeds are partially due to genetic causes and to the fluctuating circumstances of the environment. One of the most important environmental factors is feeding. Much of the work done in this area has centered upon the effect of quantity, quality, and type of feed on milk fat yield and milk fat percent.

Milk fat is the most variable milk constituent. This fact is supported by the work of Wilcox and Krienke (1964) who measured the variability through estimates of repeatability. Repeatability estimates for fat, from day to day, ranged from 0.46 to 0.62 as a result of data analysis from 2,052 milk samples taken from randomly selected Jerseys, Holsteins, and Guernseys during six consecutive days. For a longer study, Smith et al. (1966) worked out the standard deviations for each month of lactation. Their results indicated that fat is the most variable constituent of milk, ranging from ±0.27 to 0.61 for Holsteins and ±0.51 to 1.25 for Jerseys. The Guernseys were intermediate with ±0.35 to 1.07.

Several workers have shown that milk fat percent will fluctuate with amount, quality and sometimes type of feed given to lactating cows. Work by Myron and Plum (1963) indicated that by feeding 50% more grain to an experimental group of cows over the control group, which was fed according to Morrison's standards, the fat percentage dropped from 3.75 to 3.63%. Other research workers have reported results in support of this. Beitz and Davis (1964) reported that high grain rations did not significantly alter milk production when compared to a control diet but these rations did significantly lower the milk fat percentage of the milk produced. Work by Van Soest and Allen (1959) indicated that the feeding of restricted roughage with high levels of concentrates produced significant declines in milk fat percent in lactating cows and goats. Effect of high level feeding of corn as compared to silage has been studied by Huber et al. (1964). By feeding large amounts of corn to a group of lactating cows, these workers were able to depress the milk fat percent to as low as 2.53%. Feeding silage alone, however, resulted in a milk fat test of 3.59%.

Quality of feed as a factor influencing milk fat yield and milk fat percent has been studied by several workers. Extensive studies on this subject have been carried out by Yandagni et al. (1967) using concentrate mixtures of varying starch contents. The diets used contained several levels of corn starch. A level of 36% corn starch in the concentrate, equivalent to 34% corn in the feed depressed milk fat yield and percent. A level of 33.5% starch from other feeds but only 15% corn starch maintained the milk fat percent. Here it seems that both the quantity and source of starch in the diet were important factors in influencing the fat percent of milk. However, not all feed ingredients affect milk fat in the same way. Crude protein percentages of the diet do not seem to affect milk fat very much. Using three rations containing crude protein percentages of 13.3, 18.6, and 20.3 respectively, Holmes et al. (1956) found that the milk fat yield and percentages of milk fat remained identical for the three rations.

A number of research workers have been interested in the effect of type or physical form of feed on milk yield and milk fat. O'Dell et al. (1964) studied the effect of feeding pelleted coastal Bermuda grass hay on milk and milk fat production. They also investigated the frequency of feeding of this diet. They fed pelleted hay two times or four times daily, which was supplemented with baled hay or corn silage. When pellets were fed two times daily as the only forage, a milk fat percent depression was observed in each of the three trials. In one of the trials, while all the cows were fed pelleted hay two times daily, milk production was maintained at 107.2% of expectancy and milk fat percent was depressed by 0.3%.

Jones et al. (1958) studied the effect of feeding baled, wafered, or pelleted hay on milk yield and composition. They observed that milk fat percent from the cows fed pelleted alfalfa was lower than when they received the same hay from the bale or in wafer form. They also reported a significant ($P < 0.05$) difference in milk fat percent. Ronning and Dobie (1962) compared wafered with baled alfalfa hay as feeds for milk production. They found that cows on wafered hay produced, on the average, 1.8 lb more 4% FCM daily per cow but failed to observe any significant effect upon percentages of milk fat. On the other hand, Bishop _et al._ (1963) studied the effect of feeding pelleted hay on milk production and composition. A significant ($P < 0.05$) decrease in milk fat percentage associated with low-roughage high-concentrate rations was observed when compared with the high-roughage low-concentrate rations.

Other Factors Affecting Milk Yields and Composition

Apart from feeding and management, there are other factors which influence the observable variation in milk yield and milk constituents. These can be partitioned into two main influencing factors:

(1) inheritance and

(2) non-genetic influences.

Inheritance

Much of the noticeable differences in average production between the different dairy cattle breeds are due to inheritance. Differences within a breed as determined by production criteria are influenced both by environment and heredity. Individuals within breeds have many genes in common but different genotypes and environments. Therefore, cows of the same breed are more alike genetically than is the case when comparing individual cows between breeds.

Several workers have reported on the variation that exists in production between cows due to breed differences. Smith et al. (1966) have studied the composition of cow's milk and have shown the relative percentages of milk constituents. Their results show that the percentages of PLM for dairy breeds are in the decreasing order: Jersey (9.47%), Guernsey (9.19%), Ayrshire (8.93%), and Holstein (8.60%). Percentages of protein and fat were found to be 3.88, 3.63, 3.42, 3.18, and 5.36, 5.20, 4.09 and 3.75 for the Jersey, Guernsey, Ayrshire, and Holstein breeds, respectively. The high milk producing breeds, in the reverse order above, produce more total pounds of these components. However, irrespective of breed, a high positive correlation has been found to exist between milk fat percent and PLM percent and a negative correlation between milk fat and PLM percent with milk yield. Other workers who have observed this include Hancock (1953), Johansson and and Claesson (1957). Lee et al. (1961) observed that breed differences accounted for 11% of the variation in milk production, 7.4% of the variation in 4% FCM production, but only 3.7% of the variation in fat yield.

Milk fat percent has been described in the literature as a highly heritable trait whereas milk yield and milk fat yield are moderately heritable. The most recent work in this area has been done by Quartermain and Freeman (1967) who estimated the maximum heritability parameters with regards to dairy cattle breeding.

Their maximized heritability estimates were 0.366, 0.376 and 0.566 for milk yield, milk fat yield, and milk fat percent, respectively.

The magnitude of the estimated heritability depends on whether the herd is high yielding or low yielding. Research results indicate that genetic factors have a marked influence on milk yield, milk fat yield, and percent of milk components. Mason and Robertson (1956) estimated the heritability of milk yield and milk fat percent in low, medium, and high producing herds. They reported that for the low, medium, and high yielding herds, the heritabilities estimated for milk yield and milk fat percent were 0.05, 0.15, 0.22 and 0.27, 0.47, and 0.49, respectively.

Non-Genetic Influences

The non-genetic factors influencing milk yield and milk composition include: nutritional factors, age of cow, stage of lactation, season, mastitis, hormonal activity of different roughages, and reproductive irregularities. Since the nutritional factors affecting milk yield and milk composition have been discussed earlier, the factors other than nutritional will be dealt with here.

Age

Sargent *et al.* (1967) studied the effect of age at freshening on milk yield and milk constituents. They found that age at freshening accounted for 21.7%, 14.3%, 5.3% and 1.9% of the variance in milk yield, PLM, protein, and milk fat, respectively. On a within-herd-year-season-sire basis, the number of days prior to conception accounted for 6.8 and 0.4% of the variance in milk yield and PLM percent. No significant influence on fat or protein percent was evident. Work reported by Bailey (1952a) indicated that the coefficients of variation of lactation milk yield was 25% for all age groups. Variation for milk fat was approximately 10% and that for lactation PLM only 3%. Fat and PLM percentages were found to increase with the age of the cow. Lactation milk yield was least with first calf heifers and rose to a maximum for cows in the sixth lactation.

Stage of Lactation

Studies on the stage of lactation by Bailey (1952b) indicated that PLM percent increases with increasing stage in lactation--first calvers showing the lowest PLM test and the older cows showing the highest PLM test. The PLM test was found to be highest in the tenth month of lactation. Thus the PLM yield is highest during the first quarter of lactation and lowest towards the end of lactation. The opposite is true as to percentages of PLM. Waite and White (1956) found that milk yield was highest 45 days post partum. Fat and PLM contents fell rapidly for 45 days, with fat and total solids continuing to fall for an additional 30 days.

Spike and Freeman (1967) studied the environmental influences on monthly variation in milk constituents. The studies were aimed at estimating effects of age of cow, stage of lactation, month of year and the two-factor interactions of age with stage and month with stage on milk and its constituents. Interactions associated with these factors are reported to be large. Each of the interactions gave a highly significant ($P < 0.001$) F-ratio for all traits. However, the interaction of month and stage of lactation accounted for a very small portion of the total variance.

Season

The effect of season on milk yield and composition has been investigated by several workers. Rook (1959) observed that there was an increase in PLM when cows were changed from winter feed to spring pasture. If cows were well fed during the winter, the percentage of PLM in milk was not affected by spring pasture. Dijkstra (1959) found monthly variations in the PLM content of cow's milk. Von Krosigk *et al*. (1960) found that correlations among fat and PLM were all positive and large for herd-within-breeds and for months (season). Month of freshening has also been found to affect milk yield and milk composition. Sargent *et al*. (1967) observed that differences between months of freshening were significant for milk yield, PLM and protein percent but not significant for fat percent. Cows freshening in November through April had the highest milk yield, whereas cows freshening from May through October had the highest average percentage for these milk constituents.

Mastitis

Mastitis is a complex disease problem. Its complexity arises from its many predisposing causes which may vary from season to season, farm to farm, and from cow to cow. Mastitis, apart from reducing milk yield in dairy cattle, shortens the productive life of affected cows. There are, however, many known predisposing factors responsible for the precipitation of a mastitic condition in the udder. For the purpose of this study, feeding and management in relation to mastitis will be discussed.

Recent studies on the effect of mastitis on milk components by Ashworth et al. (1967) have shown that apart from the infected quarters, milk from the opposite quarters showed a decrease in total solids. They reported that the composition of milk from the opposite quarters showed highly significant decreases in total solids, fat, non-fat solids (PLM) due to subclinical mastitis as measured by the California Mastitis Test (CMT). The average decreases amounted to 0.45%, 0.57% for fat and PLM, respectively.

It has been speculated that the method of feeding dry lot as opposed to pasturing may account for the incidence, frequency, and severity of mastitis. There are two schools of thought concerning this observation:

(a) Because of the apparent unsanitary conditions of some dry lots, it has been assumed that mastitis is more frequent in cows on dry-lots than in cows on pastures.

(b) Since substances of estrogenic activity have been isolated from pasture plants, it has been speculated that pasturing cows may enhance the occurrence and in fact, increase the frequency of mastitis.

Work done along these lines has shown conflicting results. Beginning in early May and continuing into the middle of September, Pounden _et al._ (1958) used 15 cows in each of three comparable groups. One group was fed a forage mixture of freshly-cut legumes and grass, the second group was fed silage made the previous year from a similar crop grown on the same fields. The third group were alternately fed fresh-cut forage and silage. They observed that in the first group 40% had attacks of mastitis, 20% in the second group, and 60% in the third group. Pounden _et al._ (1960) observed that 24 attacks of mastitis occurred in five of a group of 15 cows fed legume grass soilage during a four-month summer period in 1958 as opposed to seven attacks in two (13%) of the 15 cows fed similar forage as silage. In a comparable period the following year, the percentage was 42. All the cows were fed similar forage as soilage. Bailey (1952c) observed that when cows are on lush pasture, there is always a high level of PLM in the milk. He held that pasture estrogens are responsible for this observation.

Moore et al. (1942) used 20 lactating cows fed grain at the rate of one lb for each 3.5 lb of milk. All animals were fed legume hay and corn silage, and were managed as a single herd. After two years, they found no significant difference in the incidence or severity of mastitis between the group receiving the heavy corn ration and the group fed a normal ration.

Forage Estrogens

Interest in forage estrogens, according to Bickoff et al. (1960) has been aroused in recent years because of their role in causing infertility in sheep that are grazing such pastures and the discovery that large quantities of estrogens administered to lactating cows can cause changes in milk production and composition. Observations by Turner (1958) indicated that milk is essentially free of estrogens even during periods of highest estrogen secretion and low milk secretion at the beginning and end of lactation. These observations indicated impermeability of mammary glands to estrogenic substances.

Bartlett _et al._ (1948) asserted that it is widely recognized that on "going out to grass," cows often show an increase in milk yield, greater than the amount ascribable to the extra nutrients ingested. They concluded that this might be due to the presence in young, rapidly growing grasses of a galactopoietic factor, for example, a hormone or vitamin. Norma and Pounden (1961) studied the effect of diethylstilbestrol and progesterone on the growth of four mastitis-producing bacteria. They postulated that freshly cut legume-grass forage may stimulate an increase in the occurrence of mastitis in dairy cows. A possible explanation given was that the plant estrogenic substances could be involved because these materials have been found to be present in various quantities in such forages.

Reproduction

Johnson _et al._ (1966) studied the relationship between follicular cysts and milk production in dairy cattle. Their study involved 90- and 305 day 2X (M.E.) milk production records that were adjusted for days open of 74 animals with follicular cysts. They observed that cystic cows produced significantly more than their herd mates for 90 ($P < 0.001$) and 305 ($P < 0.01$) days, respectively. No significant differences in production were noted when cystic animals were compared with their herd-mates during their pre-cystic lactation. This indicated that the cystic cows were not higher producers before they became cystic, but that circumstances associated with the cystic condition appear to be responsible for increased production. It was found that the longer animals were cystic, the higher was their milk production and that the anestrus cystic animals had higher milk production than those with nymphomanial tendencies. Work by Henricson (1957) supports this view.

Boyd et al. (1954) studied the relationship between level of milk production and breeding efficiency in dairy cattle. Analysis of data on 519 cows (Jerseys, Holsteins and Guernseys) showed that the correlation coefficient between milk production and number of services per conception was -0.04. When each of the 29 herds was calculated separately, the range in the intra-herd correlation between milk production and breeding efficiency was from -0.52 to 0.79 indicating an erratic relationship. Touchberry et al. (1959) studied the associations between service interval, interval from first-service to conception, number of services per conception, and level of butterfat production. Their results, however, indicated that there was no real biological relationship between services per conception and level of butterfat production. Legates (1954) studied the genetic variability of services per conception as a measure of reproductive efficiency. He reported that the mean number of services per conception was 1.80 with an estimated heritability of 0.026.

METHODS AND MATERIALS

Selection and Pairing of Cows

A total of 98 cows were used in this four-year study. They consisted of registered Holsteins and registered Jerseys selected from the Oregon State University milking herd. Twelve, 13, 11, and 13 pairs of cows were used in experimental period I (1961), Period II (1962), Period III (1963), and Period IV (1964), respectively. The details on the experimental animals as to number, breed, and age are given in Table 2.

The cows were divided evenly into two groups: One of each pair was allotted randomly to the dry-lot group and the other to the pasture group. The animals were divided and paired according to breed, age, current milk production, previous lactation yields, days fresh, days in gestation, and udder health. The cows were paired on the basis of these production and reproductive criteria in order to minimize the variation within each pair. Thus the differences observed in production would be due largely to the treatments accorded the experimental groups.

Management of Cows

The irrigated legume-grass pasture consisted of good quality Ladino clover and a mixture of orchard and English ryegrass. The

Table 2. Description of experimental animals and periods.

Period and no. of days	Number of animals: Dry Lot (DL)	Number of animals: Pasture (P)	Breed: Jerseys DL	Breed: Jerseys P	Breed: Holsteins DL	Breed: Holsteins P	Average age in months: Jerseys DL	Average age in months: Jerseys P	Average age in months: Holsteins DL	Average age in months: Holsteins P
I (84)	12	12	3	3	9	9	31.3	30.0	43.1	46.5
II (150)	13	13	6	6	7	7	44.8	40.8	47.7	43.6
III (150)	11	11	3	3	8	8	46.0	50.0	66.3	66.3
IV (68)	13	13	5	5	8	8	64.2	57.8	63.3	56.5
TOTAL AND AVERAGES	49	49	17	17	32	32	46.4	45.5	54.9	53.3

pasture was divided into four areas that were fenced to allow for strip-grazing. An electric fence was used so that the cows could be rotated through these areas. In order to ensure that the animals grazed a new section of the pasture each day, they were moved to a new strip every 24 hours. Each time the cows were moved to a new pasture area, the section previously grazed was clipped and irrigated. This practice was valuable in two ways: (1) it helped in controlling weed growth and (2) it assured a palatable and uniform growth of forage for the following round of grazing. The cows on the pasture, like those in the dry lot, were brought in for milking twice a day.

During the four yearly experimental periods the cows in the dry lot group were allowed access to the loafing barn and allowed free access to the feeding area in the main barn. All the animals were managed in a group, that is, no individual feeding was done. The concrete floors of the loafing barn and the main barn were scraped once a day to remove manure. The cows sought shade during the day in the loafing barn.

The roughage was group-fed to cows in the dry-lot. During experimental Period I, II, and III, enough grass-silage was fed twice a day, in the morning and afternoon to allow weigh-backs (refused portion of the feed). All silage fed was recorded for each feeding and daily refused feed was recorded. Alfalfa hay was weighed and group-fed in feeding bunks twice daily to cows during experimental Period I, II, and III. Refusals were weighed in order to determine feed intakes for the dry lot group. During experimental Period IV, haylage was the only roughage fed. Enough haylage was fed three times a day to allow for a weigh-back of 25 to 50 pounds per day.

Grain was fed twice a day at milking time to all cows in both treatment groups. A pelleted 14% crude protein grain concentrate was fed during Period I, II, and III. During Period IV a pelleted 16% protein grain concentrate was fed. In Period I the grain was fed at the rate of 1 lb of grain for each 4 and 5 lb of 4% FCM produced by the cows in the dry lot and pasture, respectively. The grain to 4% FCM ratio ranged from 1:3 to 1:4 during experimental Periods II and III. The amount of grain fed was adjusted once every two weeks, according to the average yield of 4% FCM during the preceding seven days. During experimental Period IV the ratios were 1:2.5 and 1:3.0 for the Jerseys and Holsteins respectively, for both experimental groups. Chemical analyses for roughages and concentrates were not determined. All cows were milked in an elevated parlor.

Collection and Treatment of Data

Daily milk weights were measured by Milk-O-Meters and were recorded at each milking. Milk samples for analysis of fat, PLM and protein were obtained during a 24-hour milking period each month, except during perior IV. No PLM and protein data were available for period I. During period IV, milk yields were recorded and determinations of fat, PLM and protein content were made at weekly intervals.

Percentages for milk fat, PLM and protein were taken from the Dairy Herd Improvement Registry (DHIR) records for the herd. Total milk was also taken from the DHIR records and, using Gaines (1928) formula, 4% Fat-Corrected-Milk (FCM) was calculated. This method converts milk of any test to a standard FCM which permits comparisons on a common energy basis per unit of milk. Protein content was determined by the Formol titration method using a 17.6 ml milk pipette instead of the 10.0 ml, the conversion factor being 1.02 (Richardson, 1953).

Data on herd health was collected by the O. S. U. veterinarian assigned to the University dairy herd. The disease of utmost importance and interest in these studies was mastitis. The study was intended to reveal information on mastitis as to the incidence and seasonal trends with respect to cows on irrigated grass-legume pasture and cows in the dry lot. The cows were checked for mastitis by the California Mastitis Test (CMT) at the start of each trial and at monthly intervals. The test was made from samples of the first milk drawn from each quarter milked directly into one compartment of a small paddle. An equal volume of CMT reagent was added to all the compartments and mixed by rotating the paddle. The degree of the reaction indicated the extent of udder irritation and possible mastitis in the various quarters.

Each compartment in the paddle corresponded to one quarter of the udder (rear right, RR; rear left, RL; right front, RF; or left front, LF). The degree of reaction of the milk samples to CMT of the positive quarters was indicated by assigning numbers to the degree of agglutination observed:

N = indicated normal or negative (milk and reagent mixture remained liquid and no gelling was observed).

Trace = indicated very small amount of gelling

1 = indicated definite gelling

2 = indicated slight jelly-like coagulation

3 = indicated jelly-like mixture that stuck together

4 = indicated very thick jelly-like mixture.

These values were entered for each quarter.

Incidences of all other diseases were recorded. From the description and diagnosis of the cases, the diseases were classified as to whether they were digestive diseases (for example, bloat), metabolic diseases (grass tetany, parturient paresis, Bovine ketosis), diseases due to injuries as a result of external trauma, reproductive irregularities (cystic and anestrus conditions), diseases of the hoof (pododermatitis) and others. Data were also collected on the number of A. I. services for each experimental year.

Data on the number of days the cows were in milk prior to the date of commencement of each trial were collected for each period. Total milk and fat production during the same period was also collected. Total milk and fat production amounts obtained were used to porject each cow's production to a 305 day lactation. Two types of conversion factors were used: factors to convert incomplete production records for milk and milk fat to 305 day, 2X records and factors to convert the projected 305 day, 2X records to M. E. records. In the first place, the DHIA projection factors for incomplete records corrected for stage in lactation and in the second place M. E. factors corrected for age. This facilitated the comparison of production performance of cows in different stages of lactation and of different ages. In case of DHIA 305 day projection factors for milk and fat only three considerations were made: days in milk, breed and age in months (whether less or more than 36 months old). On the other hand, with DHIA age adjustment factors for standardizing lactations to a mature basis, four considerations were made. These were:

age (in years and months), breed, region (Western region of United States) and season of calving. Factors were available for two seasons of calving: November to June and July to October. No conversion factors are yet available for PLM and protein.

Actual data on complete lactations (305 day, 2X) were collected for milk, fat, PLM, and protein production. Production records during the experimental periods II, III, and IV were collected for milk, fat, PLM, and protein production. The milk records were converted to 4% FCM. For experimental period I, data for milk and fat only were collected. Due to incorrect procedures in analysis for protein, data collected for protein content in experimental period I were excluded from this study.

In order to insure an accurate intra-pair and inter-group comparison, the milk records during the experimental periods were converted to a common energy basis by the use of Gaines formula which is:

4% FCM = 0.4X total milk + 15X total fat, where

FCM = Fat-Corrected-Milk.

Data on herd health were used to calculate the CMT indexes for mastitis. The CMT indexes were determined by dividing the total number of scores of all quarters by the total number of observations (n) made on each individual cow for the whole experimental period. Table 3 shows how this was done.

Table 3. Calculation of CMT index.

	Udder quarter					
	RR	RF	LR	LF	Total score	CMT index
Score	a	b	c	d	a + b + c + d	$\frac{a + b + c + d}{n}$

Information on other diseases was compiled in tables for the purpose of comparing differences between treatment groups.

There are, however, two omissions in this study: (1) the economics of the two management systems and (2) information on individual feed intake. Costs and returns for dairy herds depend much on the prevailing prices of inputs and farm products. Therefore, it would be of great value to investigate the comparable economic returns from the two management systems. In an effort to offset the deficiencies due to lack of data on individual feed intake, average feed intakes were calculated for the dry lot (silage, haylage, hay, and concentrates) and pasture cows (concentrates only).

Analysis of Data

The student's t-test (Snedecor, 1962) was used on all paired production data investigated in this study in order to determine differences between the mean performance of cows in the dry lot compared with those pastured. The 5% level of probability was chosen.

The test statistic used was:

$$t = \frac{\bar{d}}{s_{\bar{d}}}$$

where $\bar{d} = \sum_{i=1}^{n} d_i/n$ from $d_i = (x_{1i} - x_{2i})$,

x_{1i} = performance of cows in the dry lot,

x_{2i} = performance of cows on irrigated pasture,

n = number of pairs in the experiment,

$$s_{\bar{d}} = \sqrt{\sum_{i=1}^{n} (d_i - \bar{d})^2 / n}$$

The null hypothesis was that there was no difference between the mean performance of cows in the dry lot and their corresponding pair-mates on irrigated pasture. On the other hand, the alternative hypothesis was that the mean performances between the two groups were different.

RESULTS AND DISCUSSION

General Considerations

Age of cow at calving was shown to affect milk yield and milk constituents by Sargent et al. (1967) and Bailey (1952a). Because of these observations, an analysis was carried out to determine whether there was a difference between the age of cows used in the two treatment groups. From Table 4, it can be observed that there was a significant difference in age of cows used during experimental period II. There was no significant difference in age between cows in the dry lot and on pasture for experimental periods I, III, and IV.

Data on number of days the cows were in milk prior to the trials were analyzed to detect differences in stage of lactation. The mean number of days in milk prior to the initiation of each experiment is given in Table 5. Data presented in Table 5 indicate that, on the average, the cows on pasture during experimental periods I and IV were in milk longer by a little over six days than cows in the dry lot. The mean differences, however, were not statistically significant. On the other hand, during experimental periods II and III the cows in the dry lot groups were in milk longer prior to the experiments than cows in the pasture groups. The mean difference in days in milk were statistically significant for experimental period III.

Table 4. Mean age at calving for cows used in experimental periods I to IV.

Experimental period	Age in months		Mean difference
	Dry lot	Pasture	
I	40.17	42.42	-2.25
II	46.38	42.38	4.00*
III	60.73	61.82	-1.09
IV	63.61	57.00	6.61

* Statistically significant at 5% level of probability.

Table 5. Mean number of days in milk prior to the experiment.

Experimental period	Stage in lactation in days		Mean difference
	Dry lot	Pasture	
I	154.25	160.42	-6.17
II	98.69	91.15	7.54
III	126.00	111.73	14.27*
IV	146.85	153.00	-6.15

* Statistically significant at 5% level of probability.

Milk Production

Mean projected incomplete and age-adjusted (M. E.) milk records for the cows in the dry lot and on pasture were analyzed to determine whether there was a difference in the two treatment groups. Mean differences in milk production at this stage would indicate the productive capacity of each experimental group. There was no significant difference in mean performance of the two treatment groups for the projected records. No significant differences were noted in age adjusted milk records for periods I, II, and IV. However, the difference in mean milk production for the age adjusted records was statistically significant for period III. Data presented in Table 6 indicates that the dry lot groups in periods I and III out-produced the pasture groups, but this difference was not statistically significant for period I. A significant difference in age-adjusted records of the two treatment groups during period III corresponds with the significant difference noted during the same period for the mean number of days in milk prior to the trial. This obviously indicates a bias in pairing of cows at the beginning of the trial.

When actual and projected milk records were subjected to statistical comparison, no significant differences were observed between the two treatment groups for all years. The mean actual milk production was 12, 259 lb compared to 12, 327 lb for the mean

Table 6. Mean projected and age adjusted (M. E.) milk records (305 days, 2X).

Experimental period and year	Mean projected milk records in lb		Mean difference	Mean adjusted (M. E.) milk records in lb		Mean difference
	Dry lot	Pasture		Dry lot	Pasture	
I (1961)	10, 947	10, 833	114	12, 172	11, 476	696
II (1962)	11, 978	11, 728	250	13, 344	13, 883	-539
III (1963)	13, 704	13, 008	696	14, 130	13, 020	1110*
IV (1964)	13, 420	13, 093	327	14, 717	15, 071	-354

* Statistically significant at 5% level of probability.

Table 7. Mean unadjusted complete lactation milk records (305 day, 2X).

Experimental period and year	Mean lactation milk yields in lb		Mean difference
	Dry lot	Pasture	
I (1961)	11, 179	11, 169	10
II (1962)	13, 353	13, 989	-636
III (1963)	13, 693	12, 787	906*
IV (1964)	14, 753	14, 437	316

* Statistically significant at 5% level of probability.

projected milk yield, a mean difference of only 68 lb. These results clearly indicate that one can predict accurately the 305 day, 2X lactation yields by using DHIA factors for projecting incomplete records (McDaniel et al. (1965).

The mean unadjusted, complete milk records are presented in Table 7. A significant difference was noted between the complete lactation milk yields for the two treatment groups during period III. The dry lot group, however, produced more milk during experimental periods I, III, and IV, but these differences were not statistically significant during periods I and IV.

The mean milk yield (4% FCM) data did not reveal any significant differences for the four periods. The pasture groups out-produced the dry lot groups during periods II, III, and IV. During period I, the dry lot group outproduced the pasture group (Table 8) and the mean difference was greater than that observed in periods II, III, and IV.

Table 8. Mean milk yields (4% FCM).

Experimental period and no. of days	Mean milk yields (4% FCM) in lb		Mean difference
	Dry lot	Pasture	
I (84)	2747	2383	364
II (150)	5736	6018	-282
III (150)	4847	5076	-229
IV (68)	2758	2803	-45

Cows on pasture during experimental periods II, III, and IV consumed more concentrates (10.36, 10.31, and 15.88 lb, respectively) per day than cows in the dry lot group (9.90, 9.86, and 15.13, respectively) (Table 22). From the same table, it can be seen that during experimental period I the cows in the dry lot group consumed more concentrates (8.17 lb) than those on pasture (5.67 lb). The trend was such that greater daily concentrate consumption resulted in greater milk production. The observed trends agree with the results of McCoy (1966), Brown et al. (1962) and Murdock and Hodgson (1967). It must be pointed out, however, that the mean differences in production were quite small and did not differ significantly from zero.

Protein-Lactose-Mineral (PLM) and Protein

Looking at Tables 9 through 12, it can be noted that there were no significant differences ($P < 0.05$) in the production of either PLM or protein.

Milk Fat Production

Mean projected and age adjusted (M. E.) fat records and mean unadjusted complete lactation fat records (305 day, 2X) are presented in Tables 13 and 14. No significant differences were noted in mean projected, age adjusted, or mean unadjusted complete fat records.

Table 9. Mean unadjusted complete lactation PLM yields (305 day, 2X).

Experimental period and year	Mean PLM yields in lb		Mean difference
	Dry lot	Pasture	
II (1962)	1059	1074	-15
III (1963)	1131	1068	63
IV (1964)	1227	1207	-20

Table 10. Mean PLM yields.

Experimental period and no. days	Mean PLM yields in lb		Mean difference
	Dry lot	Pasture	
II (150)	481	514	-33
III (150)	489	466	-17
IV (68)	233	246	-13

Table 11. Mean unadjusted complete lactation protein yields (305 day, 2X).

Experimental period and year	Mean complete lactation protein yields in lb		Mean difference
	Dry lot	Pasture	
II (1962)	409	417	-8
III (1963)	394	373	21
IV (1964)	471	470	1

Table 12. Mean protein yields.

Experimental period and no. days	Mean protein yields in lb		Mean difference
	Dry lot	Pasture	
II (150)	195	207	-12
III (150)	162	167	-5
IV (68)	92	93	-1

Table 13. Mean projected and age adjusted (M. E.) milk fat records (305 day, 2X).

Experimental period and year		Mean projected fat records in lb		Mean difference	Mean adjusted (M. E.) fat records in lb		Mean difference
		Dry lot	Pasture		Dry lot	Pasture	
I	(1961)	449	443	6	486	468	18
II	(1962)	519	503	16	570	588	-18
III	(1963)	545	534	11	559	524	35
IV	(1964)	570	542	28	615	606	9

Table 14. Mean unadjusted complete milk fat records (305 day, 2X).

Experimental period and year		Mean lactation fat yields in lb		Mean difference
		Dry lot	Pasture	
I	(1961)	425	417	8
II	(1962)	518	525	-7
III	(1963)	529	507	22
IV	(1964)	587	569	18

The mean differences were so small (Table 9, 10) that they were almost negligible. The differences between mean projected, age adjusted (M. E.) records and mean complete lactation fat records were almost negligible. This further emphasized the fact that the paired cows in the two treatment groups were of similar producing abilities and, therefore, there was no bias in the pairing on the basis of milk. When actual and projected milk fat records were subjected to statistical comparison, no significant differences were observed between the two treatment groups for all years. The mean actual milk fat production was 511 lb. as compared to 513 lb. for the mean projected milk fat yields, a difference of only 2 lb.

It should be noted from Table 15 that there was a significant difference ($P < 0.05$) between the mean milk fat yields during experimental period III in favor of the pasture group.

Table 15. Mean milk fat yields.

Experimental period and no. days	Mean fat yields in lb		Mean difference
	Dry lot	Pasture	
I (84)	119	109	10
II (150)	234	249	-15
III (150)	183	197	-14*
IV (68)	111	110	1

* Statistically significant at 5% level of probability.

During the same experimental period, the pasture group consumed more concentrates per day (0.45 lb) than the dry lot group. This, however, would not explain why the pasture group produced more milk fat since in other cases where one group consumed more concentrates than the other the differences in performance were not statistically significant (Table 15 and Table 22). The highest amount of concentrates was fed in period IV at a rate of 1:2.5 to the Jerseys and 1:3.0 to the Holsteins. Concentrate consumption was highest during this period at an average rate of 15.13 lb and 15.88 lb per cow per day for the cows in the dry lot and on pasture. But there was no significant difference in milk fat production. There were five Jerseys and eight Holsteins in each group during experimental period IV. There is a possibility that the Jerseys had a lower productive response to high grain feeding (1:2.5) than the Holsteins (1:3.0).

Herd Health

Mastitis

The CMT indexes were higher for the dry lot groups during periods II and IV than for the pasture groups. However, the CMT indexes were higher for the pasture groups during periods I and III than for the dry lot groups (Table 16). However, no significant differences were noted between the two treatment groups for all experimental periods ($P < 0.05$).

Table 16. Mean California Mastitis Test (CMT) Indexes.

Experimental period and no. of days	CMT Indexes		Mean difference
	Dry lot	Pasture	
I (84)	0.665	0.821	-0.156
II (150)	0.599	0.507	0.092
III (150)	0.544	0.676	-0.132
IV (68)	0.897	0.609	0.288

Results obtained in this study did not support those of Pounden et al. (1958, 1960), who found that feeding of legume-grass soilage, silage or legume hay and concentrates led to the development of chronic mastitis.

Other Diseases

There was no discernible pattern of occurrence of diseases with regards to the treatment groups. Data presented in Table 17 indicate that the occurrence of various diseases was very erratic. One would suspect that cases of hardware disease would be frequent in cows in the dry lot. This would be a logical assumption, since there are more chances for cows in the dry lot to ingest baling wire and other extraneous matter in the hay and silage than is the case with the cows on pasture. Only one case of hardware disease was observed in the dry lot group during experimental period I.

Three cases of foot rot (pododermatitis) were observed during the four-year study, twice in cows on pasture during experimental periods II and IV and once in the dry lot cows during period IV. Diseases of an inflammatory nature were reported twice. Swelling of the udder occurred in one cow in the dry lot group (Period II) and swelling of the left mandible occurred in one cow in the pasture group (Period III). Low production in one cow suggested chronic illness in that animal (period II) and this occurred in the same cow in the same treatment group during period III. A case of an injured teat and stiffness were reported in two cows on pasture (period II). In the final analysis, five cases of diseases were reported in cows in the dry lot group and five cases in cows on pasture. On further breakdown of cases of diseases: five cases were reported during period II, two in each of periods III and IV and one in period I.

Table 17. Frequency of diseases other than mastitis.

Experimental period and no. of days	Cow no.	Treatment group	Diagnosis of the disease
I (84)	408	DL	Hardware disease
II (150)	367	DL	Swelling of mammary gland
	420	DL	Suspected illness: down in production
	649	P	Injured teat
	718	P	Appeared stiff
	720	P	Pododermatitis (foot rot)
III (150)	420	DL	Suspected illness: down in production
	430	P	Swelling of left mandible
IV (68)	405	DL	Pododermatitis (foot rot)
	713	P	Pododermatitis (foot rot)

Breeding Performance

The duration of the four experimental periods were not long enough to make a critical analysis of reproductive diseases and irregularities. Breeding data, for example days to conception, length of calving interval, length of gestation, could not be collected in a span of 68 to 150 days. However, data were analyzed for the number of services per conception and are presented in Table 18. A statistically significant difference ($P < 0.05$) was noted during period II between the dry lot and the pasture group and this was in favor of the latter group. Studies have been made on the relationship between level of milk production and breeding efficiency in dairy cattle (Boyd *et al.*, 1954). These workers reported a low correlation coefficient between milk production and number of services per conception of -0.04. Results of this study seem to support these findings.

Table 18. Mean number of A. I. services.

Experimental period and no. of days	Mean A. I. services		Mean difference
	Dry lot	Pasture	
I (84)	2.16	2.58	-0.42
II (150)	2.15	1.62	0.53*
III (150)	1.36	1.54	-0.18
IV (68)	2.07	1.38	0.69

* Statistically significant at 5% level of probability.

It is interesting to note that the mean milk (4% FCM) yields were highest for both groups in period II, the period in which a statistically significant difference was found for the number of services per conception. However, no deductions can be made from these observations since the dry lot group showed a greater mean number of services per conception, whereas the pasture group produced more milk during the same period.

Records on breeding efficiency of the cows in the two treatment groups indicated no observable differences between the two groups. Data in connection with reproductive irregularities are presented in Table 19. No valid conclusions can be drawn from data of this nature. One could, however, observe that there were no apparent differences between the two treatment groups.

Table 19. Observations on reproductive disorders.

Experimental period	Cow no.	Treatment group	Diagnosis of reproductive irregularity
II	715	DL	Anestrus
	429	DL	Cystic ovary
	395	P	Anestrus
IV	H-87	P	Anestrus
	629	P	Anestrus

Mean Daily Performance

Table 20. Mean daily performance of cows in dry lot and on irrigated pasture.

		Dry lot group					Pasture group				
Period	Days	No. of cows	Milk 4% FCM (lb)	Milk Fat (lb)	PLM (lb)	Protein (lb)	No. of cows	Milk 4% FCM (lb)	Milk Fat (lb)	PLM (lb)	Protein (lb)
I	84	12	32.70	1.18	--	--	12	28.36	1.08	--	--
II	150	13	38.24	1.56	3.21	1.30	13	40.12	1.66	3.42	1.38
III	150	11	32.31	1.22*	2.99	1.08	11	33.84	1.31*	3.10	1.11
IV	68	13	40.55	1.63	3.43	1.35	13	41.23	1.62	3.62	1.36

* Significant statistically at the 5% level of probability.

Table 20 shows the mean daily performance of cows during the four experimental periods for the two treatment groups. A most interesting observation (Tables 20 and 22) is that mean daily PLM yield increased as daily concentrate consumption increased for all years. For the dry lot group (Periods II through IV) mean daily concentrate consumption was 9.90, 9.86, and 15.13 lb, respectively (Table 22), as compared with a mean daily PLM yield of 3.21, 2.99 and 3.43 lb, respectively (Table 20). The comparable results for the pasture group were: mean daily concentrate consumption 10.36, 10.31 and 15.88 lb, respectively (Table 22) as compared with mean daily PLM yield of 3.42, 3.10 and 3.62, respectively (Table 20). The highest daily consumption of concentrates in the two groups (dry lot: 15.13 lb/cow/day; and pasture: 15.88 lb/cow/day) led to the highest daily PLM yield (dry lot: 3.43 lb/cow/day; and pasture: 3.62 lb/cow/day

(Tables 20 and 22).

Forage and Concentrate Consumption

For general interest, Tables 21 and 22 were compiled to show the daily forage (dry lot group) and concentrate consumption during the four periods. No data were available for forage intakes for the cows on pasture. The mean daily concentrate consumption for the two treatment groups is presented in Table 22. Since no individual feeding was done, there were no statistical analyses carried out on the feed intake data.

Table 21. Mean daily forage intakes of dry lot cows.

Period	Number of cows	Days	Grass silage consumed per cow per day (lb)	Hay consumed per cow per day (lb)	Beet pulp consumed per cow per day (lb)
I	12	84	76.09	9.45	3.89
II	13	150	81.26	5.74	--
III	11	150	76.05	11.54	--

Table 22. Mean daily concentrate consumption.

Period	Number of cows		Days	Concentrates consumed per cow per day (DL) lb	Concentrates consumed per cow per day (P) lb
	DL	P			
I	12	12	84	8.17	5.67
II	13	13	150	9.90	10.36
III	11	11	150	9.86	10.31
IV	13	13	68	15.13	15.88

CONCLUSIONS

The following conclusions can generally be drawn from results of the present study involving the performance of cows in the dry lot and on irrigated, grass-legume pasture.

No statistically significant differences were observed between cows in the dry lot and on pasture in connection with the following criteria:

1. Mean age at calving and mean number of days in milk prior to experimentation--periods I, III, IV and periods I, II, and IV, respectively.

2. Mean projected milk and mean projected milk fat records (305 day, 2X) for all periods.

3. Mean age adjusted (M. E.) milk and milk fat (M. E.) records (305 day, 2X) for periods I, II, IV and I through IV, respectively.

4. Mean complete lactation milk and protein records (305 day, 2X) for periods I, II, IVand II through IV, respectively.

5. Mean actual (305 day, 2X) and mean projected (305 day, 2X) milk and milk fat records for periods I through IV (98 cows).

These results indicate that there were no biases in the pairing of cows on the basis of the above criteria. This observation, however, excludes the experimental periods where statistically significant differences were found. These results further proved the validity and relative accuracy of DHIA conversion factors for projecting incomplete milk and milk fat records to a 305 day basis.

Statistically significant ($P < 0.05$) differences were observed in favor of the dry lot group in:

1. Mean, unadjusted, complete lactation milk yields (305 day, 2X), period III.

2. Mean age adjusted (M. E.) milk records, period III.

3. Mean age at calving, period II.

4. Mean number of days in milk prior to the experiment, period III.

5. Mean number of A. I. services per conception, period II.

A general conclusion that can be drawn from these results is that the dry lot group (period III) was in a more advanced stage of lactation. This indicated a bias in the pairing of cows. Probably that is why statistically significant ($P < 0.05$) differences were observed for age adjusted records.

Results on mean milk, PLM, and protein yields did not show significant ($P < 0.05$) differences for all the experimental periods. Mean differences in milk fat production between the two treatment groups were statistically significant ($P < 0.05$) favoring the pasture group (period III).

Treatment differences were nonsignificant for breeding performance data except period II where a significant difference was observed in the mean number of A.I. services per conception. This favored the dry lot group.

Data on mastitis and reproductive diseases did not reveal statistically significant differences between the two treatment groups.

On the basis of results obtained in this study, the following general statements and recommendations can be made:

1. In most cases, no statistically significant differences ($P < 0.05$) due to treatment effects were observed in the performance between the dry lot and pasture groups during the four experimental periods. However, significant differences observed in milk fat yield during period III might have been due to biases in pairing of cows on the basis of stage of lactation prior to the experiment rather than due to treatment effects <u>per se</u>.

2. Results of this study indicate that cows will perform equally well under the two management systems. It must be pointed out, however, that the legume-grass pasture was fertilized, clipped, strip-grazed and irrigated, thus insuring maximum forage production. Therefore, observations made in this study may not necessarily be applicable to other systems of pasture management.

3. Cows in the dry lot were fed grass silage and alfalfa hay, and haylage. If cows in the dry lot had been fed corn silage, different results might have been noted for the dry lot group.

4. Under situations similar to the conditions described in this study, either dry lot feeding or pasturing would yield similar results. Level of herd management with respect to the two management regimes would have a bearing on the applicability of results of this study to other dairy herds.

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APPENDIX

GLOSSARY OF ABBREVIATED TERMS

A.I. = Artificial Insemination.

CMT = California Mastitis Test.

FCM = Fat-Corrected-Milk.

M.E. = Mature Equivalent.

PLM = Protein-Lactose-Mineral.

S.E. = Starch Equivalent.