ECONOMIC ANALYSIS OF THE PRODUCTION OF BREEDING STOCK OF DAJAL CATTLE IN PAKISTAN

by

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Economics of Dajal Cattle of Pakistan

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ABSTRACT

Dajal breed of cattle will continue to be the main draft animal in West Pakistan until farming is mechanized with tractors. At present, there is a shortage of draft cattle in Pakistan as compared to the total requirements for work animals. The Government Dajal Cattle Breeding Farm at Qadirabad, along with two other farms, was established by the government to increase the availability of draft breeds of cattle and foster their propagation by supplying breeding bulls to interested farmers and local bodies in the country-side.

A research study was conducted at the Qadirabad Farm from 1958 to 1961 to work out the cost of production of Dajal breeding bulls and heifers and to see if this cost could be reduced. In the report on this study various cost items have been discussed in detail.

The cost of production of a breeding bull from birth to maturity at 2.5 years of age was found to be Rs. 724.70 and Rs. 644.72 for the two groups included in the study. The cost of raising a heifer up to the age of

960 days, the average age at first service for one of the experimental group, was Rs. 752.37 and the computed cost for the average farm heifer at maturity at 1,035 days of age was Rs. 799.72.

The main cost items were cost of the calf at birth (33 to 37 percent), cost of feed (37 to 41 percent), cost due to mortality (14 percent), labour (4 to 4.4 percent), and interest on invested capital (6.6 to 6.8 percent) aggregating 98 percent of the total cost.

It was concluded from the study that the cost of a calf at birth, the major cost item forming a very high proportion of the total cost, can be reduced substantially by following improved management practices. Costs due to mortality, labour and interest on invested capital can also be reduced along with reducing the cost of calf by better care of the cows and the calves.

The cost of a calf represented the differences between the expenditures for maintaining a cow from one calving to the next and the value of milk and manure she produced during that period. This difference was large due mainly to the high cost of maintaining the cow during the long intervals between calves and low value of the small amount of milk yield per lactation (1,742 pounds). Related factors causing the maintenance cost to be high were found to be:

1. Older age at first calving (1,346 days).
2. Longer calving interval (493 days).
3. Longer dry period (257 days).
4. Small number of calves produced during productive life by a cow (average 4.15 calves).

These different factors and their implications have been dealt with in detail in the study and it was concluded that cost of a calf at birth can be reduced substantially by improving feeding, housing and better management practices.

Through study of records of milk production of dams and their daughters, it was found that due to failure to check the milk production records of the dams of the bulls used in the breeding herd, the milk yield of the progeny of various bulls had gone down as compared to the mothers of the females. Milk yield could be increased by selective breeding based on progeny testing of bulls bred to cows from high producing family lines, as indicated by the higher production of the daughters of one of the bulls.

The most important management factors responsible for low productivity of cows and high cost of raising a calf were found to be improper feeding, breeding, housing and disease control practices.

Various recommendations for increasing the produc-

tivity of the Dajal cow and reducing the cost of a calf at birth based upon the conclusions derived from this study and results obtained from research at other places have been included in the thesis.

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CHAPTER I

INTRODUCTION

Since time immemorial, the bullock has been the main draft animal in West Pakistan. It has been used for tilling the land, for transport of commodities from one place to another in carts, in pre-rail and pre-motor days for the transport of armies and war material in times of war, etc. This is also confirmed by the archeological findings at Mohinjo-daro, the old Indus civilization which dates back to 2,500 to 5,000 B.C. where oven baked clay models of oxen and carts have been found. Hindu mythology called the cow '<u>mata</u>', meaning mother, due to two reasons; the milk of the cow, and the oxen being the main source of draft power for all practical purposes.

The situation has not changed much since Mohinjo-daro days. The bullock is still the pricipal draft animal. Other animals have also been used but only when and where bullocks are not available, particularly due to inability of the user to purchase, poverty being the reason.

Difficulties in Mechanization

Bullocks still far exceed all of the other kinds of work animals available in Pakistan, even though in many other countries of the world draft jobs are performed with the help of automatic machines. Many factors have contributed to this dependence on bullock as the principal draft power. The same factors can be held responsible for preventing expansion of tractor cultivation on a large scale in Pakistan. The National Planning Board enumerated a few of them in the following paragraphs:[1]

1. Pakistan has a large labour force, the greater part of which is under-employed. There is also unemployment. The rate of population growth is high and there is a pressing and continuing need to find employment for those not now fully employed, and for young people who join the labour force each year.

2. Existing individual holdings are small and often fragmented and possibilities of large scale farm management are limited.

3. Foreign exchange involved in the import of tractors is considerable. The use of foreign exchange, already scarce, can be justified on import of tractors only if it can be established that the addition to national income brought about by the use of tractors thus imported is at least as great as could be brought about by any alternate use of the same amount of foreign exchange.

4. When losses resulting from delayed work on account of frequent breaking down of the machinery are added to the direct expanses, the maintenance and upkeep of tractors becomes extremely costly.

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[1]Pakistan, National Planning Board, The First Five Year Plan, 1955-60, December, 1957 (Karachi: Manager of Publications, 1958), p.232.

Besides these other reasons which retard mechanization are:

1. High Initial Cost The financial position of the farmer is very weak and the initial cost of a tractor is very high. The majority of farmers are carrying on farming on the bare subsistance level; they have no means to procure and invest the sum to pay for a tractor.
2. No Mechanically Minded Farmers Farmers are not mechanically minded and the use and upkeep of machinery requires that the user to be such so that proper care of the machines can be taken. This is also a cost factor since in the absence of technical knowledge the appointment of a full-time driver-mechanic is needed which is a constant cost factor, though the machine may or may not be in use.
3. Lack of Repairing Facilities Lack of repairing facilities and of spare parts is another factor which prevents introduction of tractor cultivation to a large scale. Once a part is broken or something goes wrong with the machine, it may take months to put the machine in use again. If such a breakdown happens during the sowing season, it may cost the farmer the loss of his whole crop. This necessitates keeping of bullocks side by side with

tractors, where such machines have been introduced, so that in case of breakdown of the machine animal draft power can be used for the different farming operations.

It can be safely concluded that for a long time to come, cattle will be the main draft power available to the farmer in Pakistan, although some of the farms may be mechanized to a varying extent. Even after farm mechanization, farmers will keep cattle to supply food in the form of milk and beef to the country where the consumption of both the items is far below the normal nutritional level.

Estimated Requirements of Work Animals in West Pakistan

It will be evident from Table 1 that the total area under cultivation in West Pakistan is 38,272,000 acres. Out of this total the estimated area under irrigated cultivation is 23,551,000 acres.

It is estimated by the Department of Agriculture, West Pakistan, that a pair of good bullocks can cultivate about 12.5 acres of irrigated or 25 acres of unirrigated land. But keeping in mind the existing condition of work animals and the availability of land area per cultivator, a pair of bullocks can work but 10 acres of irrigated or 20 acres of unirrigated land. This gives the required number of bullocks for working the present irrigated and

unirrigated land to be 6,182,000.[2]

TABLE 1

BULLOCK REQUIREMENTS OF WEST PAKISTAN

Type of Work	Area (Thousand Acres)	Number of Acres per Pair of Bullocks	Number of Bullocks Required (Thousand)
Cultivation			
Irrigated land	23,551	10	4,710
Unirrigated land	14,721	20	1,472
New area to be put under cultivation	10,000	15	1,500
Carts, country-oil presses, etc.			64
Total Number of bullocks needed			7,746
Existing number of work animals			4,424
Deficiency			3,322

Source: West Pakistan, Department of Animal Husbandry, "Objective Planning in Animal Husbandry" (Lahore: undated and mimeographed), pp.2-3.

By the end of the Second Five Year Plan, another 10,000,000 acres of land is expected to be supplied with water. This land includes part of the existing unirrigated farming area and also new additions to the cultivated

[2]West Pakistan, Department of Animal Husbandry, "Objective Planning in Animal Husbandry" (Lahore: undated and mimeographed), pp. 2-3.

area out of cultivable waste land. Work animals required for this additional land are calculated to be 1,500,000 bullocks, in addition to the number required for presently cultivated area.

Bullocks are also required for pulling carts to transport goods and commodities from place to place in urban as well as rural areas. In fact, thousands of families, particularly in urban centres, live on the earnings from these animals by transporting goods to and from the railway station to the market centres and within the towns and cities. Additional requirements are for the country oil presses, for working of persian wheels for well irrigated lands, for working country grain crushers and flour mills. The Animal Husbandry Department of West Pakistan has estimated that a total of 64,000 bullocks is required for these purposes.[3]

When summed up, these figures give the overall requirements of bullocks for West Pakistan to be approximately 7,746,000, after the completion of existing irrigation projects. Even without including the requirements of current irrigation projects under execution, the total demand far exceeds the total supply, as is evident from a comparison of the totals in Table 1 and 2.

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[3] Ibid., p.3

The present number of work animals (4,424,000 including 295,000 female buffaloes and cows used for work) falls even short of total number needed for working the present irrigated land, not to speak of unirrigated area, land to be irrigated in the future, or other purposes.

TABLE 2

NUMBER OF WORK ANIMALS AVAILABLE IN WEST PAKISTAN
(Thousands)

Sex	Cattle	Buffaloes	Total
Males	3,876	253	4,129
Females	176	119	295
Total	4,052	372	4,424

Source: West Pakistan, Department of Animal Husbandry, "Objective Planning in Animal Husbandry," (Lahore: undated and mimeographed), p.3.

This deficiency is being met, at present, by working dry cows or buffaloes, camels, donkeys, etc. If these animals are replaced by bullocks, it will benefit the farmers in two ways:

1. Dry cows and buffaloes, when spared from work or plowing, will be available for breeding and milking

purposes, thereby increasing the quantity of milk and meat available and, last but not the least, the future number of work animals as well.

2. It will increase the productivity of land because with bullocks, better plowing and cultivation will result in increased per acre yield. Bullocks will also plow and cultivate a larger area per day.

Importance of Dajal Cattle

There are eight breeds of cattle in West Pakistan. Sahiwal and Red Sindhi are milk breeds, their males being lethargic and slow workers.[4] Dhanni and Rohjan are medium to light breeds with short stamina for work. They are mainly found in sub-hilly to hilly tracts of Rawalpindi and Dera Ismail Khan regions. Lohani is a small sized breed with adult males weighing from 500 to 700 pounds only. This breed is found in the hilly areas of Loralai Agency of Baluchistan and Dera Ismail Khan regions and Kohat district. Thari or Tharparkar is a dual purpose breed mainly available in Tharparkar and Hyderabad districts of West Pakistan. Animals of this breed are not available to the farmers in the former province of Punjab and Baluchistan. Bhagnari is the breed of cattle bred in the

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[4]Pakistan, Cooperation and Marketing Advisor, Livestock Wealth of Pakistan, Marketing Series C. & M.A.2 (Karachi: Manager of Publications, 1954), p.3.

regions known as Bhag, along the banks of river Nari in Baluchistan region, Sibi area of the Kalat Division and Jacobabad district. Males are white to grey in colour with compact body and powerful neck supported by a large muscular hump, hardy, powerful and very suitable for plow and heavy draft work. The male animals weigh 1,000 to 1,800 pounds.[5]

Dajal is an offshoot of the Bhagnari breed, a well established strain which has been established in the Dajal tract of Dera Ghazi Khan district due to continued breeding. It is a bit smaller in size as compared to Bhagnari, other characters remaining the same.

The breed received attention by the Animal Husbandry Department of the then Province of Punjab, when, after the establishment of Pakistan, the main source of stud bulls of the Hariana breed, the Hissar Farm was cut off. The only breed to chose for heavy draft work was Bhagnari or Dajal. A farm was opened at Qadirabad in Montgomery district on 1,011 acres of irrigated land in 1949 and another simultaneously at Dadu on about 600 acres of land by the provincial government of Sind.

The present stock was purchased from the home tract of the breed in three instalments from 1950 to 1952.

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[5]M. Masud and S. Hussain, Livestock Breeds of West Pakistan (Lahore: Published by the Authors, 1960), p.13.

Young bulls, after attainment of 2.5 years of age are sold to the local bodies and municipal committees at a subsidised price of Rs. 170.00 and to the private breeders for Rs. 425.00 each.

CHAPTER II

PURPOSE OF THE STUDY AND PROCEDURE

Purpose

The present study was undertaken at the Government Dajal Cattle Breeding Farm at Qadirabad, West Pakistan, starting in June 1958 and continued there until September 1961. Its purpose was:

1. To determine the cost of production of breeding stock of Dajal cattle at Qadirabad Farm.
2. To ascertain whether the cost of production could be reduced, and, if so, how.

The data on 445 animals collected at the farm were brought to Beirut and their analysis was made the basis of this report.

Procedure of the Study

The first part of the study was conducted on two groups of calves. In the first group 21 calves, 14 males and 7 females, were taken in June-July, 1958, at birth. They were maintained at the farm under conditions similar

to those of other calves. Data of all expenditure, which included the items of feed, viz; milk consumed, concentrates, green and dry roughages, common salt, were recorded as to quantity and value. Data for other cost items, which included expenditures for ropes and chains, housing, labour, medicines, etc., were also maintained. Study on Group II was started in January-March, 1959, except two calves one male and one female which were born in the first week of April and included in the experiment. Similar data were recorded for Group II as for the previous group.

During the course of the experiment, one female and two male calves from the Group I and two females and three males from Group II died of various causes. They were dropped from the study as overall mortality of the calves on the farm was considered to be more representative of mortality in arriving at the increase in cost of production due to this factor.

In the second part of the study, breeding data covering 1165 complete lactations were taken from the farm records and analysed to arrive at the average number of days a cow remained in milk, and for other averages which included calving interval between two successive calvings; dry period between two calvings; service period, that is the number of days a cow took for the first and final service, when there was any additional, after giving birth

to a calf; and quantity of milk produced during a lactation.

The average age at which a heifer was first served by a bull and the average age of first calving was also recorded for the 222 heifers which were added to the herd during the period and included in the study.

The data were analysed further to compare the yield of milk, calving interval and the number of days a cow remained in milk for the first four lactations, for the foundation stock and for their daughters. These figures were analysed to see the effect of the breeding of the cattle at the farm.

Effects of breeding and production differences due to various bulls were also analysed for dams and their daughters when their milk yield, calving intervals, and number of days a cow remained in milk were compared.

Cost of the calf at birth was arrived at by calculating the difference between total expenditure on a cow and income from it during the period of a lactation. For arriving at this difference, data for all receipts and cost items were maintained for 20 cows from one lactation to the next. Out of these 20 cows one cow was sold and the above data were averaged over the remaining 19 cows. These averages were used in the present study.

Effects of different variables, such as calving

interval, dry period, days in milk, age at first calving, etc., were studied in detail in relation to the production efficiency of cattle. They were incorporated in the cost of production studies and discussed at appropriate places in the chapters that follow.

CHAPTER III

COST OF RAISING DAJAL CALVES UP TO MATURITY

The cost of raising Dajal calves up to maturity was calculated separately for Group I and Group II and presented in Table 3. Group I received more feed than Group II so that their growth was much better. The animals in Group I were taken from the June-July calvings. Due to the monsoon season their mothers had better feed available and yielded more milk. They also had better feed to eat from the time they started eating roughages. The calves in Group II, on the other hand, were selected from January to March calvings. From October onward until the middle of February there is generally a shortage of roughages which recurrs again in late April and May. This had an influence on the milk yield of the cows, finally affecting the calves, through less milk flow. Influence of winter season also reduced the quantity and quality of feed for the calves. The result was that the calves in Group II had a retarded growth throughout their life up to 2.5 years. None of the heifers in Group II came in heat up to the end of

TABLE 3

COST OF PRODUCTION OF DAJAL CALVES UP TO 2.5 YEARS OF AGE AT GOVERNMENT DAJAL CATTLE BREEDING FARM QADIRABAD, PAKISTAN FOR 1958 TO 1961

Items of Cost	Group I		Group II	
	Cost (Rupees)	Percent of Total	Cost (Rupees)	Percent of Total
1. Cost of calf at birth	247.31	32.77	247.31	36.64
2. Feed	306.38	40.58	247.50	36.67
3. Labour	29.95	3.97	29.96	4.44
4. Housing	5.96	0.79	5.67	0.84
5. Equipment	12.00	1.59	6.00	0.89
6. Miscellaneous ..	0.63	0.08	0.62	0.09
7. Mortality	102.90	13.63	91.95	13.62
8. Interest on investment ..	49.75	6.59	45.93	6.81
Total cost	754.92	100.00	674.94	100.00
Receipts from manure (Approx. 9914 pounds)	30.22		30.22	
Net Cost	724.70		644.72	

Source: Experimental data from the Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

2.5 years although in Group I two heifers out of six came in estrus before reaching this age. This indicates that inadequate feeding retards sexual maturity of female cattle of the Dajal breed.

The average cost of raising calves from birth to 2.5 years of age was Rs. 724.70 and Rs. 644.72 in the two groups under experiment, as shown in Table 3. Major items of cost were the cost of calf, feed, costs due to mortality, and interest on investment. Taken together all the above items formed about 94 percent of the total cost.

For the sake of analysis, various cost items have been grouped together under 8 major headings, viz; cost of calf, feed, labour, housing, equipment, miscellaneous, costs due to mortality, and interest on invested capital.

On the income side, the total credit on account of manure was Rs. 30.22. Receipts due to sale of skins of dead calves have not been taken into consideration as it forms a very small fraction. Skins of calves which died of contagious diseases were not sold while those of young calves brought a very small price. Nearly 33 percent of total mortality in calves is in the first calendar quarter of life. Nearly 69 percent of the total mortality of calves up to 2.5 years occurs during the first year of life. So at this early age the sale value of a skin is a minor item.

Factors Affecting the Cost of a Mature Calf

Cost of Calf

The initial investment in raising an animal from birth to maturity is the cost of the animal itself to be raised. Dajal cattle are not good producers of milk. The milk yield is very small and the cow has to be maintained for having calves. The cost of the calf at birth is taken to be the difference between total cost of maintaining a cow from one calf to the next and the total receipts from the cow on account of milk and manure. The average calving interval over all lactations in Dajal cattle at the Qadirabad Farm for the period 1950 to 1961 was 393.34 days. The costs and receipts from a cow over this period are presented in Table 4.

The cost of producing a calf at the Government Dajal Cattle Breeding Farm, Qadirabad during the years 1958-61 was Rs. 247.31. Next to feed, it constitute the largest element in the cost of a mature calf. Cost of a calf at birth was 32.77 and 36.64 percent of the total costs of a 2.5 year old animal in Group I and Group II respectively, as shown in Table 3. The cost of a calf formed a bit higher percentage in Group II because of comparatively less cost of feeding the animals in that group, thereby resulting in an increased portion of cost of calf in the total cost.

TABLE 4

COST OF PRODUCING A CALF BY A DAJAL COW AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1958-1961

Items	Quantity (Pounds)	Value (Rs.)	Total (Rs.)
1. Feed for a cow during calving interval			
Green fodder	33,485.0	198.20	
Dry roughages	936.0	30.78	
Concentrates	352.0	54.49	
Common salt	5.5	0.36	283.83
2. Labour	..	..	91.63
3. Housing . ..	..	..	16.38
4. Depreciation of equipment ..	..	..	1.33
5. Bull service charge	..	..	23.12
6. Depreciation of cow	..	..	53.90
7. Interest on capital invested ..	..	..	22.53
Total costs	..	..	492.72
8. Receipts:			
Manure 19,828 pounds		32.91	
Milk 1,742 pounds		212.50	245.41
Cost of producing a calf			247.31

Source: Unpublished data from the records of the Director, Livestock Farms, West Pakistan, Lahore.

Feed

Total amount of feed consumed by the two groups of calves and its value is presented in Table 5. Feed costs on the whole amounted to Rs. 306.38 and Rs. 247.50, respectively in the two groups and constituted the largest single element of cost, namely 36.67 and 40.58 percent. Feed cost in Group II was less than in Group I because the former group received less quantity of feed, viz., nearly 100 pounds less milk, 75 pounds less concentrates, 7,500 pounds less green fodder. Some of the factors responsible for this smaller quantity of feed given the animals have been discussed earlier, seasonal fluctuation of the availability of fodder being the major one. Feeding of concentrates depended upon the availability in the farm stores.

Labour

Cost on account of labour is nearly equal in the two groups, amounting to Rs. 29.95 per calf for the 2.5 years as shown in Table 3. This is worked out on the average of 200 man-work hours per calf and accounts for 3.60 and 4.01 percent of the total cost, respectively, in the two groups.

Housing

Charges for housing the calves in the two groups

TABLE 5

FEED COSTS IN RAISING DAJAL CALVES UP TO 2.5 YEARS OF AGE AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1958 TO 1961

Items of feed	Group I			Group II		
	Quantity (Pounds)	Value (Rs.)	Percent of Total Feed Cost	Quantity (Pounds)	Value (Rs.)	Percent of Total Feed Cost
Milk	798	97.28	31.75	695	84.72	34.23
Concentrates	237	30.13	9.84	162	20.39	8.24
Green fodder	18,659	107.58	35.11	11,164	68.07	27.50
Dry fodder	2,814	70.91	23.14	2,831	73.89	29.86
Common salt	8.3	0.48	0.16	7.1	0.43	00.17
Total		306.38	100.00		247.50	100.00

Source: Unpublished experimental data from the records of Director, Livestock Farms, West Pakistan, Lahore.

were Rs. 5.96 and 5. 67 for the period of 2.5 years. The calves were housed in straw huts for winter and trees shade was used during summer. Housing charges include only rent of land and construction cost of the straw hut. The housing cost amounted to less than one percent of the total net costs for the two groups.

Equipment

Items under this head included only ropes used for tying the calves. Cost of ropes for Group I was Rs. 12.00 as compared to Rs. 6.00 for group II. The smaller charge for the latter group was due to using fewer ropes.

Miscellaneous Charges

Items under this head include cost of medicines, vaccines etc. The calves were protected against Rinderpest, Haemorrhagic Septicaemia, Black Quarter and Anthrax and so cost of these vaccines have been included here. On the whole, it is a minor item in the total cost.

Cost Due to Mortality

The total deaths of calves at the Qadirabad Farm during the first 2.5 years of life, for the period 1950 to 1960 were 218 out of 1,273 calves born during this period. This gives an overall mortality figure of 17.12 percent. Accordingly, the total cost of producing a calf

to maturity had to be increased by this percent in order to recover from the sale of surviving calves the cost of the calves that died and the costs of rearing them until they died. The increase in cost due to mortality was Rs. 102.90 and Rs. 91.95 in the two groups, respectively. Mortality cost was about Rs. 11.00 less in Group II than in Group I due to the lower overall cost in the former group. The loss due to mortality constituted about 13.63 percent of the total cost and was the third largest item in the total cost.

Interest on Investment

Interest was the fourth largest item in the cost of raising calves. It amounted to Rs. 49.75 and Rs. 45.93 in Group I and II, respectively. The interest was calculated at 4 percent per annum for 2.5 years on the basic cost of a calf at birth plus 17.12 percent of this basic cost for the same period representing the interest on dead calves, and on half of the total of other costs, including additional costs due to mortality, for the same period. Interest was charged on but half of the variable costs because this amount represents the average of the amount spent on other items through out the period of 2.5 years, beginning from zero on the first day and ending in full investment on the last day.

Costs of Raising Heifers up to Breeding Age

From 1950 until June 1961, out of the total heifers added to the breeding stock at the Qadirabad Farm 222 were included in the present study due to their records being complete. The average age at first service for all these heifers was 1,035 days. This is 123 days over the 2.5 years of age at which the male calves are sold and the cost for which period has been worked out in the earlier part of this chapter and summarized in Table 3. To arrive at the cost of production of average heifers up to age of first service, it was necessary to determine the cost of feeding and caring for the animals during the 123 days between 2.5 years and 1,035 days of age. This has been calculated from the costs for raising the heifers in the experimental Group I until breeding age at 960 days. The costs for rearing the heifers in Group II beyond 2.5 years and up to breeding age could not be used for calculation because none of the heifers in this group came in heat by the time at which the experiment was terminated when the writer left the farm to take up graduate study at the American University of Beirut, in Lebanon.

Cost of Raising Heifers in the Experimental Group I

The average age at first service of the heifers in Group I in the experiment was 960 days, that is 48 extra

days after the male calves reach saleable age. The additional cost for these heifers for this period came to Rs. 30.32 per animal and the credit on account of manure was Rs. 2.65. This brought the net additional cost to Rs. 27.67. The itemization of these costs is given in Table 6. Total net cost of raising heifers to breeding age in the experimental group was thus Rs. 752.37, obtained by adding the additional cost of Rs. 27.67 to the cost up to 2.5 years of Rs. 724.70, as given in Table 3.

Average Cost of Raising Heifers for 1,035 Days

Average age at first breeding of a Dajal heifer on the Qadirabad Farm based on records for 222 heifers during the years 1950 to 1961 was 1,035 days. Accordingly, the ordinary heifer on the farm has to be fed and cared for 123 additional days after 2.5 years of age to be ready for breeding. The calculated additional cost for these 123 days has been worked out on the basis of the feed data for the experimental group given in Table 6. It is presented in Table 7. The net additional cost for 123 days maintenance of a heifer was found to be Rs. 74.52. The gross cost was Rs. 81.31 and the credit from manure amounted to Rs. 6.79. The overall net cost of raising heifers from birth to the average breeding age of 1,035 days in the herd, on the basis of quantities for the

TABLE 6

COST OF RAISING HEIFERS IN GROUP I FOR AN ADDITIONAL 48 DAYS AND FINAL COST UP TO 960 DAYS AT GOVERNMENT DAJAL CATTLE BREEDING FARM QADIRABAD, 1958-61

Particulars	Cost for 48 Days (Rs.)	Cost up to 960 Days (Rs.)
Cost of calf up to 2.5 years of age	..	724.70
Additional costs:		
Feed		
Green fodder 3,025 pounds	17.46	
Dry fodder 73 pounds	3.20	
Concentrates 2 pounds	0.24	
Salt ½ pound	0.04	
Labour	1.57	
Housing	1.62	
Equipment	0.13	
Costs due to mortality (one heifer died out of 346 during additional 48 days) = 0.29 % of the cost of calf and cost of feed etc.	2.17	
Interest on capital invested	3.89	30.32
Total	30.32	755.02
Returns from manure (Approx. 2,607 pounds)	2.65	2.65
Net Cost	27.67	752.37

Source: Unpublished experimental data from the records of Director, Livestock Farms, West Pakistan, Lahore.

TABLE 7

COST OF RAISING 273 HEIFERS FOR THE ADDITIONAL 123 DAYS TO BREEDING AGE AND FINAL COST UP TO 1,035 DAYS AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD 1950-1961[a]

Particulars		Cost for 123 Days (Rs.)	Cost up to 1,035 Days (Rs.)
Cost of calf up to 2.5 years of age ..			724.70
Additional costs			
Feeds			
Green fodder	7,752 pounds	44.74	
Dry fodder	188 pounds	8.21	
Concentrates	5 pounds	0.62	
Salt	1.3 pounds	0.09	
Labour		4.03	
Housing		4.15	
Equipment		0.33	
Mortality (4 heifers died out of 346) = 1.12 %		8.82	
Interest on capital invested .		10.32	81.31
Total costs		81.31	806.01
Returns from manure (Approx. 6,681 pounds)		6.79	6.79
Net cost		74.52	799.22

[a]Costed at quantities for experimental Group I heifers and at 1958 to 1961 prices.

Source: Unpublished data from the records of Director, Livestock Farms, West Pakistan, Lahore and Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

experimental Group I and at 1958 to 1961 prices was Rs. 799.22, as compared to Rs. 752.37 for a period of 960 days for the experimental group. The extra cost for the later maturity of average heifers was Rs. 46.85. This indicates the economic loss which results from inadequate care and feeding of heifers being raised for breeding purposes.

CHAPTER IV

FACTORS WHICH CAN CONTRIBUTE TO REDUCING THE COST OF PRODUCTION OF A CALF

Factors which can contribute to reducing the cost of production of a mature calf can be divided into two major groupings: (1) those relating to the original cost of the calf, and, (2) those relating to the costs of raising the calf up to maturity, which include all other costs.

Original Cost of the Calf

This is the largest single item in the cost of raising a calf up to maturity. The cost of a calf at birth, as already discussed, is the net cost of maintaining a cow from one calving to the next. The following factors contribute to this expense and are discussed in detail in the following pages:

1. Age of the cow at first service and calving.
2. Calving interval in between two successive calvings.
3. Length of lactation period.

4. Amount of milk produced during a lactation.
5. Selection and breeding of animals.
6. Management.

Age of the Cow at First Service and Calving

The average age at first service in Dajal cattle at Qadirabad Farm for the 222 heifers considered in this study was 1,035 days (148 weeks). Average age at first calving for the same group of animals was 1,346 days (192.3 weeks). The average gestation period for the 1,065 calvings covering first to tenth lactations of cows in the herd under study was 286.97 days. This leaves the difference of 24 days between first service and conception which is due to repeat services in some heifers in order to produce conception.

Average age at first calving of Dajal cattle is compared with other cattle breeds in India and Pakistan in Table 8.

Dajal breed, when compared with other local breeds of cattle, appears to be at a par in the age at first calving but when this breed is compared with Western breeds, there is a great difference in the age at first service, resulting in a corresponding variation trend of age at first calving. Age at first service of the Dajal cattle is compared with some of the western breeds of cattle in Table 9.

TABLE 8

AGE AT FIRST CALVING IN DAJAL CATTLE[a] AS COMPARED WITH OTHER BREEDS OF CATTLE IN INDIA AND PAKISTAN[b]

Breeds of Cattle	Number of Cows in the Study	Age at First Calving (Months)
Dajal	222	44.3
Red Sindhi	639	41.7
Kangayam	477	44.1
Gir	88	47.0
Kankrej	98	47.4
Tharparkar	422	49.4
Sahiwal	18	45.8
Hariana	558	46.7
Non-descript	302	47.4

[a]Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

[b]V.N.Amble, K.S.Krishnan and P.N.Soni,"Age at First Calving and Calving Interval for some Indian Herds of Cattle," Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXVII (1958), pp.83-92.

TABLE 9

COMPARISON OF DAJAL CATTLE[a] WITH WESTERN BREEDS[b] FOR AGE AT FIRST SERVICE

Breeds of Cattle	Age at First Service (Months)
Dajal	34.00
Jersey	15-18
Guernsey	16-20
Ayrshire	17-21
Holstein	18-22
Brown Swiss	19-23

[a]Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

[b]P.T. Dix Arnold, R.B. Becker, and A.H. Spurlock, Dairy Cattle and Their Care, Agr. Exp. Sta. Bul.599 (Gainesville: University of Florida, 1958), p.36.

The age at first service in Dajal cattle is nearly twice as great as in some of the western breeds. The shortest age at first service was recorded to be 18.1 months which compared favourably with the western breeds. The lowest age in the experimental group under study was 25.5 months, average age in the same group for six heifers being 960 days (31.6 months).

In fact, age at first service varies with the size and maturity of individual animals in the different breeds.[1] The maturity of a heifer depends to a great extent on the nutritional level on which it was raised. This was confirmed in an experiment conducted at the Cornell University Agricultural Experiment Station in 1958-59 to study the effect of different nutritional levels (under feeding and over feeding) on growth and development of Holstein heifers. It was found that age at first estrus was strikingly different in the three groups maintained under experiment on high, medium and low levels of feeding.[2] Heifers on high level of feeding came in heat at 37.4 weeks

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[1] P.T.Dix Arnold, R.B.Becker and A.H.Spurlock, Dairy Cattle and Their Care, Agr. Exp. Sta. Bul. 599 (Gainesville: University of Florida, 1958), p.36.

[2] A.M.Sorensen, et al., Causes and Prevention of Reproductive Failures in Dairy Cattle: I. Influence of Underfeeding and Overfeeding on Growth and Development of Holstein Heifers, Cornell Univ. Agr. Exp. Sta. Bul.936 (Ithaca: New York State College of Agriculture, 1959),p.15.

of age, the earliest age being 29 weeks, those on medium level averaged 49.1 weeks. Out of the five heifers under experiment on low level of nutrition, three came in estrus while the remaining two did not come in heat up to 80 weeks of age. It was concluded that there was a tendency for heifers to come in estrus for the first time at a given stage of skeletal growth,[3] and that there is no harm if the heifers raised on high nutritional level are bred at 37 to 40 weeks of age, when they are expected to bear calves at 79 to 80 weeks of age.[4] Histological examinations, after slaughter, of the reproductive tract of those heifers confirmed the above findings and normal conception was expected when bred at this age.

Other workers, including Turk and Burke[5] also recommend to breed heifers any time after they have attained a particular weight, which of course depends upon the nutritional level at which the animal had been raised.

Data for the Dajal cattle from the Qadirabad Farm were analysed and the results are presented in Table 10 to show the production of milk during a lactation, calving

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[3] Ibid., p.16.

[4] Ibid., p.35.

[5] K.L.Turk and J.D.Burke, Raising Dairy Calves and Heifers, Cornell Extension Bul. 761 (Ithaca: New York State College of Agriculture at Cornell University, 1962), p.26.

TABLE 10

PRODUCTION OF MILK DURING A LACTATION, CALVING INTERVAL, DRY PERIOD, DAYS IN MILK AND OTHER PARTICULARS OF DAJAL COWS FOR THE FIRST FOUR LACTATIONS ACCORDING TO THE AGE AT FIRST CALVING AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950 - 1961

Age at First Calving (Days)	Age at First Service		Age at First Calving		Calving Interval	
	No. of Animals	Average Age (Days)	No. of Animals	Average Age (Days)	No. of Animals	Average No. Days
Up to 900	5	569.8	5	854.0	19	482.5
901-1000	1	687.0	1	977.0	3	416.7
1001-1100	11	789.8	11	1076.4	14	514.3
1101-1200	44	856.8	44	1150.9	96	512.1
1201-1300	45	939.5	45	1250.3	99	520.8
1301-1400	25	1053.4	25	1367.9	64	477.2
1401-1500	47	1142.2	47	1447.7	103	502.3
1501 and over	35	1303.2	35	1677.4	40	523.1
Herd average 1 to 10 lactations	222	1035.8	222	1346.4	898	493.4

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

TABLE 10--Continued

Dry Period		Days in Milk		Milk Yield		Average Yield Per Day in Milk (lbs.)	Average Yield Per Day/ Calving Interval (lbs.)
No. of Animals	Average No. Days	No. of Animals	Average No. Days	No. of Animals	Average (Pounds)		
19	240.6	19	241.9	19	1857.8	7.68	3.85
3	162.7	3	254.0	3	1499.3	5.90	3.60
14	314.1	24	201.5	24	1244.0	6.18	2.42
96	278.2	112	229.7	112	1640.4	7.14	3.20
99	284.0	118	235.1	118	1824.0	7.76	3.50
64	254.5	76	220.8	76	1835.8	8.31	3.85
103	263.3	124	242.2	124	1941.0	8.01	3.86
40	265.5	63	252.3	63	1841.7	7.30	3.52
898	257.3	1165	234.6	1165	1742.1	7.42	3.53

interval and other particulars for the first four lactations according to age at first calving.

In the group having the ages at first calving up to 900 days, five heifers calved at an average age of 854 days. In this group milk yield per day of lactation averaged for the first four lactations was 7.68 pounds per day for 242 days in milk. Overall average output throughout the calving interval of 482.5 days for the first four lactations was 3.85 pounds per day.

Maximum quantity of milk during a lactation, averaged over the first four calvings, was 1941 pounds in 242 days of milking and a per day of lactation average of 8.01 pounds. Overall average milk per day of 502 days calving interval was 3.86 pounds. This was in the group whose age at first calving was 1,401 to 1,500 days, average age being 1448 days and average age at first service of 1,142 days. This was followed by the age group whose age at first calving was up to 900 days. In this group average milk yield in a lactation was 1858 pounds in 242 days of milking. This group had an overall milk yield of 3.85 pounds per day of calving interval.

To see the actual difference of milk yield during the life-time of a cow, the life-time milk yield was worked out for different age-at-first-calving groups. This was obtained by the following method:

To the over all average age at first calving of 1342.42 days, was added 2,047.53 days, the average days a cow remained in herd. This figure was obtained by multiplying average calving interval of all lactations of 493.38 days by 4.15 (assuming that the cows on the average were culled 493.38 days after the last calving), the average number of calvings a cow remained in herd.This gave the total herd life of a cow before it was culled or died to be 3,393.85 days. On this cow herd-life and total-life base the average calvings and milk yield was weighted. To obtain the herd-life of a cow in each group, the average age at first calving of each group was subtracted (assuming that the average age at time of culling was the same for all groups) from 3,393.95 days, the total life of a cow. This average herd-life of each group was divided by the calving interval of the respective group. This gave the average number of calves borne by that group of cows.

Life-time milk yield of a group was obtained by multiplying the average milk yield of the group in a lactation (Table 10) by the number of calves borne by that group, as computed above. An example for the age group having age at first calving up to 900 days has been worked out and presented in Appendix A.

Data analysed for various age-at-first-calving

groups is presented in Table 11.

It will be seen from the Table 11 that the maximum number of calves and milk was obtained when the age at first calving was the minimum of up to 900 days. Lifetime milk yield in this group worked out to be 9,772 pounds with 5.32 calves borne by each cow as compared to 7,229.6 pounds over 4.15 lactations of all cows. This also compared favourably with the age-at-first-calving group with 1,401 to 1,500 days which otherwise gave maximum average yield in a lactation (Table 10). Calculated according to this weighted method this age group produced 7,511.8 pounds of milk and 3.87 calves in its life with an overall average of 2.21 pounds per day of life.

This increased milk yield over the herd life of a cow and 1.17 additional calves gives an absolute advantage to early maturing heifers over late maturing ones. This finding is in conformity with other workers, namely Venkayya and Anantakrishnan (1956[6] and 1957[7]) who found with Red Sindhi, Gir and Ayrshire x Sindhi crosses that age at first calving had a positive correlation with the

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[6]D. Venkayya and C.P. Anantkrishnan, "Influence of Age at First Calving on Milk Yield, Lactation Length and Calving Interval," Indian Journal of Dairy Science, Vol. IX (1956), pp. 164-172.

[7]D. Venkayya and C.P. Anantkrishnan, "Influence of Age on Milk Production in Dairy Cattle," Indian Journal of Dairy Science, Vol. X (1957), pp. 100-105.

TABLE 11

COMPUTED LIFETIME WEIGHTED MILK YIELD AND NUMBER OF CALVES BORNE PER COW ACCORDING TO DIFFERENT AGES AT FIRST CALVING AT GOVERNMENT DAJAL CATTLE BREEDING FARM QADIRABAD, 1950 - 1961

Range of Age at First Calving (Days)	Average Age at First Calving (Days)	Average Calving Interval (Days)	Average Number of Calves Borne by Each Cow	Lifetime Weighted Milk Yield (Pounds	Overall Weighted Milk Yield Per Day of Life (Pounds)	Computed Age at Culling (Days)
All ages	1346.42	493.38	4.15	7229.55	2.13	3393.95
Up to 900	854.00	482.50	5.26	9772.03	2.88	"
901 - 1000	977.00	416.67	5.80	8696.11	2.56	"
1001 - 1100	1076.36	514.28	4.51	5610.62	1.65	"
1101 - 1200	1150.86	512.10	4.38	7184.95	2.12	"
1201 - 1300	1250.30	520.83	4.12	7514.67	2.21	"
1301 - 1400	1367.90	477.15	4.25	7801.94	2.30	"
1401 - 1500	1447.70	502.34	3.87	7511.75	2.21	"
1501 and over	1677.40	523.10	3.28	6040.71	1.78	"

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan and Table 10.

first lactation yield but that it had no relation with the subsequent lactations. In their study they found that early breeding heifers completed their fourth lactation 16 months earlier than the late breeding heifers. Thus, early breeding heifers have an absolute advantage over late breeding, since this leads to saving in the feed and maintenance costs for one year and a longer productive life with almost as much production of milk per lactation as late calvers.

Misner and Dalrymple,[8] working on Holstein cows found that as the age at first freshening increased, absolute quantity of milk produced during the productive life, number of calves produced and milk produced per day of life decreased. They concluded that longer production per day of life can be obtained by having heifers freshen at two years of age rather than later in life.

Age at first calving has another influence on the life-time production of a cow. It is that fertility of a cow increases up to a certain age, then levels off and then declines. Use of this increased fertility period can be made by breeding heifers at a young age. If the heifers

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[8] E.G.Misner and D.B.H.Dalrymple, "Ages, Production Rates and Reasons for Disposal of Cows in Seven State Institution Herds," Department of Agricultural Economics A.E.1000 (Ithaca: New York State College of Agriculture, 1955), p.30 (Mimeographed).

are bred at a later age, then they move towards the declining fertility phase of life after producing only a few calves, thereby decreasing the total number of calves obtained from a cow and also the total quantity of milk obtained during the productive life.[9] This was confirmed by Tenable and Salisbury, as quoted by Salisbury and Van Demark,[10] who conducted a study on 12,621 cows ranging in age from 1 to 12 years. Herman, as quoted by the same authors,[11] also confirmed this in his survey of cattle bred by artificial insemination. In his study, 198,555 virgin heifers had a 70.11 percent non-return rate (apparently 70.11 percent conceived of first insemination as they were not brought again for re-insemination with in the period mentioned) at 60 to 90 days after insemination whereas 476,333 cows under eight years of age had a non-return rate of 73.22 percent for the same period and cows over eight years of age had a non-return rate of 68.70 percent.

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[9]Cause and effect may be confounded, e.g. the heifers are bred or conceive late because they are of low fertility, and not of low fertility because they are bred late.

[10]G.W.Salisbury and N.L.Van Demark, Physiology of Reproduction and Artificial Insemination of Cattle (San Francisco: W.H. Freeman and Co., 1961), p.526.

[11]Ibid., p.526.

This loss of calves and milk due to lower fertility from those cows which gave birth to their first calf at a later age can be a contributing factor to the high cost of the calf. Breeding data for Dajal cattle maintained at Qadirabad Farm was not analysed to confirm the above statement due to lack of all relavent records here in Beirut.

Factors Influencing the Age at First Service and Calving

In Group I, the average age at first service for the six heifers under experiment was 960 days while none of the heifers in Group II came in heat by the time the study was discontinued.

As discussed earlier, various factors influence age at first service and thereby the calving age. Some of these, in addition to varying management and animal husbandry practices for which no correct estimate can be made, are environmental factors such as season of the year and the nutritional level upon which the heifers have been raised. Some of these factors, such as effect of winter season on the young calves as compared to older, affect one age group more than the other. All these factors and their effects cannot be separated from one another and analysed individually.

According to Salisbury and Van Demark[12], the

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[12] Ibid., p. 524.

nutritional level on which the heifers are raised is the main factor of greater or shorter age at first calving. This is in conformity with the findings of Sorensen et al.[13] at Cornell University where heifers maintained on a higher nutritional level came in estrus much earlier than those kept on low nutritional level. The writer also reached the same conclusion from his study at Qadirabad Farm. Heifers in Group I got somewhat better nutrition than those in Group II, as indicated in Table 5, and so came in estrus at a comparatively earlier age.

Other factors responsible for later or shorter age at first calving can be management decisions and responsibility, physiological or pathological. A few of them are:

Management factor:

1. No service at all.

Physiological factors:

1. Failure of conception, may be due to later service and short time of heat, or infertile bull.
2. Failure of implantation of fertilized ovum.
3. Anatomical abnormalities of the reproductive tract.

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[13]Sorensen, et al., op cit., p.15.

Pathological factors:

1. Infections of the genital tract.
2. Early embryonic mortality.

These factors, although important, are beyond the scope of the present study.

Heritability of Fertility

Available literature was reviewed and incorporated in the study to see if inheritance of fertility has anything to do with the age at first service and calving, conception rate and other allied factors.

Much work has been done on the study of fertility as an inherited character. Dunbar and Henderson[14] analysed data for artificially inseminated females and found the heritability rate of non-return after artificial insemination to be .004 and that of calving interval to be zero.

Pou et al.[15] analysed the data of a large herd and found the heritability of estrous-cycle length regularity to be 0.05, of service per conception 0.07 and of days

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[14] R.D.Dunbar, Jr., and C.R.Henderson, "Heritability of Fertility in Cattle," Journal of Dairy Science, Vol. XXXVI (1953), pp.1063-71.

[15] J.W.Pou, et. al., "A Study of Breeding Efficiency in the Beltsville Dairy Herd," Journal of Dairy Science, Vol. XXXVI (1953), pp. 909-15.

from first service to conception to be also 0.07.

Carman[16] found the heritability of days to first estrus after calving, days to conception and number of services per conception, to be zero.

Rottensten and Touchberry[17] while working on the data of Danish Progeny Testing Stations found the heritability of high conception rate to be zero, although, the heritability of expression of heat symptoms was as high as .21.

It can be concluded from the above discussion that age at first calving can be reduced only by better feeding and management since the available evidence indicates that genetic factors influencing fertility are overshadowed by environmental factors.

I can safely say from my experience at the Qadirabad Farm from which the data for this study came that the animals there were not getting the required level of nutrition. This was because of a large number of animals with a limited area available for fodder cultivation and a limited quantity of concentrates available. These

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[16] G.M. Carman, "Interrelations of Milk Production and Breeding Efficiency in Dairy Cows," Journal of Animal Science, Vol. XIV (1955), pp. 753-59.

[17] K. Rottensten and R.W. Touchberry, "Observations on the Degree of Expression of Estrus in Cattle," Journal of Dairy Science, Vol. XL (1957), pp. 1457-65.

management factors appear to be important reasons for the late age of first calving of the great majority of the heifers.

A lot can be done in this direction and this will definitely reduce the age at first service. The Dajal female has the character of early maturity provided the right quantity as well as quality of feed is provided to it. Many calves under the research study had a growth rate of a pound a day for a considerable period of time until either their ration was reduced due to non-availability of feed, or a management decision was made, or the influence of adverse season such as winter in combination of one or both the above factors. The effect of winter season on growth will be discussed in one of the later chapters.

These checks on growth could have been avoided by better management, thereby lowering the maturity age of heifers, and, finally the cost of calf at birth.

Calving Interval Between Two Successive Calvings

Following age at first calving, the other factor which influences the milk yield of a cow during a lactation and her productive life and thereby affects the cost of the calf, is the calving interval.

It was found by Salisbury and Van Demark through the analysis of breeding records that cows calving every

twelve months have a higher milk yield per day of the interval between calvings.[18]

Amble and coworkers[19] while analysing the data for various breeds of Indian cattle, found the calving interval to be non-heritable. Singh,[20] on the other hand found that age at first calving has no influence on the length of interval between the first and second calf of a cow. He also found his findings to be in agreement with other workers.

Data for the Dajal cattle on Qadirabad Farm was analysed for the first four calvings according to the various lengths of calving interval groups. The results are reported in Table 12. It will be apparent from this table that when all the four lactations are considered, the maximum amount of 7.69 pounds of milk per day of lactation was obtained from the group whose calving interval was 350-399 days, the average being 375 days. This was followed by 7.61 pounds per day of lactation in the group

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[18] Salisbury and Van Demark, op cit., p.573.

[19] V.N. Amble, K.S. Krishnan and P.N. Soni, "Age at First Calving and Calving Intervals for Some Indian Herds of Cattle," Indian Journal of Vety. Science and Animal Husbandry, Vol. XXVII (1958), pp.83-92.

[20] O.N. Singh, "Age at First Calving and its Relation to Calving Interval in Dairy Cattle," Indian Journal of Dairy Science, Vol. X (1957), pp. 63-66.

TABLE 12

AVERAGE CALVING INTERVAL, DAYS IN MILK, MILK YIELD, WET AVERAGE, OVERALL AVERAGE AND NUMBER OF DAYS OF GESTATION IN MILK FOR THE FIRST FOUR CALVINGS ACCORDING TO VARIOUS CALVING INTERVAL GROUPS FOR GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950-61

Calving Interval (Days)	Number of Calvings	Average Calving Interval (Days)	Average Days in Milk	Average Milk Yield (Pounds)	Pounds Milk Per Day in Milk	Overall Average	No. of Days of Gestation Period in Milk
Up to 349	86	330.96	213.14	1515.91	7.11	4.58	168
350 - 399	119	375.22	222.62	1712.04	7.69	4.56	134
400 - 449	121	424.23	229.93	1750.40	7.61	4.15	92
450 - 499	96	473.66	234.14	1738.21	7.42	3.67	46
500 - 549	56	523.38	229.20	1651.25	7.20	3.15	- 8
550 - 599	59	573.36	262.54	1959.17	7.46	3.42	- 25
600 and over	155	693.37	264.24	1876.11	7.10	2.70	-143
All intervals	692	484.88	236.54	1743.30	7.37	3.75	37
Herd Average		493.38	234.63	1742.06	7.42	3.53	..

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

with 400 to 449 days calving interval. The overall average milk yield of 4.56 and 4.15 pounds per day of calving interval was next highest in the two respective groups after 4.58 pounds in the group of calving interval up to 349 days.

Apparently, the average milk yield of a lactation increases as the calving interval increases up to the calving interval group of 400 to 449 days, then starts declining as the calving interval increases. This increase in milk yield seems to be due to delayed conception and longer lactation period. Earlier conception results in a double pressure on the cow, one for the prenatal development of the calf and the other for milk production, which pressure delayed conception reduces.

Maximum yield of 1,959 pounds in a lactation is in the calving interval group of 550 to 599 days. This may be due to the reason that most of the high milking cows having a long calving interval fall in this group. However, average milk yield of 7.46 pounds per day of milking and overall average of 3.42 pounds per day of calving interval in this group was relatively less as compared to other smaller calving intervals where it was comparatively more. This gives an indication that apparently there is an increase in the milk yield in a lactation due to an increase in calving interval (due to late conception and

longer lactation period) but absolute advantage is in the short calving interval, where overall milk yield per day of calving interval will result in more milk in the productive life of the cow.

In Table 13 the data have been analysed according to various calving interval groups for the first lactations only. It will be seen from this table that maximum milk per day of calving interval was in the first group of up to 349 days calving interval followed by the next two calving interval groups. Age at first service of 1,039.68 days and age at first calving of 1,349 days in the calving interval group of 400 to 449 days are practically equal to the herd average of 1035.8 and 1346.4 days respectively. For arriving at the most economical calving interval under present conditions we may consider this as representative of the herd, although its use has its own limitations as it can be reduced by better feeding and management.

One thing more to be noted from Table 13 is that as the age at first service and calving increases, calving interval between the first two calves is reduced. Conversely as the age at first calf goes down, the first calving interval increases. The apparent reason for this trend appears to be the nutritional one. The nutritional level on which the heifers are raised is poor, as will be discussed in a later section. The heifers which conceive

TABLE 13

ANALYSIS OF BREEDING DATA FOR DAJAL CATTLE FOR FIRST CALVINGS ACCORDING TO VARIOUS CALVINGS INTERVAL GROUPS, GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD
1950 - 1961

Calving Interval (Days)	Number of Cows in the Group	Average Age at First Service (Days)	Average Age at First Calving (Days)	Average Calving Interval (Days)	Average Service Period (Days)	Average Days in Milk	Average Milk Yield (Pounds)	Average per Day Milk Yield (Pounds)	
								During Lactation	During Calving Interval
Up to 349	15	1086.25	1380.50	331.27	45	228.93	1623.67	7.09	4.90
350 - 399	27	1020.57	1310.14	378.74	93	221.22	1569.70	7.10	4.14
400 - 449	28	1039.68	1349.12	424.46	138	229.28	1824.50	7.96	4.30
450 - 499	24	1002.83	1353.96	474.67	189	226.25	1628.33	7.20	3.43
500 - 549	22	978.56	1307.28	519.95	234	217.82	1524.45	7.00	2.93
550 - 599	16	978.88	1270.69	578.00	292	242.06	1903.19	7.86	3.29
600 and over	62	964.42	1270.37	692.02	404	250.03	1631.60	6.52	2.36
All intervals	194	998.50	1309.23	526.10	240	233.68	1660.05	7.10	3.16
Herd average for first lactation	222	1035.77	1346.42	526.76[a]	240[a]	233.04[b]	1598.33[b]	6.86	3.03

[a]Average for 196 animals.

[b]Average for 241 animals.

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

at an early age do not get full requirements for growth and pregnancy and later for production of milk. So they need a longer time to make good the loss of energy used up in pregnancy and production, which results in a longer time to come in heat for the second calf.

Most Economical Calving Interval Under Existing Management Conditions

Calving interval, as already discussed, is influenced much more by non-genetic factors such as feeding and management than by genetic. If calving interval can be reduced to an average of 400 days (under the existing management conditions) with the present average milk yield of 1,731 pounds (average for 350 to 399 and 400 to 449 days calving interval groups in Table 12), this will result in one additional calf during the average productive life of a cow of 2,047.53 days (Appendix B). In addition an additional quantity of 1,617 pounds of milk produced during four lactations will be available, when the present age at first calving is taken as it is and only calving interval is reduced.

When the production of calves and milk is calculated with the age at first calving reduced to 900 days, two additional calves and 3,556 pounds of more milk per cow is obtained (Appendix B).

It has been shown in Appendix C that by reducing the

age at first calving to 900 days and the calving interval to 400 days, keeping other factors unchanged, the cost of calf at birth will reduce by Rs. 153.92. This cost may lowered further by better management, when well fed and cared for cow will yield more milk approaching its inherited capacity.

With the cost of calf at birth reduced by Rs. 153.92, other costs accounted for in production such as interest on invested capital, costs due to mortality etc. will also go down, finally reducing the cost of mature bull or heifer.

Lactation Period and Lactation Yield

Lactation period, lactation yield, and length of dry period of a cow are inter-related. However, there is a general relation that yield tends to increase within inherited capacity with the length of lactation period. Although the capacity to produce milk during a lactation and quantity of milk produced per day of lactation is inherited by a cow from its parents, yet the exhibition of this latent capacity depends upon proper feeding, care and management of the cow. Calving interval, on the other hand, has a very low heritability and is strongly influenced by the environment and management. Calving interval in its turn is composed of two parts; dry period and lactation

period.

It will be seen in Table 14, where data had been analysed according to calving intervals for the first four lactations, that longer the calving interval, the longer is the dry period. On a percentage basis, when the calving interval is 143 percent of the average (average calving interval of first four lactations for the herd being taken as 100), the dry period is 172 percent of the average (herd average taken as 100, as above). Dry period continuously increases as the calving interval increases, as does the lactation period but the increase in calving interval causes an increase in dry period in a larger proportion as compared to the lactation period, the rise which is relatively less. It will be seen by a casual look at the various components of the Table 14, that in Dajal cattle proportionate increase in dry period is much more than lactation period due to a rise in calving interval. Furthermore, average production of milk per day of calving interval goes on decreasing as the calving interval increases. This is due to the fact that total milk produced in a lactation is relatively fixed within the inherited capacity and management practices and same milk yield in a longer calving interval is to be spread over a longer period to obtain per day average.

The facts discussed above, and the data in Table 14,

TABLE 14

CALVING INTERVAL, DRY PERIOD, LACTATION PERIOD, LACTATION YIELD, AVERAGE MILK YIELD PER DAY OF LACTATION AND CALVING INTERVAL ACCORDING TO CALVING INTERVAL DISTRIBUTION FOR THE FIRST FOUR LACTATIONS OF DAJAL COWS AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950 - 1961

Calving Interval Range (Days)	Calving Interval (Days)		Dry Period (Days)		Lactation (Days)
	Average	Percent of 1 to 4 Lactations Average	Average	Percent of 1-4 Lactations Average	Average
Up to 349	330.96	68.26	117.82	47.45	213.14
350 - 399	375.22	77.38	152.20	61.30	222.62
400 - 449	424.23	87.49	194.30	78.26	229.93
450 - 499	473.66	97.69	239.51	96.47	234.14
500 - 549	523.38	107.94	294.20	118.50	229.20
550 - 599	573.36	118.25	310.81	125.18	262.54
600 & over	693.37	143.00	429.13	172.84	264.24
Averages for 1 to 4 Lactations	484.88	100.00	248.28	100.00	236.54

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

TABLE 14 --Continued

Period	Lactation Yield (Pounds)		Average Number of Pounds of Milk per Day			
			During Milking Period		During Calving Interval	
Percent of 1-4 Calvings Average	Average	Percent of 1-4 Calvings Average	Average	Percent of 1-4 Calving	Average	Percent of 1-4 Calving
90 .11	1515.91	86.96	7.11	96.47	4.58	122.13
94.12	1712.04	98.21	7.69	104.34	4.56	121.60
97.20	1750.40	100.41	7.61	103.26	4.15	110.67
98.98	1738.21	99.71	7.42	100.68	3.67	97.87
96.90	1651.25	94.72	7.20	97.68	3.15	84.00
110.99	1959.17	112.38	7.46	101.22	3.42	91.20
111.71	1876.11	107.62	7.10	96.34	2.70	72.00
100.00	1743.30	100.00	7.37	100.00	3.75	100.00

show that the length of calving interval is related to the length of dry period. When the length of the calving interval is extended due to failure of the cow to conceive, the dry period is lengthened correspondingly as the length of time between calves increases, the amount of milk produced per day of calving interval is reduced and so is the total amount of milk produced during the life of the cow.

Factors Affecting the Length of Dry Period

As discussed earlier, though calving interval is responsible for the length of dry period, it is not measurably influenced by inheritance. It is influenced by environment, feeding and management. Calving interval in its turn is increased by delayed conception of the cow. The delayed conception is the result of either the period before first service after calving being long, or more than one service being required before the cow conceives. Factors responsible for this delayed conception are: (1) diseases of the reproductive tract, (2) functional causes, and (3) faulty management.

1. Diseases of the Reproductive Tract

   The number of abortions on the farm was very small. Although the herd was not tested for any infectious diseases of the reproductive tract, yet

it is presumed that this factor was responsible to a very small extent, if any, for the delayed breeding, as judged from the abortions and clinical evidence.

2. Functional Causes

Functional causes include: (a) cystic ovaries which cause a cow to remain in continuous heat; (b) persistent corpus luteum, when the cow does not come in heat; (c) death of the embryo, when the cow usually again comes in heat after more than 30 days following previous service; and (d) anatomical abnormalities of the reproductive tract, that is, deformation of some of the reproductive organs. All the above functional causes can be eliminated by either better management or early diagnosis and treatment. Or, if not treatable, the animals can be disposed of and loss due to maintenance expenses can be stopped. As for the embryonic mortality, it has been reported[21] that embryonic death within 30 to 40 days after insemination or service is the cause of the loss of about 15 percent of potential calves. Hard-to-settle cows have a lower fertilization rate and a considerably

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[21]Salisbury and Van Demark, op cit., pp. 482-83.

greater embryonic mortality. Aging of the ovum due to late service has also been given as a possible cause of embryonic mortality.

3. Faulty Management

Under this head can be discussed:

a. Wrong Time of the Service

When a cow is bred too early or too late in the estrus period, the chances of fertilization of the ovum are much reduced. Furthermore, there are much greater chances of embryo dying. It is recommended that cows be bred during the second half of the standing heat. Cows should not be bred earlier than six hours after the beginning of heat or later than six hours after its end.[22] It has been reported that service at the beginning of heat is 44 percent successful in causing conception whereas conception rises to 80 percent by mid-heat and remains at that level until the end of heat. Four hours after the end of heat conception rate drops to 60 percent and only 32 percent of the cows conceive when bred after 12 hours following the end of

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[22] A.S. Asdell and H.J. Bearden, Reproduction of Farm Animals, Cornell Extension Bulletin 305 (Ithaca: New York State College of Agriculture at Cornell University, 1960), pp.21,22.

heat.[23] After 36 hours of cessation of heat insemination is practically without result.[24]

b. No Service During Heat Period

Since estrous cycle in cattle is of 21 days, a heat missed means a delay of at least 21 days in the birth of next calf.

c. Breeding Either too Early or too Late After the Calving

It has been shown by different workers that breeding too early after calving reduces the rate of conception. The uterus generally recovers to its normal shape, size and colour about 60 days after the parturition.[25] The cows are recommended to be bred 60 to 90 days after calving.[26] Before this period a lesser number of cows conceive at the first service and most of the cows require more than one service to

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[23] A.S. Asdell and H.J. Bearden, Sterility and Delayed Breeding in Cattle, Cornell Extension Bulletin 737 (Ithaca: New York State College of Agriculture at Cornell University, 1959), pp. 18-21.

[24] H.H. Duke, The Physiology of Domestic Animals (Ithaca: Comstock Publishing Company, 1955), pp. 923-24.

[25] Asdell and Bearden, Cornell Ext. Bull. 305, op cit., p. 24.

[26] Salisbury and Van Demark, op cit., pp. 456-58.

conceive.[27] The conception rate increases as the interval between calving and breeding lengthens up to 90 days.[28]

The average service period (length of time before the cow is bred after calving) for Dajal cattle maintained at Qadirabad Farm from first to tenth lactations is given in Table 15. The service period is the longest in case of first calvers for which it was 239.89 days. After second lactation, where it was 183.15 days, it starts rising at a steady rate up to sixth calving for which it was 217 days before the cow was bred to conceive the seventh calf. It again starts declining, reaching a minimum of 170 days at the eighth lactation. This decline may be attributed to selection as after this age only very high producers remain in the herd. This is also confirmed milk yield for this lactation which is 1961 pounds, the maximum for all lactations except tenth in which group only two cows were present and this number is too small for any reliable conclusion.

The length of service period is influenced by:

1. Fertility Level of the Bull and Cow

Lowered fertility in males and females can be

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[27] Asdell and Bearden, Cornell Extension Bulletin 305, op cit., pp. 21-24.

[28] Ibid., p.24.

TABLE 15

AVERAGE LENGTH OF SERVICE PERIOD FOR SUCCESSIVE CALVINGS BY DAJAL COWS MAINTAINED AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950 - 1961

Number of Calving	Number of Cows	Average Service Period (Days)[a]
1	196	240
2	186	183
3	178	191
4	134	202
5	96	206
6	61	217
7	32	197
8	11	167
9	3	203
Average	897	205

[a]Decimal points have been rounded of to the nearest integer.

Source: Unpublished breeding data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

due to any one of many causes or a combination of several causes. Lowered fertility of either the bull or cow can result in the failure of a cow to conceive, thereby ending in a repeat service and longer interval before conception.

2. Level of Milk Production of the Cow

Studies conducted by Olds and Seath[29] and Branton et al.[30] indicate that the level of production affects the recurrence of estrus after calving significantly but studies conducted by other workers,[31] as also reported by Salisbury and Van Demark,[32] indicate that there is no relationship between level of production and number of services required for conception. Furthermore, Dajal breed is not a milch breed and production

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[29]D. Olds and D.M.Seath, "Repeatability, Heritability and Effect of Level of Milk Production on the Occurrence of First Estrus After Calving in Dairy Cattle," Journal of Animal Science, Vol. XII (1953), pp. 10-14.

[30]C. Branton, W.S.Griffith, H.W.Norton and J.G.Hall, "Influence of Heredity and Environment on the Fertility of Dairy Cattle," Journal of Dairy Science, Vol. XXXIX (1956), p. 933.

[31]L.J.Boyd, D.M.Seath, and D.Olds, "Relationship Between Level of Milk Production and Breeding Efficiency in Dairy Cattle," Journal of Animal Science, Vol XIII (1954), pp. 89-93.

[32]Salisbury and Van Demark, op cit., p. 577.

per lactation appears to be too small to exert any appreciable influence on the service period.

3. Season of the Year

Light appears to be the factor involved in the seasonal effect on fertility. Under wild conditions late spring and early summer months are the mating times for cattle. Lowest fertility has been reported in summer, when the excessive heat counteracts the beneficial effects of long day-light hours. In fall and winter fertility is said to be at an intermediate level, whereas the highest fertility has been reported in spring, with increasing day-light hours.[33]

In Table 16 the monthly distribution of calves born at the Qadirabad Farm has been presented. The smallest number of births was during the period of August to October, indicating that the lowest number of cows came in heat or conceived during November to January. This is the period of extreme cold and shortest day-light hours. Unfortunately, this is also the time of fodder scarcity on the Farm due to the cold season. The animals have to undergo two stresses during this period

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[33] Ibid., pp. 524 and 527.

TABLE 16

MONTHLY DISTRIBUTION OF CALVINGS AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, FOR THE YEARS 1950 - 1960

Month	Number of Calves Born	Percent of Total
January	159	12.49
February	177	13.90
March	138	10.84
April	191	15.00
May	176	13.83
June	96	7.54
July	93	7.31
August	42	3.30
September	26	2.04
October	34	2.67
November	48	3.77
December	93	7.31
Total	1273	100.00

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

which are shelterless cold wintery nights and shortage of good quality fodder. The low fertility due to short day-light hours is enhanced by the above two factors during this period.

On the other hand, birth of calves starts rising in November, reaching a peak in April and then declining till the end of June and first part of July. This start of births in November, indicates the services in February, which coincide with the end of winter and beginning of spring. February to May is also the season of abundance of Berseem (clover) green fodder. This has an additional effect of flushing on the cattle. Flushing increases the conception rate.[34] Better fodder situation, augmented by increasing day-light hours from February onward until May, results in a calf crop from November onward. Cows calving from May to October have to pass through the cold season of November to January, in which period the lowest number of cows conceive due to the factors discussed earlier, thereby finally resulting in prolonged calving interval before the next calf.

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[34]J.N.Wiltbank, "What's New for Beef," Successful Farming, Vol. LX (August, 1962), p. 17.

The findings are in agreement with Kohli and Suri[35] on Hariana cattle where the maximum percentage of calvings was in January to March, starting from December and ending in April, with the minimum percentage during August to November. The interval between calving and next fertile service was shorter than normal during the period of September to February and longer during the months of March to August in the Hariana cattle in the above study.

Findings of other workers with Hariana breed are also in conformity with the above results.[36] As compared to the above, the maximum number of calvings was obtained in April to June, nearly 10 percent each month, and minimum number of cows calved in December and January, 6.4 and 6.8 per cent respectively in Kangayam breed at Hosur.[37]

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[35] M.L.Kohli and K.R.Suri, "Breeding Season in Hariana Cattle," Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXX (1960), pp. 219-223.

[36] G.P.Sharma, K.N.Vali and K.R.Suri, "Studies on the Hariana Breed of Cattle," Research Bulletin of the East Panjab University, No.18 (1951), pp. 57-68.

[37] V.N.Amble and K.S.Krishnan,"Statistical Studies on Breeding Data of Indian Herds of Dairy Cattle. II. Kangayam Herd at Hosur," The Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXX (1960), pp. 1-29.

For Red Sindhi breed at the same farm, there was little fluctuation, maximum calvings being in October and November and minimum in January. For Red Sindhi breed at Bangalore, maximum calvings were in January and February, which was 10.9 and 11.2 percent respectively and minimum of 6.2 percent in April.[38]

All these data indicate that seasonal fluctuation in fertility can be influenced by feeding practices and management. If proper attention to feeding and management is given to Dajal cattle, the influence of season on fertility can be reduced to a large extent, if not eliminated. Thus the length of service period and calving interval can be reduced.

In Table 17, breeding data of the Dajal cattle at Qadirabad Farm is presented to show the number and percentage of cows whose first service period is less than and more than 120 days. It can be seen that the number of cows having first service period below 120 days went on increasing from first to third lactations, where the number

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[38] V.N.Amble, K.S.Krishnan and J.S.Srivastava, "Statistical Studies on Breeding Data of Indian Herds of Dairy Cattle, I-Red Sindhi Herds at Hosur and Bangalore," Indian Journal of Veterinary Science and Animal Husbandry, Vol XXVII (1958), pp.33-82.

TABLE 17

BREEDING DATA OF THE DAJAL CATTLE MAINTAINED AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, ACCORDING TO NUMBER AND PERCENTAGE OF COWS WITH SERVICE PERIOD BELOW AND ABOVE 120 DAYS, 1950 - 1961

Order of Lactation	No. of Cows in the Group	First Service Period Below 120 Days				First Service Period Beyond 120 Days			
		No. of Cows	Percent of the Group	Conceived on 1st Service	Repeat Services Required	No. of Cows	Percent of the Group	Conceived on 1st Service	Repeat Services Required
1	196	59	30.10	40	19	137	69.90	120	17
2	186	68	34.95	57	11	118	65.05	93	25
3	178	85	47.75	59	26	93	52.25	77	16
4	134	56	41.79	44	12	78	58.21	65	13
5	96	38	39.58	29	9	58	60.42	49	9
6	61	23	37.30	14	9	38	62.70	28	10
7	32	14	43.75	12	2	18	56.25	13	5
8	11	6	54.44	2	4	5	45.56	5	-
9	3	-	-	-	-	3	100.00	3	-
Total	897	349	38.91	257	92	548	61.09	453	95

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

increased from 30 to 48 percent, after which it declined up to sixth lactation. The ratio then increased again, which may be attributed to a few selected cows remaining in the herd. It will also be seen that most of the cows coming in heat when the service period was less than 120 days, did conceive on the first service, leaving a small percentage which did not conceive until after repeated services. Conception with first service in those cows whose service period is over 120 days is also high, leaving a small number as repeat breeders.

These data also suggest that when proper care is given, Dajal cows can be bred within three to four months after calving, to produce a calf from each cow within twelve to fifteen months. This will reduce substantially the cost of maintaining a cow during her dry period by shortening it substantially.

4. Nutritional Level of the Cow

According to Phillips, as quoted by Salisbury and Van Demark,[39] "an insufficient supply of energy (inanition, partial starvation or under feeding) is

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[39]Salisbury and Van Demark, op cit., p. 578.

probably one of the most common causes of nutritional reproductive disorders in cattle." Salisbury and Van Demark have quoted the findings of many other workers which lead to the conclusions that:[40]

a. Heifers in poor condition and stunted growth are slow in reaching sexual maturity and are apt to possess infantile ovaries. In such cases it is impossible for the animal to conceive a calf.

b. Undernourished cows show irregular heat periods and low fertility, or in severe cases, complete cessation of estrus.

According to Duke,[41] the time of puberty varies with the state of nutrition and climatic conditions. Animals kept on a high nutritional level reach puberty earlier. Well cared for and well fed dairy heifers reach puberty at about the seventh month whereas range cattle may reach puberty at about 15 months of age. These findings have been confirmed through experimental work at Cornell University Agricultural Experiment Station where influence of low, medium and high level of nutrition was

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[40] Ibid., p.579.

[41] Duke, op cit., p.879.

studied.[42]

It can safely be inferred from the foregoing discussion that the level of nutrition on which the animal has been maintained has a substantial effect on age at first calving and the length of time between subsequent calvings. Such an influence of nutrition was also noted by the writer in his research studies at the Qadirabad Farm. All the heifers in Group I, which received better nutrition than heifers in Group II (Table 5), came in heat at an average age of 960 days, while none of the heifers receiving poor feed in Group II came in heat, at this age.

5. Management Practices

Management factors responsible for age at first calving and length of time interval between subsequent calvings have been discussed at appropriate places. During my stay at the Qadirabad Farm for about three years, it was observed that all the stock, milking and dry, as well as growing, were practically shelterless and during the monsoon season they had to remain in knee deep mud. The winter season had a deteriorating effect on the

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[42]Sorensen et al., op cit., pp. 1-52.

cattle due to lack of shelter during windy and cold nights accompanied by shortage of good quality fodder and also of concentrates. The calving of the cows and heifers also coincide with this period (Table 16), thereby increasing the nutritional demand during the period of prenatal development of the calf and the subsequent milk production after parturition.

All these factors combined together lowered the resistance of cattle, finally predisposing them to diseases and increased mortality during this period.

The effect of low nutritional level was also noticed in the calves under experiment during the winter season when the calves used to lose weight instead of gaining. This decreased in weight was noticed for at least three months and an additional two months were needed to regain that lost weight.

If there are two winter seasons in the growing life of a heifer, this causes a setback of 10 months. If these ten months were utilized for growth instead of losing weight, the age at first calving would be reduced substantially, resulting in a material reduction in costs for producing calves. The effect of this winter season on length

of calving interval has not been worked out as it is a complex of season, weather, number of hours of day-light, and nutrition. However, it was noted that the lowest number of calvings occurred during August to October, the service time of which coincided with the winter months of extremely unfavourable conditions for animals.

It can be inferred, although it needs further study, that management is also a definite factor in causing low fertility, and thus affects the length of calving interval. Hence, the present calving interval at the Government Dajal Cattle Breeding Farm, Qadirabad, could be reduced materially through better management practices.

Calving Interval, Lactation Period and Milk Yield

Dajal is a draft breed of cattle bred for that purpose. Therefore, its milk production during a lactation is small. The interval between two successive calvings and number of days a cow remained in milk during a lactation are compared with other breeds of cattle in Indo-Pakistan in Table 18. In a previous study by Ishaq and Mumtaz[43] on the same farm, calving interval, milk yield and lactation

[43] S.M. Ishaq and Mumtaz Ali, "An Economic Analysis of the Influence of Delayed Breeding on Milk Production and Cost in Dajal Cows," Agriculture Pakistan, Vol XI (1960), pp.364-73.

TABLE 18

COMPARISON OF CALVING INTERVAL, LACTATION PERIOD AND LACTATION YIELD OF DAJAL CATTLE WITH OTHER BREEDS OF CATTLE IN INDIA AND PAKISTAN

Breed of Cattle	Calving Interval (Days)	Lactation Period (Days)	Lactation Yield (Pounds)
Dajal, present study[a]	493	235	1,742
Dajal, previous study[b]	501	244	1,907
Dhanni[c]			
First service conception group	404	226	1,580
Repeat breeders	554	232	1,614
Sahiwal[d]			
First service conception group	458	332	5,669
Repeat breeders	521	326	6,005
Sindhi herd at Hosur[e]	546	317	3,665
Sindhi herd at Bangalore[e]	447	264	2,684
Kangayam herd at Hosur[f]	506	264	1,416
Hariana[g]	531	273	1,750

[a]Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

[b]S.M. Ishaq and Mumtaz Ali, "An Economic Analysis of the Influence of Delayed Breeding on Milk Production and Cost in Dajal Cows," Agriculture Pakistan, Vol. XI (1960), pp. 364-73.

[c]S.M. Ishaq, "Economic Study of Breeding and Milk Production of Dhanni Breed," (Lahore: Livestock Economist, West Pakistan),(Undated and mimeographed), pp.5 & 6.

[d]S.M. Ishaq, "Economic Study of Breeding and Milk Production of Sahiwal Breed," (Lahore: Livestock Economist, College of Animal Husbandry), (Undated and mimeographed),p.4.

period were greater than found in the present study. The difference between the findings of the two studies may be the result of the differences in numbers of animals included in the averages. The present study covers nearly double the number of calvings as compared to the first one.

The average calving interval in the present study is 493 days with 235 days in milk during which period 1,742 pounds of milk were produced. The number of days a cow remained in milk was less than half the average interval of time between calvings, that is nearly 47.7 percent of the total calving interval of 493 days. The dry period in between two lactations was 258 days, which is 52.3 percent of the calving interval. Such a large dry period is uneconomical from the stand point of production of calves and feeding when the cows have to be fed and cared for during the longer time without obtaining any production of either milk or calf. This raises the cost of production

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[e] V.N. Amble, K.S. Krishnan and J.S. Srivastava, "Statistical Studies on Breeding Data of Indian Herds of Dairy Cattle, I-Red Sindhi Herds at Hosur and Bangalore," Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXVII (1958), pp.33-82.

[f] V.N. Amble and K.S. Krishnan, "Statistical Studies on Breeding Data of Indian Herds of Dairy Cattle. II-Kangayam Herd at Hosur," The Indian Journal of Veterinary Science and Animal Husbandry, Vol. XXX (1960), pp.1-29.

[g] G.P. Sharma, K.N. Vali and K.R. Suri, "Studies on the Hariana Breed of Cattle," Research Bulletin of the East Panjab University, No.18 (1951), pp.57-68.

of milk as well as the cost of a calf at birth, since this latter cost is the difference between income from and expenditure on maintaining a cow from the birth of one calf to the next.

Milk production depends upon two variables: (1) daily milk yield, and (2) number of days a cow remains in milk. The maximum milk yield during a lactation is hereditary and is transmitted from the dam and sire to the progeny. Whether a cow gives this amount of milk depends upon the feed and management care she receives.

In the present study, the data were analysed according to age at first calving. The results for the first group where age at first calving was less than 900 days (average 854 days) is reported in Table 19.

It will be seen from this table that the length of the lactation period is not consistent in various lactations although the animals are the same for all the four lactations. Maximum yield of milk in a lactation was obtained by this group in the fourth lactation.

In Dajal cattle many cows have lactations which go beyond 300 days. If proper care is exercised in the selection and breeding of stock for milk yield, the milk yield can be increased substantially. Selection of breeding animals supplemented with better feeding and management will result in increased milk yield and reduced dry period

TABLE 19

CALVING INTERVALS, DRY PERIOD, LACTATION PERIOD AND MILK YIELD FOR THE FIRST FOUR LACTATIONS FOR LESS THAN 900 DAYS AGE AT FIRST CALVING GROUP OF DAJAL COWS AT GOVERNMENT DAJAL CATTLE BREEDING FARM QADIRABAD 1950 - 1961

Order of Lactation	Number of Animals in the Group	Average Calving Interval (Days)	Average Dry Period (Days)	Average Lactation Period (Days)	Average Milk Yield (Pounds)
1	5	498	298	200	1,369
2	5	535	259	276	1,906
3	5	451	206	245	2,057
4	4	437	189	248	2,163
1-4	19	477	241	242	1,858

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

and finally the cost of feeding and caring for a cow when she is dry. This will reduce the loss, or eliminate it completely, in between the returns from and expenditure on a cow from one lactation to another. Lowering, or elimination of the loss arising from the long dry period will be reflected in the lowered cost of a calf at birth.

Selection and Breeding of Animals

In order to appraise the breeding done at the farm and evaluate the effect of sires on their progeny and also to compare the milk production of F_1 and F_2 generation cows with their respective dams, breeding and milk production data for the Dajal breed from Qadirabad Farm were analysed. The findings of the analysis are presented in the following sections.

Dam and Daughter Comparison

In order to eliminate the variations due to unequal records available for daughters and their dams for various lactations, comparisons were made over like lactations for cows and their daughters. Then the averages were compared. The data for the cows in the foundation stock when the farm was established and for their daughters and also for cows in the first generation (F_1) and in the second generation (F_2) were compared regarding lactation yield, lactation period, and calving interval. In addition, the female

stock which was purchased in the foundation stock, or females born on the farm from pregnant cows in the foundation herd and bred by unknown sires were included for this comparison. These animals were treated as foundation stock for the purpose of analysis and comparison. The results of the analysis are presented in Table 20.

It will be apparent from a casual look at this table that the first generation increased in milk production over the foundation stock by about 208 pounds in a lactation. This gain was significant at the 5 percent level. However this gain did not continue in the second generation (F_2) where the daughters produced an average of 746 pounds less milk than their dams (F_1), the reduction in yield being significant at the 1 percent level.

The lactation period of the F_1 generation was about a day shorter than for the foundation stock and that of the F_2 generation was about 14 days shorter than that of the F_1 generation. However, this loss was not significant statistically at the 10 percent level due to the wide variation among the animals.

Averaged over the first four lactations, the first generation animals had a calving interval about 91 days longer than the foundation stock. This increase in calving interval was statistically significant at the

TABLE 20

COMPARISON OF DAJAL COWS BELONGING TO DIFFERENT GENERATIONS WITH THEIR MOTHERS AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD 1950 - 1961

		Generations	
		First	Second
Lactation Yield (Pounds)	Number of pairs	183	38
	Mother	1,429.11	1,932.63
	Daughter minus mother	208.54[a]	- 746.08[b]
	Standard Error	82.67	157.43
Lactation Period (Days)	Number of pairs	183	38
	Mother	232.36	229.63
	Daughter minus mother	- .98	- 13.63
	Standard Error	6.96	15.35
Calving Interval (Days)	Number of pairs	128	18
	Mother	423.02	495.00
	Daughter minus mother	91.34[b]	46.06
	Standard Error	15.11	43.11

[a]Significant at 5 percent level (Appendix D).

[b]Significant at 1 percent level (Appendix D).

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

1 percent level. The F_2 generation had also a longer calving interval than their mothers (F_1) by about 46 days butthe difference was not statistically significant even at the 10 percent level.

Calving interval, being of low heritability, indicates to some extent variations in management practices. Apparently, as inferred from the data presented in Table 20 and discussed above, although the cows in F_1 generation were more poorly managed than the foundation stock, yet they produced 208 pounds more milk than their dams in a lactation whereas cows in the F_2 generation, receiving the same attention as their mothers (F_1 generation) as judged by calving interval, produced 746 pounds less milk than their mothers.

The maximum quantity of milk produced by a cow during a lactation is inherited from its parents. When a cow produces either more or less than its mother, then it is an indication that the bull may have been responsible for this decrease or increase. The F_1 generation produced more milk than their mothers inspite of the less care they received, as inferred from the longer calving interval. On the other hand the F_2 generation produced substantially less milk in a lactation than their mothers (F1 generation) inspite of the fact that management conditions were nearly equal, as indicated by no significant difference in the

average calving interval. These results necessitated the analysis of data to ascertain the influence of different breeding bulls on the productivity of their progeny. Findings of this analysis are discussed in the following section.

Progeny Testing of Bulls

As discussed above, the data were analysed for different bulls to see their ability to transmit milk productivity to their daughters as measured by the gain or loss of milk in the progeny over their dams. Progeny from each bull were separately compared with their dams over like lactations and the data were analysed to see the differences. The mother and daughter comparison is presented in Table 21.

The only bull whose progeny showed a substantially significant increase in milk yield over their dams was No. 1. The increase in milk yield of daughters over their dams from this bull was about 340 pounds, which was nearly 23 percent more than their dams yield. This difference was statistically significant at the 1 percent level. The daughters also remained in milk on an average 10 days longer than their dams but this increase was not significant statistically at the 10 percent level.

Progeny from bulls 3 and 4 also gave more milk than

TABLE 21

PROGENY TESTING OF DAJAL BULLS AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950 - 1961

Bull Number	Lactation Yield (Pounds)				Lactation Period (Days)	
	Daughter Mother Pairs	Mother's Yield	Daughter Minus Mother	Standard Error	Daughter Mother Pairs	Mother's Average
1	94	1463.44	339.51[a]	110.51	94	224.38
3	23	1436.35	617.00	522.13	23	244.39
4	16	1387.25	553.94	325.13	16	228.12
5	28	1380.04	-315.29[c]	151.78	28	221.21
6	6	1412.50	-238.33	342.95	6	223.50
43/1.1	16	1693.50	-577.31[b]	217.24	16	227.44
46/2.1	24	2021.75	-714.63[a]	170.94	24	239.50
47/2.1	34	1866.32	-739.70[a]	156.89	34	248.50

[a]Significant at 1 percent level(Appendix D)

[b]Significant at 5 percent level(Appendix D)

[c]Significant at 10 percent level(Appendix D)

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

TABLE 21 --Continued

Lactation Period (Days)		Calving Interval (Days)			
Daughter Minus Mother	Standard Error	Daughter Mother Pairs	Mother's Average	Daughter Minus Mother	Standard Error
10.92	10.14	69	428.10	73.41[a]	20.42
13.87	74.14	18	401.78	87.66	149.25
- 3.43	26.04	14	407.79	104.84[c]	51.76
-26.25	16.53	17	456.82	42.59	34.06
6 .17	42.56	4	372.25	166.50[a]	42.17
-14.00	19.83	7	472.14	70.72	64.61
-17.04	15.38	11	446.18	87.91[c]	46.12
-15.80	15.55	28	475.25	110.65[a]	34.91

their respective dams but the increase in milk yield was not significant because of a larger error due to greater variation amont the various daughters. Progeny from bulls 5, 43/1.1, 46/2.1 and 47/2.1 produced less milk than their dams, as would appear from the Table 21, the difference being statistically significant at 10, 5, 1 and 1 percent levels, respectively. Daughters from bull 6 also produced less milk than their dams, the difference was not significant at the 10 percent level. Furthermore, the number of daughters from this bull was too small to infer any conclusion.

The calving interval of the progeny from different bulls was more than their respective dams in all cases. Statistical significance for this variation is apparent from the table under reference. It may be mentioned here that the length of calving interval depends upon various management factors. Breeding bulls cannot be held responsible for differences in calving interval.

The above discussion, in the light of data presented in Tables 20 and 21, gives a proof that some bulls due to their genetic make-up transmit higher milk production to their daughters while others, for the same reasons, do not, and in fact reduce the milk production of their daughters. Therefore, it is very important for improving the milk yield of cows to test the bull for its

ability to transmit high milk production capability to its progeny. If this had been done at the Qadirabad Farm, the milk yield of the herd would not have gone down, which resulted in increased cost of the calves produced.

If progeny-tested proven sires are used for breeding, milk yield of the herd will increase. This will reduce the loss in maintaining a cow from lactation to lactation, and finally the cost of the calf at birth. Sires should also be proved regarding early maturity of the offspring. This would also reduce the cost of raising a heifer to breeding age and thus contribute to lowering the cost of producing a calf.

Reducing the Cost of Raising a Calf

Costs of raising a calf include those of feed, labour, housing, equipment, and miscellaneous costs, addition to costs due to mortality, and interest on capital invested. Various factors contributing to these costs are discussed in detail in the following pages.

Feed

In feed cost for raising a calf, milk was found to be the largest single major item in the study of expenses for raising calves to maturity. For it constituted about 34 percent of the total feed costs and the second major

item for Group I, where, because although the quantity fed was greater, the item constituted 32 percent of the total feed costs, as shown in Table 5, earlier. The milk fed per calf amounted to nearly 800 and 700 pounds in Group I and Group II respectively. In case of poor milkers, all the milk was allowed to the calves. Cows producing larger quantities of milk had one or more quarters not milked, according to the desired amount of milk to be allowed to their calves. The milk content of a quarter was determined from the amount of milk recorded each week when each cow was milked completely. Weaning was not practiced due to the fact that cows which were poor milkers used to go dry when their calves were weaned.

Turk and Burke[44] have recommended various levels of restricted milk feeding supplemented by calf starter, where the maximum level of milk fed was 347 pounds and the minimum 175 pounds.

A study conducted by the Department of Agricultural Economics at the Cornell University[45] on costs and returns in raising dairy heifers showed the quantity of milk fed to be 470 pounds per heifer plus 34 pounds of milk substitutes. In that study, it was found that milk

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[44]Turk and Burke, op.cit., pp. 7-13.

[45]Cunningham, op. cit., p.5,

constituted about 14.6 percent of the total costs and milk plus milk-substitutes taken together formed about 16.3 percent of the total feed costs. In another study in Orange County in Florida by Cribbett and Greene,[46] 38 gallons of whole milk (380 pounds) and 18 pounds of milk substitutes were fed to the growing heifers. This was supplemented with calf starter and other dairy mixes later on.

The figures of the present study, when compared to the above two studies, show that milk fed to calves at Qadirabad Farm in quantity as well as in cost is too high. On the other hand, the amount of concentrates fed to the calves under study was too small.

The total T.D.N. of whole milk is only 16.3 percent as compared to 76 percent in barley, 72 to 84 percent in corn and approximately 70 percent in cotton seed cakes.[47] There is not much difference in prices of fresh milk and these concentrates on a pound to pound basis. If the quantity of milk fed is reduced and quantity of concentrates increased, four to five times more energy can be supplied

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[46] A.F.Cribbett and R.E.L.Greene, Costs and Returns in Raising Dairy Heifers, Six Farms, Orange County, Florida, 1960, Agr. Econ. Series No.60-11 (Gainesville: Florida State University, 1961), p.7.

[47] F.B.Morrison, Feeds and Feeding, 22d ed. Unab. (Clinton, Iowa: The Morrison Publishing Company,1959), pp. 1044, 1048, 1050-1052, and 1056.

to the calves for the same cost. This will increase the development and growth rate of calves and they will attain maturity at an earlier age. Overall reduction in feeding cost will be considerable due to the earlier maturity as discussed in the section on age at first service and calving.

Green fodder, followed by dry fodder, was the main feed cost item for both the groups. Good management in the form of quality, quantity and time of feeding supplemented by maturity at early age will reduce this cost item to a considerable extent. Quantity and cost of concentrates fed, in fact, is too small and should be increased if proper nutritional requirements are to be supplied to the calves. This increased cost will, in fact, pay by reducing the age of reaching maturity.

During the course of the study at Qadirabad Farm it was noted that the calves used to lose weight during the months of December to February, due to adverse effects of winter and shortage of feed. Balanced rations during this period, supplemented by better management in protecting the calves from cold and rain in winter, will not only maintain but will increase the previous weight and growth, thereby reducing the age of reaching maturity.

The fact that underfeeding delays the maturity age in heifers as well as bulls was confirmed by various

studies at Cornell, as discussed earlier. In short, the studies conducted at the above University showed that the heifers which were fed liberal rations came in heat at an average age of 37 weeks as compared to 49 weeks for heifers fed at a medium level of nutrition and 72 weeks for those on a low level of nutrition. Similarly, bulls receiving a liberal amount of feed produced live sperm at an average age of 37 weeks as compared to 43 weeks for those fed on medium rations and 51 weeks for the bulls which were underfed.[48] In another study at the same University, the bulls raised on a high level of nutrition came into semen production at an age of 39 weeks, on a medium level at 46 weeks and on a low level at 58 weeks of age.[49]

Not only the total quantity of roughages fed but quality also counts in the rate of growth and development of calves. Different stages of maturity of grasses and roughages have varying effects on the growth of calves. This was confirmed in addition to other workers, by

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[48] R.W. Bratton, et al., Causes and Prevention of Reproductive Failures in Dairy Cattle. II. Influence of Underfeeding and Overfeeding from Birth to 80 weeks of Age on Growth, Sexual Development, and Semen Production of Holstein Bulls, Cornell Univ. Agr. Exp. Sta. Bul. 940 (Ithaca: New York State College of Agriculture, 1959), pp. 1-45.

[49] R.W. Bratton, et al., Causes and Prevention of Reproductive Failures in Dairy Cattle. III. Influence of Underfeeding and Overfeeding from Birth Through 80 Weeks of Age on Growth, Sexual Development, Semen Production, and Fertility of Holstein Bulls, Cornell Univ. Agr. Exp. Sta. Bul. 964 (Ithaca: New York State College of Agriculture, 1961), pp. 1-24.

Hemken et al.,[50] in a study at the New York Agricultural Experiment Station where in a trial calves receiving four pounds of concentrates and late cut hay did not grow as much as the calves fed good quality early cut hay and two pounds of concentrates. Thus, it is necessary for the management to be efficient in all details, giving particular attention to supplying feeds and supplements to meet the nutritional requirements for normal growth and early sexual maturity.

Labour

Labour accounts for the fifth item in the cost of production and amounts to approximately Rs. 30.00 per calf. Nearly 200 man-work hours were spent on each calf up to its attaining 2.5 years of age. Time spent on feeding and caring of each calf under the present study was nearly six times as much as was spent in raising dairy heifers in New York[51] where 35 hours were spent per heifer. The increase in time spent at the Qadirabad Farm was due primarily to the fact that calves have to be looked after

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[50] R.W. Hemken, G.W. Trimberger and K.L. Turk, Growth Rate of Dairy Calves Fed on Hay Harvested at Different Stages of Maturity and on Two levels of Grain, Cornell Univ. Agr. Exp. Sta. Bul. 933 (Ithaca: New York State College of Agriculture, 1958), pp. 25-26.

[51] Cunningham, op.cit., p. 5.

for a longer period to attain maturity. The amount of money spent per calf on this item will come down as the maturity age is reduced and also as management is improved so that each man will look after more calves.

Housing

The cost of housing at the Qadirabad Farm was too little to be reduced further. Instead, better housing facilities need to be provided. This will, in the first instance, increase the housing cost but will be economical due to protecting the calves from cold and rain in winter, thereby preventing the loss of weight and increasing the rate of growth when supplemented by better feeding. Secondly, better housing facilities will reduce the mortality due to better hygienic conditions. I may mention here that during the period of 1957 to 1961 there were three outbreaks of various diseases on the Farm, namely foot-and-mouth disease in 1957, claiming the lives of more than 80 animals, mucosal disease complex in 1959, claiming many calves in the age group 1 to 3 years, and black quarter. Thus, sanitary barns supplemented with good management and feeding, will reduce these outbreaks.

Equipment

This item consists of only the cost of ropes. The cost, although small, can still be reduced by using iron

chains instead of ropes which have to be replaced every four to six months.

Miscellaneous Costs

This item covers the medical charges per calf, and forms a minor item of cost.

Costs Due to Mortality

This is the third biggest single item in the cost structure after the cost of calf and feeding. Table 22 shows the deaths of young stock at the Qadirabad Farm for the period 1950 to 1960. It will be seen that the maximum number of deaths occurred in the first month of life. The mortality in the first quarter of life is 33 percent of the total deaths up to 2.5 years of age, and this figure jumps to 68.8 percent for the first year of life.

Total mortality up to 2.5 years of age on the Qadirabad Farm from 1950 to 1960 was 218 out of 1273 calves born during this period. This gives the mortality figure of 17.12 percent up to 2.5 years of age.

Increase in cost due to mortality was Rs. 102.90 and Rs. 91.95 for each of the survivors in Group I and II, respectively, up to 2.5 years. This formed about 13.63 percent of the total cost. To arrive at the net additional cost due to mortality the amount of interest on the amount spent on calves which died has to be taken into

TABLE 22

MORTALITY OF CALVES AT GOVERNMENT DAJAL CATTLE BREEDING FARM, QADIRABAD, 1950 - 1961

Description of Animals			Males	Females	Total	Percent of Total
First Year of Life	First Quarter	First Month	18	22	40	
		Second Month	9	10	19	30.03
		Third Month	6	7	13	
		Fourth Month	1	5	6	
	Second Quarter	Fifth Month	5	-	5	8.72
		Sixth Month	5	3	8	
	Third Quarter		13	11	24	11.01
	Fourth Quarter		11	24	35	16.05
Second Year of Life			42	21	63	28.90
Third Year of Life	First Six Months		5	-	5	2.29
	Last Six Months		-	4[a]	4[a]	...

[a]Not included in the total up to 2.5 years of age.

Source: Unpublished data from the records of Government Dajal Cattle Breeding Farm, Qadirabad, West Pakistan.

account. This item has been accounted for under the item of interest in the itemization of costs.

Better housing, feeding practices, and management should, in fact, reduce the loss of calves and thus the cost due to mortality.

Interest on Invested Capital

This item represented approximately 6 to 7 percent of the total cost of raising Dajal calves up to 2.5 years of age at the Qadirabad Farm during the period of the study. This amount will automatically go down as the other costs, such as value of the calf at birth and costs of feed, labour, mortality, etc., are reduced, as well as the age when sexual maturity is reached.

Management - A Factor in Influencing the Cost of Production

The influence of management in the production of Dajal calves has been discussed in previous sections at appropriate places. To make clear its importance as an influence on the cost of production of calves, all the factors are summarised in the following pages.

Management Factors Responsible in Reducing the Cost of Calf at Birth

Better management can contribute in reducing the

cost of calf at birth by:

1. Reducing the Age of Maturity of the Heifer

The age at which a heifer reaches sexual maturity and thereby the age at first calving, can be reduced by selection of early maturing breeding animals, by better feeding, by providing proper housing, and by protecting from adverse seasonal effects. Reduction of age at first calving will result in longer productive life of the cow. Due to the increased productive life more calves and more milk can be had from the same cow, as has been shown in Appendices A and C. Better nutrition will not only increase productive life but will also result in the production of more milk per lactation as the cows will be able to produce up to their full inherited capacity.

It has been shown in the discussion in previous sections that fertility of a cow first increases, then remains constant for some time and finally starts declining. By reducing the age at first calving, this increasing fertility in the early years of the life of a cow can be made use of to get more calves from a cow and increase her total milk output due to increase in number of lactations.

2. Reducing Calving Interval

The calving interval is not inherited. It is influenced mainly by environment and management practices.

The average calving interval in Dajal cattle at the Qadirabad Farm during the period of study was 493 days, which is very long. Calving intervals as long as two years, or even longer than that are not uncommon on the farm. This indicates poor management of the farm and of animals.

Better feeding practices, supplemented by better housing etc., will reduce this calving interval in the ways mentioned previously. It has been shown in Appendices B and C that reducing calving interval to 400 days, keeping other factors as age at first calving and milk yield constant, results in an additional calf and 1617 pounds of milk during the productive life of a cow. Also, that when due to improved management the age at first calving is reduced to 900 days, which does not appear to be impossible, then more than two additional calves and 3,356 pounds of milk are obtained. To this we can add even more milk as the cow will produce to her inherited capacity due to the care and attention she will receive in the

matters of feed, etc. Even if we exclude this additional milk production, reduction of the age at first calving to 900 days and of calving interval to 400 days will result in a reduction of the cost of a calf at birth by Rs. 151.92, that is by about 62.24 percent (Appendix C).

3. Lactation Period and Lactation Yield

The maximum capacity of a cow to produce milk is inherited but production of milk up to this amount depends upon the care she receives and the management under which she is kept. A cow, though she may be a good milker, will produce less milk and go dry earlier if she is not provided with good feed and care. Faulty management can also result in delayed breeding, long calving interval and, finally, a longer dry period due to:

a. Wrong time of service, either too early or too late in the estrus.
b. No service at all due to poor vigilance on the part of the herd manager who fails to identify a cow in heat and bred her.
c. Breeding either too early or too late after calving.
d. Using an infertile bull or a bull with low fertility.

e. Maintaining the cow at an inadequate nutritional level.

f. The seasonal influence on breeding, such as the influence of extremely unfavourable cold or hot season.

All these factors can be controlled to a varying extent by better management practices resulting in more calves and milk from the cow, thus lowering the cost of a calf at birth.

4. Selection and Breeding of Animals

It has been shown in Tables 20 and 21 that poor selection of breeding bulls resulted in lower milk production by their daughters. The milk production of the dams of bulls 43/1.1, 46/2.1 and 47/2.1 was available to the management from the farm records and the performance of the mothers of bulls 3, 4, 5 and 6 could have been obtained at the time of purchase. In the absence of any definite pedigree records, the performance of the mothers of the breeding bulls would have been an indication of the milk production capacity in their inheritance. Furthermore, before putting them to breed indiscriminately and thereby spoiling the total herd, it would have been much better if these bulls would have been progeny

tested for their ability to transmit inherited milk production capacity. Poor management is to be blamed for all this negligence which has resulted finally in not only the poor performance of the cows but also in increased cost of the calves at birth due to poor production capacity of the cows. Better management in selecting breeding bulls will result in continuous improvement of the breed in regard to its milk producing capacity and also continuously lowering the cost of a calf due to improving the productive capacity of cows in the herd.

Selection of animals is not only limited to the bulls. It should be extended to the selection of cows also. A female inherits its milking capacity from both parents and so a heifer from a poor milker will be poor milker itself unless sired by a high producing bull. On the farm under study , many of the cows were such poor milkers that they used to feed their calves only and no additional milk was obtained from them. Some of the cows even failed to feed their calves. Keeping of such animals is wasteful not only for the farm but also from the national point of view when the male calves from these cows are used as breeding

bulls in the country.

Management Factors Responsible for Reducing Cost of Raising the Calf

The following management factors can help in reducing the cost of raising a calf:-

1. Proper Feeding of the Calf

Proper feeding by meeting the nutritional growth requirements of calves will result in maturity of the animals at an early age. This will result in reduced overhead costs such as housing, labour, interest charges. Furthermore, the total quantity of feed consumed will go down when properly balanced feed is provided to the calves and un-necessary cost items, such as excess milk fed are eliminated. This will reduce the total cost of feed per animal to a minimum.

Proper feeding includes also the quality of fodder fed. Roughages when cut and consumed at proper stages of maturity give much more nutrition to growing and producing cattle than late cut.

2. Labour

Total amount of labour employed in raising a calf is high at present. This will go down to some extent when the maturity age is reduced but proper management can further reduce it, which is possible

only when a man will look after more calves than at present.

3. Housing

Poor management by not providing porper housing facilities in winter, and accentuated by fodder shortage, is resulting in an increase of at least 10 months in the age of attaining sexual maturity due to retarded growth of calves. Although this slow growth rate is due to poor feeding, but absence of shelter in the long winter nights crystallises the situation. Similarly, due to the same reasons, poor housing supplemented by poor feeding or we can say poor feeding supplemented by lack of shelter in winter nights is responsible for emaciation of the animals, loss of weight, general debility, etc. Thus poor health and general debility also predisposes the animals to many common diseases, which healthy animals could resist. The final result of poor health is a higher rate of mortality.

Proper housing will protect the growing as well as adult stock from adversities of winter, monsoon season and summer, thereby improving their health, growth, and production.

4. Mortality

The present mortality on the farm is too high.

This is the result of poor management which is not providing proper feeding, suitable housing facilities, or immunization against certain infectious diseases at the proper time. Improvement in the feeding, housing facilities, and sanitation will help in checking the high rate of mortality.

Meaning of Poor Management

The term "poor management" throughout this thesis never means that the manager of the farm was personally responsible for the poor management. The responsibility lies mainly with the Department which was the custodian of the breeding policy and which could have reduced the number of animals on the farm to make the available feed sufficient for a smaller number of animals. Or instead, provision could have been made for the purchase of feed and concentrates to meet the requirements of the number of animals kept on the farm. Part of the responsibility lies elsewhere, due to which the necessary buildings to provide shelter to the animals could not be erected.

The writer does not refer the term "management" to any specific person and so no one should infer that this term was meant for him.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

From the discussion in the previous pages, it can be concluded that the present cost of production of Dajal breeding stock at the Government Dajal Cattle Breeding Farm, Qadirabad, is higher than it need to be. This high cost is the result of high mortality in calves, late maturity age of heifers, poor milk production, long calving interval resulting in fewer calves per cow, and lower life-time milk production. Due to the same factors it can be expected that the farmer breeders have a overly high cost of producing Dajal work animals. Such a cost of production, in fact, restricts the use of animals to high income farmers. Average, or lower income farmers cannot afford to have good draft power by using Dajal bullocks and have to depend upon cheaper animals from other breeds, or even using their breeding and milking animals. This reduces the work efficiency of the farmer, further lowering his income, thus continuing the vicious circle of poverty.

If the farmer wants to increase his productivity,

he will have to use good draft animals to till the land. Until the machinery power becomes common on farms in Pakistan, draft power can be increased by providing low cost and efficient draft animals and breeding stock for producing desirable type bullocks.

Thus, the present high cost of producing Dajal cattle needs to be reduced. This can be accomplished by various ways discussed previously and summarized below.

Better Breeding Practices

The present productivity of Dajal cows on the Qadirabad Farm is deteriorating, as inferred from the analyses of the data discussed in previous sections. While analysing the transmissibility of milk yield to their progeny by various breeding bulls at the farm, it was noticed that nearly all the bulls, except one, failed to improve the milk production of their offspring; rather they reduced it. It was also noticed that many cows, although they produced even less than 1,000 pounds of milk in a lactation, were retained in the breeding herd, and in addition breeding bulls from these cows were issued to various breeding areas. The result of breeding from such bulls will be, as every body is aware, that milk yield of their progeny will be what they inherit from the parents, that is it will continue to go down.

It is my opinion that all the bulls used on this institute should be progeny tested as to their transmissibility of milk production to their offspring. The present tendency of looking for draft characters only in the breeding bull will have to be changed. Milk production and early maturity must be given attention in addition to draft.

Furthermore, the breeding bulls to be issued to the breeders should be only from good producing cows, sired by proven bulls, although it will be much more useful if the breeding bulls are issued after testing their transmissibility. However, at present this may not be possible. Under such a program, a very limited number of bulls will be available for issue. To make better use of these limited bulls, the possibility of introducing artificial insemination service should be investigated. Artificial insemination service has already been introduced in many areas and its further extension can be considered.

At present, the farmers who are keeping Dajal cows in the colonised areas of Multan, Sargodha and Bahawalpur Divisions for obtaining bullocks for draft, have to keep an additional animal, such as a buffalo to produce milk for their families because the milk yield of their Dajal cow is very low. This necessitates the cultivation of larger areas of fodder and more pressure on labour. If the milk yield of a Dajal cow is increased through better breeding,

this additional animal will not be required for milk and the existing animals can be fed better, thereby increasing their productivity. If they are to be raised economically, Dajal cattle will have to be looked upon and bred as a dual purpose breed for producing milk for the family of the farmer and not only for its calf and rearing bullocks for draft power.

Better Feeding of Animals

It was mentioned in the discussions in previous sections that the animals maintained on the farm were not properly fed. They were not getting their nutritional requirements and under the conditions in which the farm was run, this was not possible. The number of animals on the farm was beyond the carrying capacity of the land. The result of keeping this large number of animals with the limited available resources was reflected in the long maturity period of heifers which was increased considerably due to underfeeding. The later maturity age decreased the productive life of a cow in the herd. This resulted in a lesser number of calves per cow. Furthermore, due to underfeeding, the milk production per lactation went down, thereby lowering the life-time production of a cow. These factors were further augmented by a longer calving interval, high mortality due to poor health, and so on.

The longer period of maturity affected the cost of raising male as well as female stock. High production cost, small number of calves per cow in her life and lower lactation, as well as smaller life-time milk yield, increased the cost of maintaining a cow over and above the receipts from her. This increased maintenance cost caused the cost of a calf at birth to be too high.

Proper feeding of animals is necessary. Over feeding is as costly as underfeeding is harmful. For proper feeding, I think, in the absence of any provision for purchase of large amounts of fodder and concentrates, the number of animals on the farm should be restricted to the number which can be fed properly. In no case should that limit be exceeded because of the harmful results.

In the feeding of calves, the quantity of milk fed per calf is too high. It can be reduced safely, provided provision is made for milk replacements and calf starter rations. Various recommended rations are available and those containing locally available feedstuffs can be prepared at the farm. This will supply more energy per rupee basis than the milk alone and the growth rate can be increased much faster for the same cost than by feeding milk.

To meet the production and growth requirements of animals, feeding of concentrates is essential unless very

high quality hay, green fodder, or silage is available. Even the best type of fodder when cut or grazed at the wrong time of maturity generally results in poor nutritional value. Present concentrate consumption per animal at the farm under study is too low, and in addition, the animals are not getting enough roughages. Necessary provision for this source of energy is essential. Some quantity of concentrates can be replaced by cheap industrial by-products such as molasses, sugar beet pulp, etc. As compared to cereals, the customary source of energy, nearly 8 times more energy can be supplied at the same cost by feeding molasses since the latter is very cheap. A sugar mill has been established at Okara at a distance of about 14 miles from the farm. The possibility of obtaining supplies of molasses from this mill should be explored.

The present practice of feeding roughages is to use either green forages or wheat straw after removal of the grain (Bhoosa, called Tibn in Lebanon) or roughages from the mature dried stalks of sorghum. As discussed earlier, it has been found that hay or straw cut at various stages of maturity differs in nutritional value. When it is cut after maturity of the straw, its feed value goes down and more quantity of concentrates are needed to supplement the feeding of such hay. To meet the nutritional requirements of cattle and feeding them at improved

standards, it is recommended that hay be made from the various crops by cutting them at the proper stages of growth when their nutritional value is at its maximum. This will ensure a cheap source of energy and will reduce the quantities of concentrates required.

Preparation of silage from green fodder is one of the best ways of maintaining its feeding value and having it for animals when other green fodder is not available. This easy and cheap source of maintaining quality fodder availability throughout the year, particularly during periods of green fodder shortage, has been totally ignored. By storing the fodder as silage at the proper time of maturity will avoid the loss of fodder during its abundance, and help preserve its quality. Furthermore, this will ensure a supply of quality roughages when needed. Ensiling the fodder should be started forthwith.

No attempt has been made to analyse the mineral contents of soils and nutritional, mineral, and vitamin contents of various fodder crops. An analysis of fodders should lead to balancing the supply of various minerals and vitamins in the concentrates fed to animals. Proper supply of minerals, vitamins and trace elements is very necessary for efficient utilization of feed, growth, and milk production.

Housing

Absence of proper housing for animals has so far resulted in the wastage of other efforts to improve the condition of the animals. It was pointed out that absence of proper housing for the cattle on the farm in winter accompanied by fodder shortage resulted in poor health of animals, loss of weight, increased mortality, lower milk production, and lowered fertility. Growing animals used to have at least five months set-back (3 months of losing weight and 2 months of regaining it) each year due to not being provided with proper housing facilities. If this period would have been utilized for growth by providing proper feed and housing, it would have reduced maturity age by at least 10 months. Some construction work was started on the farm in 1960 and 1961 and some animal barns were constructed but these were too few for such a large number of animals. In fact, each animal should be housed in winter and protected during the cold season and also provided shelter from rain during the monsoon season when they have had to stand in knee deep mud.

Arrangements for proper housing will result in maturity at an early age, increased production of milk, lower mortality rate due to better health, and greater resistance against diseases.

Management Practices

Some of the items for which management is responsible have been discussed in the previous section on breeding, feeding and housing. Some of the other items to which management should give attention are:

1. Cull all unwanted animals at a very early age to avoid loss on their maintenance.
2. Infertile animals should be culled as soon as they are detected to be unfertile and untreatable. Maintaining an unproductive cow for a year costs as much as a productive cow. Data from the farm records have shown that many unproductive cows which should have been culled long before have been kept on the farm for quite a few years. This places a burden of cost on other animals. Such animals should be disposed off as early as they are detected.
3. For early detection of unfertile cows and also for efficient production and management, cows should be tested for pregnancy regularly. This will help in early detection of unfertile cows and also help in taking care of those which are not coming in estrus due to one reason or another.
4. A well set program of disease control is a must. All the animals should be inocculated against

those diseases which are commonly prevalent in the area. Definite instructions issued by the Department of Animal Husbandry should be strictly followed. Animals should also be tested against brucellosis, tuberculosis and other contagious reproductive diseases and positive cases removed from the herd.

5. The present strength of seven bulls on the Farm for 250 cows is too high a number. Saving in this direction can be made by introducing artificial insemination, when only two bulls will be sufficient for farm and adjoining area. The two kept should be those who have definitely increased the milk yield of daughters over their dams after early maturity.

Summary of Recommendations

1. Progeny tested bulls from high producing cow should be used for breeding the cows on the farm artificially.
2. Nutritional level of the animals should be improved. This can be improved by:
   a. Feeding molasses and other industrial by-products
   b. Cutting forages at the proper stage of maturity and converting them to hay and silage to preserve their feed value.

c. Reducing the quantity of milk fed to calves and increasing concentrate feeding.

d. Analyse the composition of forages available for balancing the rations for their nutritional value.

3. Improve the housing of the animals.

4. Improve management by:

a. Culling all unwanted animals as soon as possible.

b. Culling all infertile cows.

c. Pregnancy testing cows periodically.

d. A well set program of disease control.

e. Reducing the number of bulls on the farm and introducing artificial insemination using semen from the best progeny tested bulls.

f. Reduce the calving interval through recognized good management practices.

g. Reduce the dry period and increase the lactation period by selecting high producing cows.

h. Select and breed early maturing heifers.

5. Issue to breeders only bulls from high producing cows.

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APPENDICES

APPENDIX A

Calculation of Life-time Milk Yield and Number of Calves Born per Cow According to Age at First Calving

Total and Productive Life of A Cow:

Average age at first calving . . . . . 1346.42 days

Average number of lactations a cow remained in the herd 4.15

Average calving interval . . . . . 493.38 days

Average number of days a cow remained in the herd:
= 493.38 x 4.15 = 2,047.53 days.

Average life of a cow 1,346.42 + 2,047.53 = 3,393.95 days.

Life-time Production for Cows in the up to 900 Days Age-at-First-Calving Group

Total age of a cow 3393.95 days

Average age at first calving 854.00 days

Herd productive-life of a cow = 3393.95 - 854.00
= 2,539.95 days.

Average calving interval in the group: 477.4 days

Average number of calves born by this age-group
= 2539.95 ÷ 477.4 = 5.32

Average milk yield of this group in a lactation
= 1857.8 pounds

Total milk yield during the herd-life for 5.32 calvings
= 1857.8 x 5.32 = 9,883.5 pounds.

Milk yield per day of life = 9883.5 ÷ 3393.95
= 2.91 pounds.

APPENDIX B

Calculated Productive Life Milk Yield of A Dajal Cow After Reducing the Calving Interval to 400 Days And Age at First Calving to 900 Days

Productive life of a cow = 2047.53 days (Appendix A)

Number of calves produced with 400 days calving interval

= 2047 ÷ 400 = 5.11

Present herd-life milk yield = 1742 x 4.15 = 7229.5 lbs.

Herd-life milk yield @ 1731 pounds of milk (Average for 400 days C.I.Group) for 5.11 calvings = 8846 pounds.

Additional milk yield in life due to reduction in calving interval = 8846 - 7229 = 1617 pounds.

Number of calves borne by each cow when age at first calving is reduced to 900 days and average calving interval to 400 days:

Productive life = Age at disposal - age at first calving

= 3393.95 - 900.00 = 2493.95 days

Total number of calves in 2493.95 days @ a calf every 400 days = 2493 ÷ 400 = 6.23

Total-life milk per cow with reduced age at first calf and reduced calving interval

= 1731.22 x 6.23 = 10,785.5 pounds

Additional milk produced during the productive-life of a cow by reducing age at first calving to 900 days and calving interval to 400 days

= 10,785.5 - 7,229.5 = 3,556.0 pounds.

APPENDIX C

Savings in the Cost of A Calf at Birth by Reducing to 900 Days the Age of A Heifer at First Calving And Calving Interval to 400 Days

Total life of the cow (Appendix A) = 3393.95 days.

Productive life when age at first calving is 900 days = 2493.95 days

Calves produced by a cow with 400 days calving interval = 6.23

Present cost of 4.15 calves produced in the productive life of a cow @ 247.31 each calf (Table 4) = Rs. 1026.34

Cost of each calf when we get 6.23 calves instead of 4.15 calf = Rs. 1026.34 ÷ 6.23 = Rs. 164.74

Additional income per lactation with additional 3356 pounds milk during the productive-life of a cow = Rs. 71.35

Net cost of the calf = Rs. 164.74 - 71.35

= Rs. 93.39

Savings in the cost of calf at birth = Rs. 247.31 - 93.39

= Rs. 153.92

APPENDIX D

COMPARISON OF OBSERVED AND THEORETICAL VALUES OF 't' AND NORMAL DEVIATE FOR DETERMINING THE STATISTICAL SIGNIFICANCE OF THE DATA IN TABLES 20 AND 21

Description		Normal Deviate or 't'	Observed Values	Theoretical Value		Degrees of Freedom
				Value	Probability (Percent)	
First Generation	Milk Yield	N.D.	2.522	1.960	5	364
	Calving Interval	N.D.	6.040	2.576	1	254
Second generation	Milk Yield	N.D.	4.738	2.576	1	74
Bull No.1	Milk Yield	N.D.	2.849	2.576	1	186
	Calving Interval	N.D.	3.593	2.576	1	136
Bull No.4	Calving Interval	$\underline{t}$	1.894	1.706	10	26
Bull No.5	Milk Yield	$\underline{t}$	1.901	1.673	10	32
Bull No.6	Calving Interval	$\underline{t}$	3.953	3.169	1	6
Bull 43/1.1	Milk Yield	$\underline{t}$	2.655	2.042	5	30
Bull 46/2.1	Milk Yield	$\underline{t}$	4.214	2.690	1	46
	Calving Interval	$\underline{t}$	1.906	1.725	10	20
Bull 47/2.1	Milk Yield	$\underline{t}$	4.713	2.657	1	66

Only those results have been reported which were Statistically significant in Tables 20 and 21.