ANALYSIS OF MANAGEMENT IN DAIRY FARMS

THESIS
SUBMITTED TO THE KURUKSHETRA UNIVERSITY
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
in the faculty of dairying, Animal Husbandry And Agriculture

by
AJIT KUMAR KUNDU
B Sc. (Dairying), M. Sc. (Dairying)
Division of Dairy Cattle Genetics & Breeding
National Dairy Research Institute
Karnal (Haryana) INDIA
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TO

MY

ELDER BROTHER

DR. R. K. KUNDU, M.B.B.S.

Dr. S. B. Basu, M.V.Sc., Ph.D.,
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DECEMBER 28 , 1982.

I certify that the work reported in the thesis entitled " ANALYSIS OF MANAGEMENT IN DAIRY FARMS " was carried out by Shri Ajit Kumar Kundu, under my guidance for the requirement of DEGREE OF DOCTOR OF PHILOSOPHY in the Faculty of Dairying, Animal Husbandry and Agriculture, Kurukshetra University.

(S. B. Basu)

/--7 CKNOWLEDGEMENTS

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(AJIT KUMAR KUNDU)

CONTENTS

CHAPTER-I

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INTRODUCTION

INTRODUCTION

Traditionally, dairying has figured as a mere adjunct to the farm enterprise - mix in India. Keeping of dairy animals was mainly associated with using of secondary farm produces, provide sufficient traction energy and milk was an incidental product mainly meant for home consumption. With the gradual awareness of nutrition in Indian diet, uniform acceptance for milk to be incorporated into diet by all, including nonproducers, on the basis of its international desirability, milk production was incorporated in Indian farming system in an important way in mixed farming situation.

Despite its acknowledged importance milk production in the country since 1940 did not register more than 1.1 percent per annum growth rate as against more than 2.5 percent per annum of population accentuating already fragile imbalance of demand for and supply of milk in India. It has been increasingly realised that dairy development can be identified as harbinger of bringing cherished socio-economic changes removing regional imbalance.

Enhancement of milk production is then precondition to a chain of favourable linkages leading to enhancement of standard of living of millions of small, marginal and landless farmer families.

It should, however, be recognised that milk production is a biological process and crucially depends on genetic, nutritional, economic and managerial resources at the command of a farm family. Dairy, thus can not progress unless all these factors are combined under optimal condition by a conducive management. Milk production, in essence, can be profitable under two conditions namely : i) supply of nutrients required for milk production as cheaply as possible and (ii) higher levels of production by the dairy cow, so that the proportion of feed cost to cost of milk production could be kept low.

The present economic conditions demand that not only the individual animals be high producers but should be profitable also. The object of a dairy farm owner is to ensure and improve the profitability of the dairy enterprise. Achievement of this desired economic goal needs an efficient management programme that skillfully blends husbandry, biological and economic factors and principles. Though many factors are important in contributing to the profitability of a dairy operation, the decisions of the owner or operator are important.

There are marked differences between herds in the average production per cow. Apart from differences in genetic origin, difference in management practices of the herds is another major cause for it. Every manager has to make for reaching decisions each year concerning the organization and intensity of the different farm enterprises which comprise his farm business. How effectively he manipulates the factors of production and how completely he uses his resources will in the final analysis determine the net income of the enterprise. However, some factors which are important to a high net income, such as the demand for dairy products and the price of fluid milk are largely beyond the control of the individual producer. The importance of making optimum use of all resources is recognised by almost every body. On most farms, machinery is under employed. In many instances, labour efficiency can be improved substantially by relatively inexpensive alteration in farm buildings and advance planning of daily and weekly operations. Hardin (1965) has reported an exhaustive list of determinants of a successfull manager. Among the more relevant factors, Hardin(1965) emphaisised capability of identification of specific and definable goals, realistic identification of problems and estabilishment of priorities. For achieving success a manager has to be endowed with energy, skill, initiative, risk bearing ability, technical competence, talent - based man power management, knowledged of marketing, honesty and sound business ethics.

In the context of Indian farm situation, capital and labour resources are limited. Each day, each week and each year, there are several important alternatives for which money could be spent or work applied. So, a manager has to weight the values in order to decide which purchases to make to obtain the greatest advantage with the capital available. He has to prepare a schedule of the place and time for his work to produce the greatest net return. There is also a need to make necessary adjustment in cropping pattern, farm practices and resource use structure before any advantage is realised from the dairy enterprise.

Studies on the various management practices followed in different dairy farms in India are very limited and there is a need for stepping up research work in this field. The present study is an attempt to fill the critical gap in the analysis of management in dairy farms. The study was taken up with the objectives :

1. To investigate the differences in management and other variables between average production herds and high production herds.
2. To study the relationship between various management factors and herd average milk production and dairy farm net income.
3. To determine the most efficient use of various resources that optimise :

a) highest level of production per man employed

b) profitable volume of production per productive unit

c) lowest possible capital investment per cow and

d) proper margin of net return.

The study was pursued with a hope that such study will enable one to understand the magnitude of production as affected by differences in management practices, influence of specified farm management factors on dairy farm net income and allocation of limited farm resources for maximizing the profit. It is thus likely that such a study may help further improvement in production of all types of dairy farms. With the help of quantitative analysis, an attempt has been made to suggest some breeding, feeding and management procedures for maximizing profits in dairy farming.

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CHAPTER - II

REVIEW OF

- LITERATURE -

- REVIEW OF LITERATURE -

Dairy farming is by virtue of its nature an intensive system of land use. Not all farms are, however, equally efficient in milk production. Lack of land, housing, milking facilities, water supplied, electricity, manpower efficiency etc. may all operate to preclude milk production from being a profitable enterprise. Management of dairy farms calls of judicious development of resource mix which would optimise production of milk. Considerable literature has in past been reported. This chapter is devoted to review the available literature pertaining to management of dairy farm. Additionally impact of management on the economic traits of dairy animals has also been reviewed.

I. Management practices in dairy farms

Erickson (1973) analysed the high and average milk production dairy farms with the specific objective to examine certain management factors that influence the milk production. His study revealed that the owners of high milk producing herds when compared with average producing herds would (a) not use breeding and dry dates on herd report, (b) have a dry cow mastitis treatment, (c) vaccinate his calves, (d) have more of his cows identified by sire number, (e) milk earlier in the morning in the summer, (f) have high producing cows, (g) feeds more pounds of grain to average cows, (h) have a lower grade protein percent in the hay and (i) have more cows with a higher veterinary bill.

Brown and White (1973) reported that 41 to 48 percent of total variation in herd average milk production and 90% of variation in income was contributed by feed costs, concentrate feeding, days in milk, green feed costs and other feed costs. In another study Brown and White (1975) observed the association of five management variables i.e. herd size, amount of silage, dry forage fed, days on posture and concentrate fed with production. Increase in milk yield was significantly related to increase in amount of concentrate fed, percent days in milk, total yearly cost of feed and prices of concentrate.

Fowers (1978) observed that the management practices had positive effects on the rates of milk production and income per operator. Percent days in milk, pounds of concentrate fed and body weight were the three most important variables which were reported to be associated with increased milk production.

Crowley _et al_. (1978) observed that management of feeding was probably the main factor in increasing the amount milk fat production.

Voermans (1979) conducted a survey on 120 dairy farms with herds of 70-160 cows. The questions related the management, labour supply and use, housing of livestock, machinery, storage of products, feeding system, administration and annual production. He observed that feeding system, housing of livestock and administration were major factors of annual milk production.

Bratton (1979) reported that management practices do affect rates of production and the operations income. The strongest relationships to income he noted were lbs. of concentrate fed per cow, % net energy from succulents, % days in milk and average age of all cows. He further noted that farmers under 40 years of age generally followed better management practices and earned better incomes than thouse above 40 .

Bowman _et al_. (1980) carried out a study based on a series of three questionnaries covering calf management, mastitis control and land and crop management from 1975 to 1977 on a ramdom sample of 640 dairy farms on the Dairy Herd Analysis Service (DHAS). Information on dairy cow nutrition, farm production efficiency and farm productivity as measured by herd average production of

4 percent fat-corrected milk (4% FCM) and income over feed costs were collected. In a multiple regression analysis, 37 farms management factors accounted for 79.9 and 69.5 percent of the variation in herd average production and income over feed costs respectively. Level of meal and succulent (Silaged) feeding accounted for the largest amount of the variation in production and income.

Fredeen et al. (1980) noted in their study that percent days into lactation, concentrate intake and age accounted for most variation in milk yield among cows in 56 herds. Sixty percent of inter-herd variation was accounted for by body weight, percent days in lactation, herd size, maize silage-roughage ratio, concentrate intake, digestibility of 1st cut hay, age, and concentrate texture.

a) Identification of animals

Hooven (1978) reported that accurate identification of individual animals and a system of keeping valid records are major pre-requisites in the effective management of large dairy herds. Accurate record systems provide dairyman with a large array of management information that increases the profitability of the dairy business.

b) Herd size

Speichter and Hepp (1973) observed calf mortality increased as herd size increased from 9.7% for herds of less than 25 cows to 16.6% for herds of more than 85 cows. Mortality after birth was a function of herd size, with the greatest death lossess (4.1%) occuring during the first week.

Zyunkina (1978) noticed the adverse effect of over-crowding in loose byres on dairy milk yields. He observed that temporary over-crowding of loose byres due to irregular intake of cows resulted in a drop in daily milk yield of upto 22 percent.

c) Effect of management factors on economic traits of milch animals

Effect of management factors on lactation curves was studied by Clark (1966b) and Wallace (un dated). Clark (1969) after examining nearly 23400 cow records concluded that strong associations existed between production and calving interval, length of lactation and dry period. For every 30 days of lactation over 180 days, the increase in yield was 20-25 lbs. of butter fat.

Four hundred twenty five records of Holstein-Friesion cows were analysed by Ramirez and Martinez (1980) to know the effect of number of days open, lactation length, body weight at calving and 305 days lactation milk yield on total yield. Lactation length and body weight at calving had highly significant effects on total milk yield.

d) Housing system

Light (1966) reported that the type of housing best adopted to a particular farm depends upon many factors : climate, cost, size of herd, personal preference and the condition and layout on the present housing system, were considered to be its major determinations.

Mellor and Davidhizar (1973) reported that free stall barn permitted expansion without alteration of the milking center, have convenient and a smooth flow of cow traffic.

Kempster et al. (1981) noted that effects of herd size, herd book registration, breed and pipeline milking were significant for milk yield and fat content. Herds with 50-55 cows had the highest overall average yield. They further observed that average yield from loose-house cows was greater than that of tied-up cows although the difference was not significant.

e) Culling of undesirable animals

Albright (1960) found that for maintaining milk production at high level, dairy cattle should be culled constantly and replaced with replacements from within or outside the farm. According to Aurejac and Daree (1977), the optimum age for culling should be between the sixth and seventh lactations, although this will vary with individual animals and breeds. Kot (1977) investigated the causes of culling in large herds. He found that sterility, low yield, age and udder disease were responsible for 5.7, 26.45, 8.2 and 5.7% respectively. According to Darre and Senechal(1977) two of the main reasons for culling cows are poor milk yield (about 27% of the total) and sterility (about 20%), average number of lactation per cow is about 3.5, and that 50 percent of cows are culled before the fourth lactation. Other causes of culling include brucellosis, mastitis, arthritis, and economic factors.

f) Quantification of management

Management has in past been defined by various workers. Thierawf et al. (1978) defined management as the process of allocating an organization's inputs (human and economic resources) by planning, organizing, directing and controlling for the purpose of producing outputs (goods and services) desired by its consumers so that organization objectives were accomplished. However most literature ignores its role as input for generation of output. Moreover management effect as an output has also not been precisely defined or measured. Often measurement of personal traits, has been treated as synnonym to management. According to Nielson (1962) management is human behaviour and the behavioural antecedents can be related to the economic effect of management behaviour.

The development of techniques to predict managerial performance from behavioral antecedents had widespread implications in USA in selection of farm managers and tenant operators and extending of credit to farmers. A major problem in studies of management performance was the development of more adequate measures of performance to serve as criterion variables. Harrington (1964) stated that the development of useful predictive measures was largely dependent upon the development of reliable and valid criterion variable.

With the problems involved in developing measures of management performance, some researchers in USA had used various kinds of rating techniques. Professionals rate the management ability or performance of operators they know according to some specified criteria. Such technique was used by Mc Cormick et al.(1959), Mac Eashern et al.(1962) and Justus et al.(1968). Indirect versions of rating techniques was used by Reiss (1964) .

II. Management factors and net dairy farm income

Early studies on the relationship of farm management factors to income made use of tabular analysis or simple correlation procedures. Such studies have been of value in pointing out the variations in net income that occurred as the value of one management factor varied. The procedures however failed to furnish meauigg-ful information of the relative value of farm management factors in explaining variation in net income among farms.

Kyle (1953) made use of multiple linear Correlation analysis to study the relationship of five farm management factors to net farm income on Indiana farms of U.S.A., using farm account records from 1946 through 1950. Although the majority of the farms were corn-hog operations, the study was of interest because of the method of analysis. A multiple correlation coefficient of 0.66 was obtained. Partial correlation coefficients : number of tillable acres, crop yield, percent tillable acres in corn, work units per man, feed fed per tillable acre were respectively 0.77, 0.33, 0.24, 0.18 and 0.14.

Albright (1962) utilized cost accounting records for a five year period on 39 Los Angeles countyy commercial dairy farms. Multiple regression analysis were conducted to ascertain the relative importance of individual production factors as they affected percent return on capital investment. Statistical analysis of these data indicate that the most important management factors were production cost, roughage, concentrate, labour herd replacement, total operating costs, quality of milk fat produced and price received for milk fat. The size of herd, cows per man, hours per cow, dry cow percentage, culling percentage, investment per cow and feeding effeciency were constituted group of lesser important factors.

Speicher and Lossiter (1964, 1965) studied the association of farm management factors with dairy farm net income. Fourteen farm management factors were found to have their association with net farm income and all of them were significant ($P < 0.05$) in explaining variation in net income.

Beynon and Langley (1965) investigated the relative importance of certain factors in profitable milk production. Their study revealed that density of stocking, milk yield per cow, price received per gallon milk, costs of concentrate and fertilizer per forage acre together explained 75% of the variation in gross margins. The two major factors determining gross margins were density of stocking and milk yield per cow.

Brown and Elrod (1966) estimated the milk production cost and returns from 50 herds in Georgia with an average herd size of 63 cows and an average annual yield per cow of 10629 lb. 4% fat milk. Average annual milk production costs were $ 36000 per farm and $ 571 per cow, the main components of costs included feed, investment, labour and management amounting to

43, 21, 15 and 6% of the total costs respectively. Annual net returns average $ 8520 per farm and $ 137 per cow.

Miller (1968) and Brown and White (1973) studied the linear relationships between various hard management factors and income over feed costs. They observed that milk price and milk production were positively associated with income over feed costs while feed cost per 45.4 Kg. milk, grain prices and other feed costs were negatively related to this economic measure of herd management.

Speicher and Brown (1970), based upon the data from 332 dairy farms, reported the close relationship between the pounds of milk sold per cow and annual income per cow. They observed when the annual milk sales per cow were between 10 and 11 thousand pounds, income per cow including milk and cattle income totaled $ 691. However, total expense per cow average $ 683 for a net annual return per cow of only $ 8. When milk sales per cow averaged 1600 lbs. net annual return per cow was $ 141.

Null (1977) made use of crosstabulation analysis and pearson correlation to know the effects of 13 management factors on farm income. Among the practices that seemed to show the most observable relationships to labour and management income per operator were: lb. concentrate fed per cow, percent net energy from succulents and average age of all cows. The practices showing the greatest effect on milk sold per cow were : concentrate fed, average body weight at first calving, average age of all cows and average number of days dry.

In Belgium, Devisch and Helleman (1978) analysed the cost price of milk and reported that labour cost contributed more than 40 percent, other fixed and variable costs could make up 20-35%. Cost price of milk decreases markedly with farm size due to economics of scale in use of labour. The study conclusiggly revealed the superiority of increasing milk yields than to expand the dairy herd.

Carley (1978) and Ovinge (1979) studied the average net income from dairy farms. They investigated the effect of feed cost, overhead cost and calving interval. Feed cost and labour cost were the primary factors to determine the net income from dairy farms.

III. Management factors and herd average milk production

There are some major differences in the various management practices followed in different dairy farms which affect their average milk production.

This average production is the ultimate concern of the dairyman in his role as manager of that business. Dairying as practiced is basically a means of marketing the products of land and labour. Under such a system of farming it is to be expected that factors such as the cropping system, crop yields, size and organization of the farming operating play an important part in determining the level of production resulting from the operation of the dairy farm. The reliability of Dairy Heard Improvement Association (DHIA) herd average records for characterizing herd management variables has been reported by Miller et al.(1968). They reported that herd management variables which are measured more objectively such as milk yield, percent days in milk, milk price, feed costs and concentrates fed are measured and reported with considerable accuracy in the DHIA record while more subjectively measured variables such as succulents and dry forage fed were less reliable in characterizing herd management.

Miller and Dickinson (1968) and Miller (1969) have shown that management practices related to feeding, particularly amounts of concentrate and reporductive efficiency (percent days in milk) had the greatest value in predicting herd average milk production in Holstein herds and were the most important characteristics common to higher producing herds.

Annon (1971) revealed that the mean milk yield of cows enrolled in Dairy Herd Improvement Association in the U.S. increased from 9713 lbs. of milk in 1956 to 12307 lbs. in 1967. During this same period, the average annual milk production of all other cows in the U.S. increased from 5809 lbs. to 8139 lbs. These higher levels of milk production was the contribution of AI.

Daily milk yields and calving interval has a negative correlation (Hegelschuer and Hemm, 1971 and Sznajder and Wycisk, 1974). Their results showed that highest milk yield/day of calving intervals, both in the immediate and the following lactation was achieved with a calving interval of 310-349 days.

The mean milk yields/cow as affected by purchase of heifers to enlarge the herd depends on many factors including the time when the heifers calve and are added to the herd, their age at calving, the relationship between age and milk yield per standard cow (Ettema, 1973).

Brown and White (1973) studied the management factors associated with herd average milk yield utilizing a total of 1380 Guernsey, 13614 Holstein and 804 Jersey Dairy Herd Improvement yearly herd average records from eight eastern and southeastern states completed between 1965 and 1970 in U.S.

The independent variables were concentrates fed, succulents fed, dry forages fed, percent days in milk, price of grain, other fed costs, price of milk, herd size and days on pasture. Concentrate feeding, percentdays in milk, grain costs and other feed costs were major management factors associated with herd average milk production.

Pejin and Lyesov (1973) reported that the relationship between milk production and fed costs was best expressed by an increasing function with slowly decreasing marginal production. The relationship between milk production and feed consumption (especially concentrates) was a rising curve of steadily increasing gradient, suggesting potential for further increase in production. The relationship between milk production and salaries showed a similar curve.

Rosselet (1974) compaired high (4230-4700 kg. per annum), average (3800-4229 kgs. per annum) and low (less than 3800 kgs. per annum) milk producing herds in relation to management factors. His study revealed that the group with highest yield was characterised by lower average age of cows (65.7 months), lower age at 1st calving (31 months), higher concentrate costs per head and more intensive fodder growing (less forage area per head but higher costs per forage hectare).

The economics of high milk production were also discussed in relation to price of concentrate and the milk to meal price ratio and the correlation between milk yield and concentrate costs was examined. Bosnic (1975) also reported similar results and contented that milk production was highly dependent on feed and labour costs and sale price of milk (correlation coefficient 0.96), milk production increased with increase of expenditure on feed upto D 4000 per cow per year, when it reached a maximum of 4162 kgs.

Lerdon (1979) utilized regression analysis to determine the effects of different variables on milk production (per hectare and per farm) during 1974 in 124 farms in the provinces of Valdivia and Osorno, Chile. Number of cows per hacter and area used for dairying were found to be major factors affecting milk production per hacter but concentrate expenditure per cow and silage volume per cow had less effect. Total milk production per farm decreased with increasing age of farmer and (to a lesser extent) with increase in the area used for dairying. It also registered decrease with increasing rain fall, being highest on farms with only 1000-13000 mm precipitation. Milk production was highest on recently formed soil and lowest on loamy soils.

The report of Giacver (1979) examined the factors influencing yield levels and discussed profitability of varying these factors from the point of view of both social cost benefit and the individual farmer.

The five factors considered were quantity of concentrate per cow, quantity of roughage, quality of roughage, herdmanship and genetic endowment of cows. The social cost benefit analysis suggested the necessity to reduce concentrate input, improve roughage quality by growing more roots and cutting silage early.

IV. Resource use efficiency

Maximization of profit is the major consideration for any business enterprise for its success in the long run. The profit can be maximised either by increasing the value of output from a given resource-mix, or by producing the same quantity of the product with the minimum cost. In a competitive market, prices are exogeneous to an individual because there are large number of persons who are individually producing very small proportions of total production of a commodity. The only alternative is thus to reduce the cost of production through retionalization of resource use. Feed and labour are the principle inputs in milk production and the former, particularly concentrates from a critical input. Feed costs alone constitute nearly two-third of the total cost of milk production. Concentrates, in turn, represents a substantial portion of this cost. In view of this, a study inquiring into the maximization of milk yield with limited resources, assumed considerable importance.

a) Production functions and economic optima in milk production

Albright et al. (1964) used Cobb-Douglas form of production function for large commercial dairies in Los Angeles county from 1956-1960 for optimazation of resources used. He optimized the resource used by calculating the marginal value of productivity of different inputs.

Krefft (1967) tried to interpretate mathematically, the milk yields and heeping costs in 1964/65 of 1300 cows on 84 farms and estimated by geomatic specification of cost-milk yield relationships. The result out maximum gain calculated from this specification per cow was at a milk yield per cow approaching 8000 lit. per year.

Brigmane et al. (1970) analysed the labour productivity in dairy farming by using production function model. They calculated the labour (man days) per 100 kg. milk. The results revealed that 2.12 ± 0.07 labour mand-days per 100 kg. milk were required. Similarly number of cows required per milker was 13.58 ± 0.10 .

A method of determining the economically optimum yield level of a cow was presented by Krefft (1972) which involved the use of a second order parabolic equation for specification of cost-yield relationships of milk production . In order to specify milk production process, Singh and Jha (1975) fitted linear,Cobb-Douglas, quadratic and square root forms production equation for economic optima in milk production. They finally chosen Coob-Douglas type of production function for presentation of economic analysis on the basis of their inherent conformity to production logic and also the significance levels of the variables. The functions were fitted for Murrah and non-descript buffaloes seperately season wise . Their finding revealed that farmers cared more for the Murrah than for non-descript buffaloes, leguminous fodders were the cheapest source of nutrients and significant increase in the milk yield could be obtained by a reallocation of feed inputs.

Iosif et al. (1977) make use of Cobb-Douglas function to analysis the relationship of milk production per cow (Y) to labour costs per cow (L) and material costs per cow (M) for the four calender years 1970-1973 in Romania. The relationship indicated that marginal productivity of labour amounted to more than twice that of material cost. The function generated economics of scale which could indicate that resources used in the sample cows couldbe augumented more for economic production of milk.

b) Use of Linear programming technique

Linear programming technique has been successfully used for achieving the objectives of profit maximization or cost minimization in any production process and milk production is also not an exception. Dairy scientists commonly use this technique to calculate last-cost, nutritionally-balanced dairy rations, both with or without matrix generations.

Kikumoto (1961) collected data from five farms in a semimountain village in 1960. He analysed data on land and seasonal labour used in dairy farms by linear programming. Murthy (1965) was the first to employ linear programming technique in animal feeding problem in India. He worked out least cost feeds from among a few feeds for various levels of milk production and for two different price situations.

Metzger (1968) developed a linear programming model to determine optimum resources use and management practices for the maximization of net return in each of eight representative dairy farm situations. The model provided for alternative forage crops, harvesting method and fertilizer level and for alternative grain feeding levels. The effect of level of milk price was also considered.

Nisar and Elterich (1972) determined the optimal farm income for large size dairy farms with 317 and 298 acres of cropland. They also used linear programming technique to determine the most profitable organization under variable milk price. Neves and Tollini (1973) used linear programming for resource allocation and combination of activities in dairy farms with the objectives to develop empirical models characterising the organization of four different sized dairy farms of diverse types given the initial array of resource constraints (land, labour and capital), technology and product and factor prices. The effort resulted in determination of the optimal organizations for the four different size dairy operations which in effect examine the differences, if atall, between the actual and optimal farm organizations. This was followed by presenting suggestions that could aid both private and public decision-makers.

Kahlon et al.(1975) used the linear programming technique to find out the levels at which the dairy (milch cow and buffalo) could profitably enter the production programmes of the farmers of Punjab, Land, labour, capital and farm yard manure were the constraints in their study.

Verma and Pant (1978) studied the existing cropping pattern and suggest the adjustments in it to incorporate the dairy enterprise optimally and the effect of dairy enterprise on employment and farm incomes by utilizing linear programming technique in Jaipur district of Rajasthan. Land, labour, capital, manure and tractor and bullock power were the limiting factors in their study.

Jones et al. (1980) reported that the using linear programming one could have the reasons why certain feedstuffs should be included in the ration to affect the economics of milk production, decisions to sell on farm produced grain, evaluation of the adequacy of forage supplies and like.

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CHAPTER - III.

METHODS

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MATERIALS

METHODS AND MATERIALS

It is proposed in this chapter to present methods and materials chosen to meet the objectives of this study. A brief discussion of methods and concepts used in the discussion is also projected in this chapter.

1. Selection of Dairy Farms

Commensurate with the objectives of this study, the selection of dairy farms was accomplished by purposive selection of 4 Military, 6 Institution/University, 2 State Government and 4 private dairy farms. From these farms, data collection was restricted to only Holstein X Zebu cattle (H.F.Crossbred) and Murrah buffaloes. This was mainly done to preserve the uniformity of the data from genetic variances.

The input-output information of milk production was collected for a period of five years (1975-79). In addition, informations for Murrah buffaloes of some village herds under the Operation

Research Project of National Dairy Research Institute were also included.

The details regarding location of the farms, species and period for which informations were collected are presented in table - 1.

TABLE - 1

DETAILS ABOUT FARMS

Farm's location	Species	Period
1	2	3
A. Military Farms :		
Military Dairy Farm, Ambala.	H.F. Crossbred Murrah buffalo	1975-1979 1975-1979
Military Dairy Farm, Meerut.	H.F.Crossbred Murrah buffalo	1975-1979 1975-1977
Military Dairy Farm, Agra.	H.F. Crossbred Murrah buffalo	1975-1979 1975-1978
Military Dairy Farm, Lucknow.	H.F.Cross-bred Murrah buffalo	1975-1979 1975-1979
B. Institution/ University Farms:		
National Dairy Research Institute, Karnal.	H.F.Crossbred Murrah buffalo	1975-1979 1975-1979
Southern Regional Station, N.D.R.I., Bangalore.	H.F.Crossbred	1975-1979
Demonstration Unit of N.D.R.I., Karnal.	Murrah buffalo	1975-1979
Eastern Regional Station, N.D.R.I., Kalyani.	H.F. Crossbred	1975-1979

Contd....

Contd. table-1

1	2	3
Veterinary College Farm, Mathura, C.S.A.K.V.V.	Murrah buffalo	1975-1979
Cattle Breeding Project, B.C.K.V.V., Haringhata.	H.F. Crossbred	1975-1979
C. State Government Farms:		
State Livestock Farm, Kalyani.	H.F. Crossbred	1975-1979
State Livestock Farm, Mathurikund, Mathura.	Murrah buffalo	1975-1979
D. Private Farms :		
Nirmal Kennedy Centre Dairy Farm, Green Park, Jessore Road, 24-Pgs. (W.B.)	H.F. Crossbred	1975-1979
Rama Krishna Ashram Dairy Farm, Narendrapur, 24-Pgs. West Bengal.	H.F. Crossbred Murrah buffalo	1975-1979 1975-1979
Kamal Dairy Farm Private Limited, Ashok Nagar, Maniktala, 24-Pgs., West Bengal.	H.F. Crossbred	1975-1979
Express Dairy Private Limited, Behala, Calcutta-35	H.F. Crossbred Murrah buffalo	1975-1979 1975-1979

Contd....

Contd. table - 1

1	2	3
O.R.P. Villages :		
Bhainkhurd Village herd, Karnal(Haryana)	Murrah buffalo	1979
Sanghoa Village herd Karnal (Haryana).	Murrah buffalo	1979
Tikri Village herd Karnal (Haryana).	Murrah buffalo	1979
Kailash Village herd Karnal (Haryana).	Murrah buffalo	1979
Uchana village herd Karnal (Haryana).	Murrah buffalo	1979
Shamgarh village herd Karnal (Haryana).	Murrah buffalo	1979

The herds were divided into two categories - high (average yield of more than 6 litres for H.F. Crossbreds and more than 3 litres for Murrah buffalo herds) and average (6 or less litres for H.F. crossbreds and 3 or less litres for Murrah buffaloes).

2. The data :

The present analysis is based on the secondary data collected from sixteen organised dairy farms and primary data from six villages under Operational Research Project of National Dairy Research Institute. A total of 65 sets of observations for H.F. crossbred cattle and 53 sets of observations for Murrah buffaloes were collected. The data pertained to collection of information on the different inputs used, quantity of milk and dung produced, number of animals sold and their monetary values were collected. Additionally, management practices with regard to feeding, breeding, milking, calf rearing, labour utilization etc. were also documented. The figures on expenditure of each farm's layout, buildings and equipments were recorded from the account sections of each organised farms under the present study. The data on salaries, wages and allowances paid to the employees and number of workers of each organised farm and expenses on electricity, fuel and water were also collected from the records of the accounts section of respective farm under study. The above figures for individual farmer in ORP were calculated from collected primary informations.

3. Methods of analysis

A. Quantification of management

A production analysis (Heady and Dillon, 1961) was used to study the general pattern of the productivity of resources used in the farms year wise. A production function is simply a mathematically stated relationship between inputs and outputs.

A production function of following type was estimated for each year from 1975 to 1979.

$$Y = ax_1^{b1} \quad .. \quad .. \quad .. \quad X_n^{bn} .$$

Taking Logarithms,

$$Log_e\ Y = Log_e\ a + b_1\ log_e\ X_1 + \ldots + b_n\ log_e\ X_n \quad .. \quad (i)$$

In these production functions, estimated income was considered as the dependent variable (Y) and the selected resources considered as independent variables were : X_1 (number of cows), X_2 (total labour cost), X_3 (operating cost), X_4 (non-animal capital), X_5 (hay equivalent in tons) and X_6 (tons of concentrate), "a" was a constant.

The estimated coefficients (b values) in the above equation were the elasticities of production of their respective inputs. The elesticities indicated the percentage change in total income that would have resulted from a one percent change in that input.

A residual was computed for each farm in each year by substracting the logarithm of total income as estimated by the production function from the logarithm of the actual total income received as follows :

$$\text{Residual} = \text{Log } Y - \text{Log } Y_e \quad .. \quad .. \quad (ii)$$

where Y = actual income received and

Y_e = estimated income.

Since the residual was in logarithms, it was the ratio of actual income to estimated income. The quantities of inputs (X_1 through X_6) used to estimate income were those actually employed in the farm. Thus the deviation represents the effect of any inputs omitted from the production function, as well as random or luck elements. Using this deviation as a measure of management performance, dairy farms were ranked within years and the cosistency of performance over the five year period were also studied.

B. Rank correlation

Correclation between ranks of dairy farms based on production analysis and percent return of capital investment were calculated separately for both the H.F. crossbred cattle and Murrah buffalo farms using standard procedures (Spearman, 1904) .

The rank correlation R was calculated by the following formula :

$$R = 1 - \frac{6 \sum d^2}{n (n^2 - 1)} \quad .. \quad .. \quad (iii)$$

where d = the difference between the two ranks of a farm,

n = number of observations.

Then the coefficient of correlation " r " between the two ranks was calculated as follows :

$$r = 2 \operatorname{Sin} \left(\frac{\pi}{6} R \right) \quad .. \quad .. \qquad (iv)$$

C. <u>Coefficient of concordance</u>

To test the hypothesis that the annual ranking was random, against the hypothesis that there was consistent year to year pattern in the rankings, the coefficient of concordance (Kendall and Smith, 1939) was used. The mathemetical model used for the purpose was

$$W = \frac{12S}{m^2(n^3-n)} \quad .. \quad .. \qquad (v)$$

Where W = coefficient of concordance,

m = number of years,

n = number of farms and

S = sum of the squares of the deviations of the total of the ranks assigned to each farm from $m(n+1)/2$.

D. <u>Regression procedures</u>

i) <u>Model Specifications</u>

Multiple regression procedures of linear as well as nonlinear specifications were stipulated to establish the relationships between various management factors and both herd average milk production as well as net income of dairy farms.

The independent variables for explaining variances in net income were (i) herd size, (ii) total milk production, (iii) milk yield per cow, (iv) percent days in milk , (v) concentrate fed per cow per year, (vi) succulent fed per cow per year, (vii) dry forage fed per cow per year, (viii) feed cost per cow per year, (ix) feed cost per 50 kg. milk produced, (x) milk price per litre, (xi) fat percentage of milk, (xii) number of labour employed, (xiii) number of tillable acres of land, (xiv) concentrate price per kg. and (xv) number of cows per man employed.

The independent variables employed for explaining variances in the herd average milk production were (i) herd size, (ii) percent days in milk, (iii) concentrate fed per cow per year, (iv) succulent fed per cow per year, (v) dry forage fed per cow per year (vi) milk price per litre, (vii) concentrate price per kg. and (viii) number of tillable acres of land.

The linear mathematical model was :

$$Y = b_o + b_1x_1 + b_2x_2 + \quad .. \quad .. \quad + b_nx_n \quad .. \quad \text{(vi)}$$

where,

Y = dependent variable,

b_o = intercept i.e. the expected value of 'Y' when x_1 , x_2 .. x_n were each zero,

b_1, b_2 .. b_n = coefficients of linear partial regression of 'Y' on x_1 , x_2 .. x_n .

The quadratic mathematical model used was

$$Y_{ij} = b_o + b_k x_k + b_k' x_k^2 \quad .. \quad .. \quad \text{(vii)}$$

where,

Y_{ij} = dependent variable of i^{th} year of j^{th} farm,

b_o = general mean,

x_k = the k^{th} independent variable corresponding to the ij^{th} observation,

b_k = the partial regression coefficient corresponding to x_k ,

x_k^2 = the square of the k^{th} independent variable, and

b_k' = the quadratic regaression coefficient corresponding to x_k^2 .

E. Correlation procedures

The correlation coefficient among herd average variables and net income variables were calculated using standard statistical method (Snedecor and Cochran, 1967)

$$r_{xy} = \frac{\sum_{i=1}^{n} x_i \ y_i}{\sqrt{\sum_{i=1}^{n} x_i^2 \ \sum_{i=1}^{n} y_i^2}} \quad .. \quad .. \quad (viii)$$

were x_i and y_i were respectively deviations from mean of independent and dependent variables specified in (vi) and (vii) ,

x_i^2 = squares of deviations from the mean squares for 'X',

y_i^2 = squares of deviations from the mean squares for 'Y',

$x_i y_i$ = cross products of deviations from the mean of the two variables.

F. Production functions

To establish input-output relationship, production functions were fitted separately for both H.F. crossbred cattle and Murrah buffaloes. Linear, Cobb-Douglas and quadratic forms of relationships were employed for the purpose of scanning the " best-fit " specifications.

The veriables included in the production functions were as follows :

$$Y = (x_1 , \ x_2 , \ x_3 , \ x_4 , \ x_5)$$

where,

Y = annual milk production in litres per adult animal,

X_1 = tonnes of hay-equivalent fed per year per adult animal,

X_2 = Kilogrammes of concentrate mixture fed per year per adult animal,

X_3 = number of labour employed per year per adult animal,

X_4 = number of tillable acres of land per adult animal,

X_5 = annual operational costs other than X_1 to X_4 per year per adult animal.

i) Specification of production functions

The specification of production functions were :

a) Linear :

$$Y = b_o + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 \quad .. \quad (ix)$$

b) Cobb-Douglas:

$$Y = b_o . x_1^{b1} . x_2^{b2} . x_3^{b3} . x_4^{b4} . x_5^{b5} \quad .. \quad (x)$$

c) Quadratic :

$$\begin{aligned} Y = {} & b_o + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 - \\ & b_6x_1^2 - b_7x_2^2 - b_8x_3^2 - b_9x_4^2 - b_{10}x_5^2 + \\ & b_{11}x_1x_2 + b_{12}x_1x_3 + b_{13}x_1x_4 + \\ & b_{14}x_1x_5 + b_{15}x_2x_3 + b_{16}x_2x_4 + \\ & b_{17}x_2x_5 + b_{18}x_3x_4 + b_{19}x_3x_5 + \\ & b_{20}x_4x_5 \quad .. \quad .. \quad (xi) \end{aligned}$$

ii) Production maximizing quantities of inputs

The quantities of different inputs which maximize the milk production was calculated with the help of " best-fit " production function on the premise of marginality principle which implies maximisation of output from the fixed producing unit when the marginal products of 'n' resources are simultaneously equated to their respective prices divided by the prices of the product. The prices of inputs and output were taken as their average prices for five years (1975-1979).

The specification of conditions were obtained by differentiating the ' best-fit ' production function with respect to x_1, x_2, x_3, x_4, x_5 respectively as given below :

$$\frac{dy}{dx_1} = \frac{px_1}{py} \quad .. \quad (xii)$$

$$\frac{dy}{dx_2} = \frac{px_2}{py} \quad .. \quad (xiii)$$

$$\frac{dy}{dx_3} = \frac{px_3}{py} \quad .. \quad (xiv)$$

$$\frac{dy}{dx_4} = \frac{px_4}{py} \quad .. \quad (xv)$$

$$\frac{dy}{dx_5} = \frac{px_5}{py} \quad .. \quad (xvi)$$

G. Optimisation procedures

Linear programming

In order to optimise dairy incomes the Linear Programming model was employed. It is a matter of common knowledge that feed, fodder, land, labour and capital are the limited resources on any dairy farm. Optimal allocations of these limited resources are the main objective of every farm manager. Linear programming is a systematic and accurate method of determining mathematically the optimum combination of inputs so as to maximize the income or minimize the cost within the limit of available resources. Land, dry matter content of green, concentrate and dry forage, land and operating cost were treated as constraints in the formulation of problem on dairy farm.

For calculating the dry matter (DM) content of feeds and fodder, it was assumed, that green fodder, concentrate and dry forage were having 20%, 90% and 90% dry matter respectively.

i) Selections of activities

In order to determine an optimal programme for different farm sizes, H.F. crossbred cows and Murrah buffaloes were treated as two alternative activities. Linear Programming technique was used in those dairy farms, where these two species of cattle were reared. An adult cow or buffalo was considered as one activity.

ii) The model

The optimal plans were devaloped through Linear Programming analysis using the following model,

$$\text{Maximize}: \quad Z_0 = p_1 x_1 + p_2 x_2 \quad \ldots \quad \text{(xvii)}$$

subject to

$$a_{11} x_1 + a_{12} x_2 \leqslant b_1 \quad \text{(land)}$$

$$a_{21} x_1 + a_{22} x_2 \leqslant b_2 \quad \text{(DM)} \quad ..\text{(xviii)}$$

$$a_{31} x_1 + a_{32} x_2 \leqslant b_3 \quad \text{(labour)}$$

$$a_{41} x_1 + a_{42} x_2 \leqslant b_4 \quad \text{(operating cost)}$$

$$x_1 , x_2 \geqslant 0$$

where

Z = total income from milk to fixed farm resources annually.

p_j = annual return per real activity

a_{ij} = the input-output coefficient of i^{th} resource and j^{th} activity

x_j = level of j^{th} activity.

4. Concepts used in the study

Total income

Total cash received in a year from sale of milk,dung and animals.

Net income

Total income minus total expenditure.

Operating cost

Total expenditure incurred in feeding, labour, depreciation, net of inventory change and rents and taxes.

Total labour cost

The total annual expenditure incurred in permanent and casual labour.

Non-animal capital

They are the cost of fixed assets like cattle sheds, land, machineries and equipments.

Hay equivalent

Hay equivalent is a measure of green fodder, hay (dry) and silage fed. It was computed by summing up of factors obtained from total green fed divided by four, total silage divided by three and total tons of hay reported over the whole years.

Total succulents/concentrate/dry forage fed annually

It was calculated as the ratio between total succulents/concentrate/dry forage fed annually to total number of adult units.

Grain price

Annual average price paid for one Kg. of concentrate.

Feed cost per cow

It was computed on the basis of adult animal unit. It was total feed expenditures annually involved in a adult animal unit.

Feed cost per 50 Kgs. milk

It was the total feed cost incurred in the production of 50 kgs. of milk.

Herd size

It was the total number of adult animals. This included milch, dry and adult male animals. It was calculated as average number of milch, dry and adult male animals for 12 months.

Herd average milk production

It was the ratio of total milk production to total number of adult females (in milk and dry) .

Milk yield per cow (wet average)

It was calculated as ratio between annual milk production and average number of milch animal per day for the whole period constituting 365 days.

Milk price

Average price for a litre of milk in a particular year .

Percent days in milk

It was computed as ratio between lactation length and calving interval and was expressed as percent.

Number of man employed

It was calculated on the basis of average number of labour (permanent and casual) employed each month in a year. The number of casual labour was calculated on the basis of eight hours daily basis. The part time permanent labour was also estimated on the basis of six and half hour a day basis.

Number of cows per man employed

It was computed as the ratio between total number of adult cows in the herd and the total number of man employed averaged over the year.

Number of tillable acres of land

It was the number of total acres of land used for cultivation throughout the year.

CHAPTER - IV

RESULTS AND DISCUSSION

- RESULTS AND DISCUSSION -

Commensurate with the objectives of this study the results have been presented in the following three aspects :

I. Quantification and documentation of the managerial elements,

II. Relationship between management factors and herd average milk production and net income,

III. Efficient use of various farm resources for optimum production efficiency and profit from dairying enterprise.

I. Quantification and documentation of managerial elements :

In most dairy farms the income from milk must represent from 80 to 90 percent of the total receipts. Other sources of income can include cattle sales and manure. The income per cow is governed most by the level of milk production and the fat percent of milk. Thus high herd average milk production is one of the major characteristics of profitable dairy farming. Effécient management must be able to generate higher milk production. Differences in the management practices from one farm to another are thus likely to be reflected in herd average milk production.

a) Performance differences between high and average herds:

In order to bring out managerial variations on herd productivity the relevant data were collected and the same are set out in table - 2.

TABLE - 2

AVERAGE ECONOMIC TRAITS OF TWO CATEGORIES HERDS

Attributes	H.F.Crossbred herds		Murrah buffalo herds	
	High production.	Average production.	High Production.	Average production.
Average herd size (No.)	404	287	214	149
Mean milk production (litres)	8.39	3.63	4.52	2.26
Lactation length(months)	10.62	13.22	11.21	14.50
Calving interval (months)	14.40	16.73	14.90	20.20

It can be seen from table - 2 that the mean milk production for high and average production herds of H.F. crossbred cattle were 8.39 and 3.63 litres respectively. For Murrah buffalo, these figures were 4.52 and 2.26 litres respectively. The mean herd sizes in high and average production herds were 404 and 287 in H.F. crossbred cattle and 214 and 149 in Murrah buffalo. The herd sizes were larger in high production herds of two species. This was possibly due to the availability of more lands for fodder cultivation. In H.F. crossbred cows, the lactation length and calving interval in the herds of average production group ranged from 12.25 to 14.50 months and 14.77 to 18.70 months respectively whereas in the herds of high production group the ranges were 9.90 to 11.40 months and 12.70 to 15.84 months respectively. The overall average lactation length in the two categories of herds were 13.22 and 10.62 months and that of calving intervals were 16.73 and 14.40 months. In case of Murrah buffalo the ranges for lactation length and calving interval for high production herds varied from 9.10 to 13.30 months and 13.50 to 17.80 months respectively whereas in average production herds these were 12.60 to 15.50 months and 18.10 to 21.10 months. Average figures for lactation length and calving interval of high production herds were 11.21 months and 14.90 months and these for average production herds were 14.50 months and 20.20 months. The average calving intervals in high production herds of H.F. crossbred and Murrah buffalo were shorter than that of average production herds. Similarly the lactation periods were also of standard lengths in high production herds of two species. These indicated that cattle in high production herds were regular breeders.

b) Managerial variation of high and average production herds:

Table - 3 presents the differences in management practices and other variables between average and high production herds of H.F. crossbred and Murrah buffaloes respectively. The information present summary of management practices in five average and eight high production herds of H.F. crossbred cattle and eight herds in each categories of Murrah buffaloes.

In case of average production herds of H.F. crossbred cattle, fodder were offered two times a day in the manger. The timings for stall feeding were around 8.00 A.M. and 5.30 P.M. in the morning and evening respectively. The concentrate was offered at the time of milking only. The cows were milked in stalls twice daily in the morning at about 6.00 A.M. and in the evening at about 4.30 P.M. The animals were maintained largely on concentrate and dry forage because green fodder was mostly a constraint due to lack of land and other facilities. Whenever green fodder was available, it was fed unchaffed. Due to the non-availability of sufficient lands, grazing of cattle was not

TABLE - 3

Differences in Management practices and other variables between average production and high production herds of H.F. crossbred and Murrah buffaloes

Management practices and other variables.	H.F.crossbred herds		Murrah buffalo herds	
	Average production	High production	Average production	High production
Frequency of stall feeding (% of farms)	2(100)	3 (30), 2(70)	2 (100)	3(24), 2(76)
Time for feeding	8.00 A.M. and 5.30 P.M.	7.00 A.M. and 5.30 P.M.	7.00 A.M. and 4.00 P.M.	6.30 A.M. and 5.00 P.M.
Types of feeds-green/ concentrate/straw/ combination of three	Concentrate and straw	Green fodder and concentrate	Combination of three.	Green fodder and concentrate.
Green fodder	Unchaffed	All except leguminous fodder chaffed	-	-
Average grazing hours	Not practiced	Only few farms, hour unspecified	Few farms, hour unspecified.	Only few farms, hour unspecified.
Distance of grazing area in Km.	-	1/4 to 1 Km.	1/4 to 3 Kms.	1/4 to 2 Kms.
Calves allowed to suckle or wean	Mostly suckling	Mostly weaned	Mostly suckling	Mostly weaned.
Dehorning of calves	Mostly not practiced.	Mostly practiced	Mostly not practiced	Mostly practiced.
Branding of calves and its purpose.	Not common.	Extrimly followed for identification purpose.	Not common	Extrimly followed for indentification in organised herds.
Health measure taken	Vaccination against Rinderpest, H.S. and F & M. diseases.	In addition to the usual vaccination deworming was also done frequently.	Vaccination against RP, H.S., F & M diseases.	In addition to the usual farm vaccination deworming was also done frequently.

Contd......

Contd.. Table -3

Management practices and other variables.	H.F. crossbred herds		Murrah buffalo herds	
	Average production	High production	Average production	High production
Place of milking and hours of milking.	Stall, two milkings one at 6.00 A.M. and other at 4.30 P.M.	Milking was done in Milking Parlours at 5.00 A.M., 12.30 P.M. and 6.00 P.M.	Two times stall milking at 6.00 A.M. and 6.00 P.M.	Two times milking in milking Parlour at 6.00 A.M. and 6.00 P.M.
Housing system.	Mostly stall housing system.	Mostly loose housing system.	Mostly stall housing system.	Mostly loose housing system.
Average quantity of green fodder/day/ adult unit offered.	12.06 Kgs.	45.43 Kgs.	32.77 Kgs.	47.51 Kgs.
Average quantity of concentrate/day/ adult unit offered.	6.29 Kgs.	5.45 Kgs.	1.57 Kgs.	3.73 Kgs.
Average quantity of dry forage/day/ adult unit offered.	4.44 Kgs.	3.22 Kgs.	2.55 Kgs.	3.34 Kgs.
Average number of cows per man employed	5	4	5	4

possible. Regarding the management of young stock, the calves were allowed to suckle and dehorning and branding were not common practices. Although all the classes of animals were vaccinated against Rinder Pest, Haemorrhagic Septicaemia and Foot and Mouth diseases, the calves were not dewormed as a rule against parasitic diseases. Stall housing system was followed almost in all the herds for all the classes of animals. The average quantities of green fodder, concentrate and dry forage per day per adult unit were 12.06 kgs., 6.29 kgs. and 4.44 kgs. respectively. The average number of cows per man employed was five.

In high production herds of H.F. crossbred cattle, the animals were stall-fed twice daily excepting for few herds where they were fed thrice. The timings for offering fodder in the manger were before 8.00 A.M. and after 4.30 P.M. in the morning and evening respectively. The concentrate was offered three times a day at the time of milking. The cows were milked three times a day in separate milking parlours at about 5.00 A.M., 12.30 P.M. and 6.00 P.M. Green fodder was enough in most of the herds. The animals were fed green fodder throughout the day in groups with little amount of concentrate and straw. The green fodder was generally chaffed before feeding. Except in two farms, grazing was not practiced and the distance of grazing areas varied from 1/4 to 1 Km.

Regarding the management of young stock, the calves were weaned, dehorned, branded for identification and deworming against parasitic diseases in addition to vaccination of the animals of all classes against Rinderpest, Haemorrhagic Septicaemia and Foot and Mouth disease. Loose housing system was followed in most of the herds. The average quantities of green fodder, concentrate and dry forage per day per adult unit were 45.43 kgs., 5.45 kgs. and 3.22 kgs. respectively. The number of cows per man employed was four. There was not much of managerial differences concerning reproduction of the animals in two categories. In both high and average production herds, heat detection of animals was done by attendants meant for it and insemination was done artificially by their own bull's semen.

The major differences in management practices between high and average production H.F. crossbred herds lie in extra care and precaution exercised in case of farmer. This extra care is attributed to early milking, reliance on green fodders, group feeding, weaning of calves, practices like dehorning, branding, and deworming of calves, separate milking facilities, provision of loose housing system, provision of superior (quantitative as well as qualitative) feed and fodder, less animals per man power and intensive fodder cultivation.

The animals in average production herds of Murrah buffaloes, were offered fodders twice a day in the stalls. The timings for offering fodder in the stalls were about 7.0 A.M. in the morning and 4.00 P.M. in the afternoon. The concentrate was fed at the time of milking at 6.00 A.M. in the morning and 6.00 P.M. in the evening. The animals were milked in the stall itself. The animals were mostly thrived on concentrate and straw as green fodder was not sufficient due to shortage of lands and other facilities. The animals were fed individually. In ORP villages during rainy season, animals were allowed to graze and the distance of the grazing areas varied from 1/4 to 3 Kms. The calves were allowed to suckle their dams and they were not dehormed, branded and dewormed. The animals of all classes were vaccinated against Rinderpest, Haemorrhagic Septicaemia and Foot and Mouth diseases. The animals of all classes were kept in the stalls. The average quantity of green, concentrate and dry forage per day per adult animal were 32.77 Kgs., 1.57 Kgs. and 2.55 Kgs. respectively. The number of adult buffalo per man employed was five.

In high production herds of Murrah buffaloes, the fodder was offered in the manger two times a day in 76 percent of the herds, but in remaining herds it was three times a day. The fodder were offered before 7.00 A.M. in the morning and after 4.00 P.M. in the afternoon. The concentrate was fed at the time of milking. The milking was performed at about 6.00 A.M. and

6.00 P.M. in the milking parlours of the herds. The animals in ORP villages were milked in the stall itself. The green fodder was sufficiently fed to the animals, thus a small amount of concentrate and straw were fed to the animals. The group feeding was practiced in all the herds except in ORP villages where individual feeding was followed. Animals in the farms of ORP villages were allowed to graze during rainy season and the distance of the grazing areas varied from 1/4 to 2 Kms. The calves were weaned, dehorned, branded and dewormed in organised herds only.

The animals of all classes were vaccinated against Rinderpest, Haemorrhagic Septicaemia and Foot and Mouth diseases. Loose housing system was common in all the herds, but the animals in ORP villages were kept in the stalls. The average amounts of green, concentrate and dry forage per day per adult animals were 47.51 kgs. 3.73 kgs. and 3.34 kgs. respectively. The number of animals per man employed was four.

The major differences in management practice between high and average production buffalo herd lie in extra care and precaution exercised in case of the former. This extra care is attributed to early milking, reliance on green fodders, group feeding, weaning of calves, practices like dehorning, branding and deworming, separate milking facilities, provision of loose housing system, provision of superior (quantitative as well as qualitative) feed and fodder, less animal per man power and intensive fodder cultivation.

c) Quantification of management :

Management is one of the most crucial inputs which determines success or failure of an enterprise-mix. Presence of almost all modern resources, however in the absence of efficient management, would not generate efficient good services. This is principally so because the pattern of combining resources for production is only entrusted to management. In the present context, management can be difined as "the process of allocating an organization's inputs (human and economic resources) by planning, organizing, directing and controlling for the purpose of producing outputs (goods and services) desired by its consumers so that organization objectives are accomplished" (Thieraft et al.,1978).

This present study attempts to quantify the management skill using production function approach suggested by Albright et al.(1964). In this case, estimated income was stipulated to be a function of several factors or resources. The selected resources considered as independent variables in the production function included : number of cows (x_1), total labour cost (x_2), operating cost (x_3), non-animal capital (x_4) hay-equivalent in tons (x_5) and tons of concentrates (x_6). The log-linear model was employed to generate yearly productive functions for each of the five years (1975-79). The estimated coefficients (b-values) in the above equation were the elasticities of production of their respective inputs. The residual, was computed for each dairy and year by substracting the logarithm of estimated total income(log y_e) from the logarithm of the actual total income (log y). Since the residual was in logarithms, it was essentially ratio of actual income to estimated income. Using this deviation as a measure of management skill, dairy herds were ranked, within years, over five years' period.

The resultant ranking of H.F. crossbred herds on the basis of managerial efficiency are set out in table- 4 (coefficients are presented in Appendix - 1). It can be seen from the table that there were sizable inter - and intra farms variations in managerial ranks. In the year 1975, only the last four farms (10th through 13th) had positive rank coefficients. In 1976 the number of farms (2, 3, 11, 12 and 13) with positive ranks increased although one of the farms (10) lapsed into negative coefficient. Since then for the rest of year increasing number of farm were endowed with positive managerial ranks. However with time, there was change in ranks of some of the farms due to change in managerial personnel, natural calamity etc. These differences not-withstanding, three farms (11, 12 and 13) had

TABLE - 4

Ranking of crossbred farms on the basis of management ability

Ranks

Farm Code No.	1975	1976	1977	1978	1979	Over all
1.	VI	IV	X	IV	IV	IV
2.	VII	VIII	VIII	VIII	VIII	VI
3.	V	III	II	III	II	II
4.	IX	IX	IV	IX	X	VIII
5.	VIII	VI	VII	X	IX	VII
6.	XIII	XIII	XIII	XII	XI	XI
7.	X	X	VI	VII	VII	VII
8.	XI	XII	XI	XIII	XIII	X
9.	XII	XI	XII	XI	XII	IX
10.	III	VII	IX	VI	VI	V
11.	IV	II	V	V	V	III
12.	II	V	III	II	III	II
13.	I	I	I	I	I	I

consistently positive ranking coefficients and another three (6, 8 and 9) were marked for consistently poor managerial abilities. Another category constituted of farms (3, 7 and 10) which can be termed as potentially efficient farms. Taking the yearly fluctuations into account four farms (3, 11, 12 and 13) were marked with highest managerial efficiencies and the farms with medium efficiency included 10th, 7th, 5th, 4th and 2nd. The rest (1, 6, 8 and 9) were consistently poorly managed farms with crossbred herds.

The results of managerial skill rankings of the farms with buffaloes are set out in table-5 (coefficients are presented in Appendix-2). The table indicates that there were sizable variations in managerial ranks within and between the farms. In the year 1975, only four farms (2, 3, 4 & 6) had positive rank coefficients. In 1976, the number of farms with positive rank coefficients increased to five by adding one of the farm (8). In 1977 the number of farms (2, 4, 5, 6, 9 and 10) with positive ranks increased although two of the farms (3 and 8) lapsed into negative coefficient. In 1978, only three farms (4, 6 and 8) had positive rank coefficients. In 1979 the number of farms (1, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15, and 16) with positive ranks increased and only two farms (5 and 10) had negative rank coefficients. However, with time there was some shifting up and down of the farms in their managerial performance. These differences

TABLE - 5

Ranking of Murrah Buffalo Farms on the basis of Management ability

Ranks

Farm Code No.	1975	1976	1977	1978	1979	Over all
1.	VI	VIII	VIII	IV	XI	IX
2.	I	IV	II	-	-	III
3.	IV	II	VII	V	-	V
4.	III	I	III	I	I	I
5.	V	VII	VI	VII	XIII	X
6.	II	V	V	II	XII	VI
7.	VIII	X	X	VI	VII	XII
8.	X	III	IX	III	III	VII
9.	VII	IX	I	VIII	V	VIII
10.	IX	VI	IV	IX	XIV	XIII
11.	-	-	-	-	VI	VIII
12.	-	-	-	-	II	II
13.	-	-	-	-	IX	XIV
14.	-	-	-	-	X	XV
15.	-	-	-	-	VIII	XI
16.	-	-	-	-	IV	IV

not withstanding, three farms (2, 4 and 6) had consistantly positive ranking coefficients and another four (1, 5, 7 and 10) were marked for poor managerial abilities for four year each. Another group constituted of farms (3 and 8) which can be termed as potentially efficient farms. On the basis of yearly fluctuations, it could be seen that three farms (2, 4 and 6) were marked with highest managerial efficiencies and the farms with medium efficiency included 3rd and 8th. The rest (1, 5, 7, 9 and 10) were consistently poorly managed farms.

In the analysis cited by Albright (1962), percent return on capital investment was used as a measure of success. Consequently, it is of interest of compare the rankings of farms on this criterion with the rankings on the basis of residuals. A rank correlation test showed a significant relationship at 1% level of probability in each of the five years.

To test the hypothesis that the annual rankings was random, against the hypothesis that there was consistent year-to-year pattern in the rankings, the co-efficient of concordance was used. The coefficient of concordance for H.F. crossbred was calculated for complete five years, whereas for Murrah buffaloes, it was calculated for three years, i.e., upto 1977 because beyond this, informations for ten farms were not completed. The W-values of 0.8672 and 0.5610 for H.F. crossbred and Murrah buffaloes, respectively, were significant ($P \angle 0.01$). Thus, there is a strong evidence that the dairy farms which were superior (as indicated by their ranks based on deviation from regression in inputs or by percent return on capital investment) were consistently superior from year to year. A similar consistency was evident, for those dairy farms who were mediocre and inferior. These results agree with the finding of Albright et al. (1964) who quantified management in 30 dairy farms from 1956 through 1960.

II. Relationship between management factors and herd average milk production and net income :

a) Relationship between various management factors and dairy farm net income.

The net income derived from the operation of dairy farms is the ultimate concern of the dairyman in his role as manager of that business. Dairy as practiced is basically a means of marketing the products of land and labour. Under such a system of farming, management factors, as well as dairy sales and expenses, play an important part in determining the level of net income resulting from the operation of the dairy farm.

Measures of farm business activity and physical inputs and outputs, referred to in this investigation as farm management factors, have been used by several workers in the field of farm management as a tool in farm business analysis. Early studies on the relationship of farm management factors with income made use of tabular analysis or simple correlation procedures. Those procedures failed to furnish more meaningful information on the relative importance of farm management factors in explaning variation in net income among farms. Multiple regression analysis was employed in the present study as a means of determining relative importance of the various farm management factors in explaning variance in net incomes. Such information can be of value of characterizing the more profitable dairy operations and in pointing out management factors which should be given particular emphasis in dairy farm business analysis. But before that the inter-relationships of degree of association and dispersal attributes need to be done. From the later category mean, S.D. and C.V. were computed for crossbred and Murrah buffalo for fifteen herd management variables which are presented in table - 6 .

A perusal of table - 6 reveals that farms under consideration had an overwhelming performance of the stocking of crossbred animals. This could probably be attibuted to their higher daily milk yield per animal, higher percent days in milk, lesser consumption of succulent fodder, lesser feed costs/50 kg of milk produced, higher and favourable substitution of capital by labour. Almost all mean magnitudes of the measures presented unmistakably favoured keeping of crossbred animals over buffaloes excepting, of course higher fat yield, less acrage allocation and higher price of milk of the later category of animals.

TABLE - 6

Means and standard deviations (SD) for management practices on dairy farms.

Measure	B.F. crossbred			Murrah buffalo		
	Mean	SD	CV(%)	Mean	SD	CV(%)
Herd size	404.2769	474.9807	117.4869	228.5660	191.2022	83.6529
Total milk production (litre)	582087.9692	649631.5164	111.6036	171592.3396	171629.6879	100.0217
Milk yield per animal(daily)in litre	9.4458	3.8033	40.2644	6.0498	1.9018	31.4357
Percent days in milk	73.6708	8.2201	11.1578	64.7566	7.4505	11.5053
Succulent fodder fed/ animal/year(kg.)	11742.1102	8836.5363	72.2550	15111.5413	6759.9165	44.7334
Concentrate fed/ animal/year(kg.)	2099.7177	1095.6401	52.1803	1159.4012	939.8227	81.0610
Dry forage fed/ animal/year (kg.)	1508.8127	1066.6230	70.6928	1060.7016	482.7902	45.5161
Feed cost/animal/yr.(Rs.)	2859.0707	1346.8915	47.1004	1971.6033	917.1722	46.5191
Concentrate price(Rs.)	0.8583	0.1990	23.1853	0.9060	0.1944	21.4569
Milk price (Rs.)	1.9632	0.5601	28.9883	2.5034	0.7090	28.3214
Fat percent of milk	4.2246	0.3000	7.1012	7.1717	0.7828	10.9151
Number of man employed	73	105.1831	144.0084	41	36.7712	89.6858
No.oftillable acre of land	182.4692	304.3165	166.7769	134.6528	124.6287	92.5555
Number of animal per man employed.	3.3692	0.2143	6.3605	3.5415	2.0855	58.8874
Feed cost/50 kg milk produced (Rs.)	74.7466	85.3000	114.1280	78.0515	27.3464	35.7750

The magnitudes of coefficient of variation indicated that from amongst crossbred animals, percent days in milk, concentrate price, milk price, fat percent of milk and number of cows per man employed, were characterised by higher degree of stability. All other attributes in crossbred herd were relatively higher unstable. On the other hand, only four attributes (percent days in milk, concentrate price, milk price and fat percent of milk) turned out to be relatively more stable. The inter-category comparisons of the herds revealed that where as a large number of attributes (herd size, total milk production, milk yield per animal, succulent fodder fed/cow/year, dry forage fed/cow/year, feed cost/animal/year, fed costs/50 kg.milk produced, number of man employed and number of tillable acre of land) were characterised by higher relatively instability, the same could be said about buffalo herds for only a few (concentrates fed/animal/year, fat percent of milk, and number of animals per man employed).

It thus can be concluded that the mean attributes of milk production in crossbred herd were desirable but were, nevertheless, characterised by more relative variance.

Zero-order correlations among the fifteen management variables for H.F. crossbred and Murrah buffalo are set out in table - 7. It can be seen from the table - 7 that the net income (y) in case of H.F. Cattle was significantly and positively

TABLE - 7

Zero-order correlations among net income variables for H.F. crossbred & Murrah buffalo herds a b

	Net income (y)	Herd size (x_1)	Annual milk prod. (x_2)	Daily milk yield per cow (x_3)	Percent days in milk (x_4)	Succulent fed/cow/yr. (x_5)	Concentrate fed/cow/year. (x_6)	Dry forage fed/cow/yr. (x_7)	Feed cost/ [illegible] cow/yr (x_8)	Feed cost/ 50kg. milk (x_9)	Per kg. concentrate price. (x_{10})	Per kg milk price (x_{11})	Fat % of milk (x_{12})	No. of man employed. (x_{13})	No. of tillable acre (x_{14})	No. of cows/ man employed. (x_{15})
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Net income (y)		-0.6536*	-0.2143	0.3384*	0.3501*	0.3378*	0.0483	-0.0829	0.1011	-04027	-0.0433	0.079	0.3076	-0.7597*	0.1382	-0.3252*
Herd size (x_1)	-0.0127		0.8254*	-0.0727	-0.3642*	-0.1762	-0.1521	0.0398	-0.0774	-0.0636	0.1074	-0.230*	-0.3609*	0.9149*	0.3554*	-0.0298
Annual Milk production (x_2)	0.1924	0.8866*		0.2505*	-0.2917*	0.0548	-0.1103	-0.0002	0.0535	-0.1475	0.0929	-0.349*	-0.3139*	0.6876*	0.6616*	0.0963
Daily milk yield per cow (x_3)	0.1539	-0.2539	-0.0123		0.0949	0.6368*	0.1541	-0.3421*	0.4225*	-0.2899*	0.1643	-0.292*	-0.0803	-0.1530	0.3871*	-0.1308
Percent days in milk (x_4)	-0.0739	-0.0229	0.0385	0.3440*		0.2605*	0.1450	0.1957	0.1660	0.2292	0.0169	0.120	0.1498	-0.3962*	-0.1901	0.2922*
Succulent fed/cow/year (x_5)	-0.3959*	0.3287*	0.1362	0.1896	-0.0311		-0.1028	-0.3087*	0.3273*	-0.1973	0.2428*	-0.441*	-0.1036	-0.2189	0.1468	-0.2392*
Concentrate fed/cow/yr. (x_6)	0.4350*	0.0303	0.3667*	0.3967*	0.2075	-0.3837*		0.5800*	0.7604*	0.6036*	-0.1276	0.170	0.2395*	-0.1342	-0.0467	-0.1771
Dry forage fed/cow/year (x_7)	0.2455	0.0977	0.3914*	0.3049*	0.2812*	-0.2830*	0.6865*		0.4802*	0.8947*	-0.0219	-0.013	0.0655	0.0134	-0.0042	0.2009
Feed cost/cow/year (x_8)	0.1339	0.2577*	0.5179*	0.4515*	0.2118	-0.0726	0.8090*	0.6266*		0.6213*	0.3248*	-0.113	-0.1175	-0.1021	0.0401	-0.3123*
Feed cost/50kg. milk (x_9)	-0.0551	0.3615*	0.3707*	-0.2522*	-0.0978	-0.3311*	0.4325*	0.2757*	0.5357*		0.1876	-0.002	0.0441	-0.0464	-0.1605	-0.1403
Per Kg. concentrate price (x_{10})	-0.4212*	0.0216	-0.0520	0.0550	-0.0652	0.2688*	-0.3541*	-0.2497*	0.0546	0.0359		-0.075*	-0.2442*	-0.0256	0.1086	-0.1089
Per Kg. Milk price (x_{11})	0.5769*	0.1308	0.2684*	-0.0477	0.0037	-0.6278*	0.5944*	0.3465*	0.4685*	0.5800*	-0.2270		0.2725*	-0.1530	-0.4238*	0.1589

Contd.....2

Contd..table - 7.

	Y	(x_1)	(x_2)	(x_3)	(x_4)	(x_5)	(x_6)	(x_7)	(x_8)	(x_9)	(x_{10})	(x_{11})	(x_{12})	(x_{13})	(x_{14})	(x_{15})
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fat percentage of milk (x_{12})	-0.5442	-0.0414	-0.2163	-0.0909	0.3248*	0.2847*	-0.4776*	-0.4155*	-0.3717*	-0.2665*	0.2227	0.514*		-0.3784*	-0.3776*	0.2015
Number of men employed (x_{13})	0.1927	0.8481*	0.8433*	0.2919*	-0.1932	0.1346	0.2130	0.1402	0.3014*	0.3692*	-0.0831	0.320*	-0.1454		0.1595	-0.2262*
Number of tillable acres of land (x_{14})	-0.1886	0.6184*	0.5869*	-0.0415	-0.1910	0.4072*	0.0647	-0.0174	0.3147*	0.3366*	0.2545*	-0.083	-0.1334	0.5288*		0.3769*
Number of cows/men employes. (x_{15})	0.0524	0.0479	0.0598	-0.2106	-0.0556	-0.3159*	0.0015	0.2077	0.0172	0.2131	-0.0830	0.079	-0.4221*	-0.2140	0.0352	

a_/ H.F. crossbred correlations above the diagonal, Mu-rrah buffalo below.

b_/ All correlations with absolute value more than 0.23 and 0.25 for cattle and buffalo are statistically significant ($P \angle 0.05$)

that large herd depends more on green feeding, which in turn decrease fat percent and thus milk price.

correlated with daily milk yield per cow, percent days in milk, succulent fed per cow per year, fat percentage of milk, number of cows per man employed and was negatively correlated with herd size and number of men employed. It thus seems that at the present level of technology, increases in stocking rate and labour in H.F. crossbred cattle farms may decrease the net income. For Murrah buffalo herds, unlike H.F. crossbreds, the net income was significantly and positively correlated with concentrate fed per buffalo per year, milk price and negatively correlated with succulent fodder fed per buffalo per year, concentrate price and fat percentage of milk. This difference of Murrah buffalo from H.F. crossbred was probably due to the more dependance of buffalo on concentrate feeding and flat rate of milk inrespect of fat content. There have been quite a few inter-variable correlations. For instance, herd size, in H.F.crossbred herds, was significantly and positively correlated with annual milk production, number of men employed, number of tillable acres of land and negatively correlated with percent days in milk, per Kg. milk price, fat percentage of milk. The negative correlation of herd size with percent days in milk indicates a decrease in the breeding efficiency of animals with increase of herd size. Negative correlation with fat percent of milk indicates that large herd depends more on green feeding, which in turn decrease fat percent and thus milk price.

In Murrah buffalo, herd size was significantly and positively correlated with annual milk production, succulent fed per buffalo per year, feed cost per buffalo per year, feed cost/50 Kgs. milk produced, number of men employed and number of tillable acres of land. Positive correlations with succulent fodder fed and number of tillable acre of land indicated increasing dependence of large herds on green feeding. Feed cost per buffalo increased becaused the buffaloes in larger herds produce more milk and so consumed more feed.

Annual milk production of H.F. crossbred herds was significantly and positively correlated with daily milk yield per cow, number of men employed, number of tillable acres of land and negatively correlated with percent days in milk, per kg. milk price, fat percentage of milk and in Murrah buffalo herds, it was positively correlated with concentrate fed per buffalo per year, dry forage fed per buffalo per year, feed cost per buffalo per year, feed cost per 50 kg. milk produced, milk price, number of men employed and number of tillable acres of land. Daily milk yield per cow was significantly and positively correlated with succulent fodder fed per cow per year, feed cost per cow per year and number of tillable acres of land and negatively correlated with dry forage per year per cow, feed cost per 50 kg. milk produced and milk price in H.F. crossbred herds, but in Murrah buffalo herds, it was significantly and positively correlated with percent days in milk, concentrate fed per buffalo per year, day forage fed per buffalo per year and fed cost per buffalo per year and negatively correlated with feed cost per 50 kg. milk produced and number of men employed. Results indicated that high producing herds required more men employed and tillable lands. In crossbred cows, higher milk yield was with lower price which in buffalo herds, the reverse was found. It might be due to restricted, consumer preference for cow's milk. Larger milk production failed to extend proportionately the consumer market for cow's milk as a result of which milk price decreased.

Percent days in milk in H.F. crossbred herds was significantly and positively correlated with succulent fodder fed per cow per year and number of cows per man employed but negatively correlated with number of men employed and in Murrah buffalo herds, it was significantly and positively correlated with dry forage fed per buffalo per year and fat percentage of milk.

As expected, succulent fodder fed per cow per year was significantly and positively correlated with feed cost per cow per year and per kg. concentrate price and negatively correlated with dry forage fed per cow per year, per kg. milk price and number of cows per man employed.

In Murrah buffalo herds, concentrate fed per animal per year was significantly and positively correlated with concentrate price, fat percentage of milk and number of tillable acre of land. As dry forage fed per animal per year in both the species significantly and positively correlated with feed cost per animal per year and feed cost per 50 kgs. milk produced. In addition to this, in buffalo herds, it was significantly correlated with milk price positively and with fat percentage of milk negatively. Feed cost per cow per year in H.F. crossbred herds was significantly correlated with feed cost per 50 kgs. milk produced and concentrate price positively but fed cost per 50 kg. milk produced was not correlated significantly with any variables. In buffalo herds, feed cost per buffalo per year and feed cost per 50 kg. milk production were correlated significantly and positively with milk price, number of men employed and number of tillable acres of land, but negatively with fat percentage of milk. Concentrate price was significantly and negatively associated with milk price and fat percentage of milk in H.F. crossbred herds, but in buffalo herds it was associated with number of tillable acres of land positively. As the concentrate price increased there showed a tendency to feed more green fodders.

The correlation coefficient of milk price with fat percentage of milk was positively significant in both the species but it was negatively associated with number of tillable acres of land in H.F. crossbred herds and positively with number of men employed in Murrah buffalo herds.

Fat percentage of milk was significantly and negatively correlated with number of men employed and number of tillable acres of land in H.F. crossbred herds and with number of buffalo per man employed in Murrah buffalo herds. Such associations are indirect through less milk production. The negative correlation of fat percentage of milk with tillable acres of land in H.F. crossbred indicate that high producing animals tend to depend heavily on green fodder and thus these animal in process need more labour in case of stall feeding. Number of men employed was significantly and positively correlated with number of tillable acres of land only in Murrah buffalo herds. Number of tillable acres of land was positively and significantly correlated with number of cows per man employed in H.F. crossbred herds.

In general, net income in both the species was associated with daily milk yield, percent days in milk, milk price and number of cows per man employed and negatively with number of labour employed, feed and fodder cost and some extent herd size. Finally the significant degree of associations (x_1, x_2, x_3, x_{13}, x_{13} ; x_2, x_3, x_{11}, x_{13}, x_{14} ; x_3, x_5, x_8, x_{14}; x_4, x_5, x_{15}; x_5, x_8, x_{10} ; x_6, x_7, x_8, x_9, x_{12}; x_7, x_8, x_9; x_8, x_9, x_{10}; x_{11}, x_{12}, x_{14}, and x_{14}, x_{15}) in crossbred herds and similarly for buffalo herds (specially whose value exceeds 0.50) may pose problem of multicollinearity and thus may violate the basic assumption of independance in independent variables.

Quantitatively to identify and determine the nature of relationship between herd management factors and yearly net income, multiple regression both linear and quadratic models as described previously were employed. Table - 8 presents partial regression coefficients both linear and quadratic when net income was the dependent variable. Preliminary research had indicated possible quadratic effects for several of the independent variables. Therefore, the quadratic model which included both linear and quadratic effects were alternatively specified. Additionally, a model including only linear terms was also calculated to determine the relative magnitude of the each independent variable.

It can be seen from table - 8 that fifteen independant variables in the regression model which were stipulated to have cause-effect relationship with the net income in both the species. Together, these variables accounted for 85.75% for linear and 93.50% in quadratic function for H.F.crossbred herds. In case of buffalo herds these variables accounted for 76.71 percent of variance in net income under linear and 92.13% variance in Murrah buffalo herds under quadratic

TABLE - 8

Regression coefficients (b) and standard errors (ES) for quadratic model (both linear and quadratic) and linear with net income as the dependent variable

Independent variables		H.F. Crossbred cattle				Murrah buffalo			
		Quadratic		linear		Quadratic		linear	
		b	SE	b	SE	b	SE	B	SE
Herd size	Linear	1145.4222**	1177.2496	-1155.3562**	318.6640	-1045.2148**	493.1659	-4.9050	233.6283
	Quadratic.	-0.5972**	0.3031			0.3679*	0.6194		
Annual milk production	Linear	2.6209**	0.7065	1.0425*	0.1764	-0.0069	0.6402	0.1076	0.2463
	Quadratic	-5.0249**	1.6933			Neg.	-		
Milk yield per animal (wet ave)	Linear	31101.3437	95149.5739	-6185.1282	22189.1493	-43903.1726*	20351.9632	10998.4209	8319.0904
	Quadratic	-1973.6185	4219.6718			3864.3491**	2003.7192		
Percent days in milk	Linear	-43009.5857	113981.4244	606.1775	7268.1421	10084.2800*	12439.1329	-275.1109	1606.8000
	Quadratic	348.9726	823.4091			-92.5286*	101.1634		
Concentrate fed/animal/yr.	Linear	120.3908	288.3799	52.5560	99.4734	113.5463*	91.3557	37.2371	27.0734
	Quadratic	-0.0020	0.0508			-0.0118	0.0177		
Succulent fed/animal/yr.	Linear	22.7360*	22.9225	16.2229	9.5305	4.3478	7.0107	-1.1762	3.4546
	Quadratic	Neg.	0.0005			Neg.	0.0001		
Dry forage fed/animal/yr.	Linear	111.4842	191.3860	31.7832	104.7919	-92.0530*	86.4377	-25.8993	26.6113
	Quadratic	0.0097	0.0739			0.0404*	0.0345		
Feed cost/animal/year.	Linear	-622.5398*	464.7378	-119.4688	117.4434	-104.9171	33.1303	-30.8168	31.8404
	Quadratic	0.0542**	0.0668			0.0066	0.0126		
Feed cost/50 kg.milk production.	Linear	-138.3176	5005.3002	473.8843	1521.1961	-1329 .2227	2162.0945	-1213.8869*	607.8012
	quadratic	-2.6440	12.5028			7.2986*	10.0523		
Milk price(per litre)	Linear	3062299.4872	1063634.7698	80816.2779	123702.7504	-432908.5957**	174335 .0661	92567.5389*	30624.8254
	Quadratic	-568583.1587**	218959.8597			84657.0293**	26789.9478		
Concentrate price(per kg.)	Linear	2935252.3126**	1697678.2209	113522.8220	353304.2707	-103915.0743	303888 .6261	58319.4400	65200.1351
	Quadratic	-1.5962	969941.8519			67674.2869	162945.0980		
Fat %tage of milk	Linear	727598.0027	5187740.9636	20810.1187	194714.2239	235880.3564*	205711.7795	-38881.0283*	21373.2434
	Quadratic	-84621.2247**	600994. 3363			-14070.7798*	15400.3030		
Number of men employed.	Linear	-20144.7290	4992.8707	-3890.4808*	1263.8965	-493.1961	2525.3012	439.3395	852.2883
	Quadratic	21.5075**	8.3397			22.2168**	17.2312		
No.of tillable acre of land	Linear	515.1507	1610.9399	-411.4596	328.1681	777.5964	364.5733	46.0810	131.0492
	Quadratic.	-0.9647*	1.1004			-1.3098**	1.1192		
No.of animals/man employed.	Linear	-1.2971	1208956.6956	304759.2921	344999.3276	45243.3261	25563.3894	4271.1371	8359.0618
	Quadratic	268867.7457	84410.8136			-2335.3349*	1314.1131		
	R^2	0.9350		0.8575		0.9215		0.7671	

** Significant at 1% level. * = Significant at 5% level.

specification. These results are in consonance with those reported by Miller (1968) who considered only linear effects and did not include feed cost in his model. However, the results reported by Brown and White (1973) were indicated " better-fit " on similar data under quadratic specification.

In H.F.crossbred herds, out of fifteen variables herd size, annual milk production and number of men employed were significant in explaining variances in the net income. Speicher and Lossiter (1965), Miller (1968) and Brown and White (1973) observed that milk price, milk production per cow, concentrate feeding, grain price and other feed costs were relatively more important than the others in determining income over feed cost for Holstein, Jersey and Guernsay breeds. In linear regression analysis, except the total milk production all the independent variables were important in determining the net income. One unit increase of herd size or labour employed resulted in Rs.1155.35 or Rs.3890.48 decrease in net income. This finding is contrary to the belief that increase in herd size results in more net income. In the present study increase in herd size was probably not commensurate with resource-mix and cost effectiveness of milk production. Addition of one litre of milk to total milk production resulted in Rs.1.04 increase in net income. Thus, the management needs to strive for increase the milk yield of individual cow, rather than resort to over stocking of animals.

Under quadratic specification, the explanation power of the model was considerably increased. Consequently linear as well as quadratic terms of herd size (x_1), milk production (x_2), [succulents (x_6 for only linear term)], feed costs (x_8), milk price (x_{10}) and number of labour employed (x_{13}) contributed significantly in explaining the variance in net income. It can thus be concluded that quadratic response of the management variable was better related with net income than its linear counterpart.

In Murrah buffalo herds, unlike H.F. crossbred, feed cost per 50 kg. milk produced, milk price and fat percent of milk turned out to be signifcant in explaining variances in the net income out of the fifteen variables considered. In linear regression analysis like H.F. crossbred, all the variables except total milk production were important. According to this specification, a change of one unit in feed cost per 50 kg. milk produced and in fat percentage of milk may cause decrease of Rs.1213.88 and Rs.38851.02 of net income respectively. This could be attributed to excessive feeding of concentrates rather than green fodder. As the milk yield decreases fat percentage of milk increase and thus negative effect of fat percentage of milk was probably due to low production of milk by individual buffaloes. Like wise, the production of milk resulted in more cost of milk production. Increase of one unit of per litre milk price resulted in increase of Rs.92567.53 of net income. The other independent variables although had nonsignificant effect, but their contributions to net income were important. An unit change in annual milk production, milk yield per buffalo, concentrate fed per buffalo per year, number of men employed, number of tillable acres of land and number of buffalo per man employed caused an increase of net income by Re. 0.10, Rs.10998.42, Rs.37.28, Rs.439.38, Rs.46.08 and Rs.4271.13 respectively. On the other hand, an unit increased in herd size, percent days in milk, succulent fed per buffalo per year, dry forage fed per buffalo per year, feed cost per buffalo per year and concentrate price resulted in decrease of net income by Rs.4.90, Rs.275.11, Rs.1.17, Rs.25.89, Rs.30.81 and Rs.58319.44 respectively.

Like H.F. crossbred, under quadratic specification, the explanation power of the model was considerably increased over the linear model. For the linear as well as quadratic terms, herd size (x_1), percent days in milk (x_3), [concentrate (x_5 for only linear)], dry forage fed (x_7), [feed cost (x_8 for linear, feed cost/50 kg. milk produced (x_9 for quadratic)], milk price (x_{10}) , fat percentage of milk (x_{12}), [number of labour employed x_{13} for quadratic)], number of tillable acres of land (x_{14}) and number of buffaloes per man employed (x_{15}) contributed significantly in explaining the variance in net income. Thus quadratic response of the management variables was better related with net income than its linear counterpart.

Figs.1 and 2 were plotted using the partial regression coefficients of quadratic forms of net income on herd size and wet average of H.F.crossbred herds. The optimum net income was realised when the herd size reached the strength of 975 adult units. Similarly, the optimum net income was realised with herd average milk yield at 7.87 litres per day.

The discussion reveals that the major determinats of net income realization in case of H.F. crossbred herds are milk production,milk price and fat percent of milk. Similarly in Murrah buffalo herds, per litre milk price, milk yield per buffalo and number of buffalo per man employed were more important determinants which contribute positively to the enhancement in net income. The results are in consonance with Spechter and Lassiter (1965) who investigated similar study and reported that number of tillable acres, crope value per tillable acre and livestock income per $100 feed expense were of primarly importance in explaining variation in net income. Management factors such as crop yield and milk sales were of secondary importance in explaining variations in

QUADRATIC FORM OF RELATIONSHIP BETWEEN "HERD SIZE AND NET INCOME" IN HOLSTEIN-FRIESIAN CROSSBRED HERDS

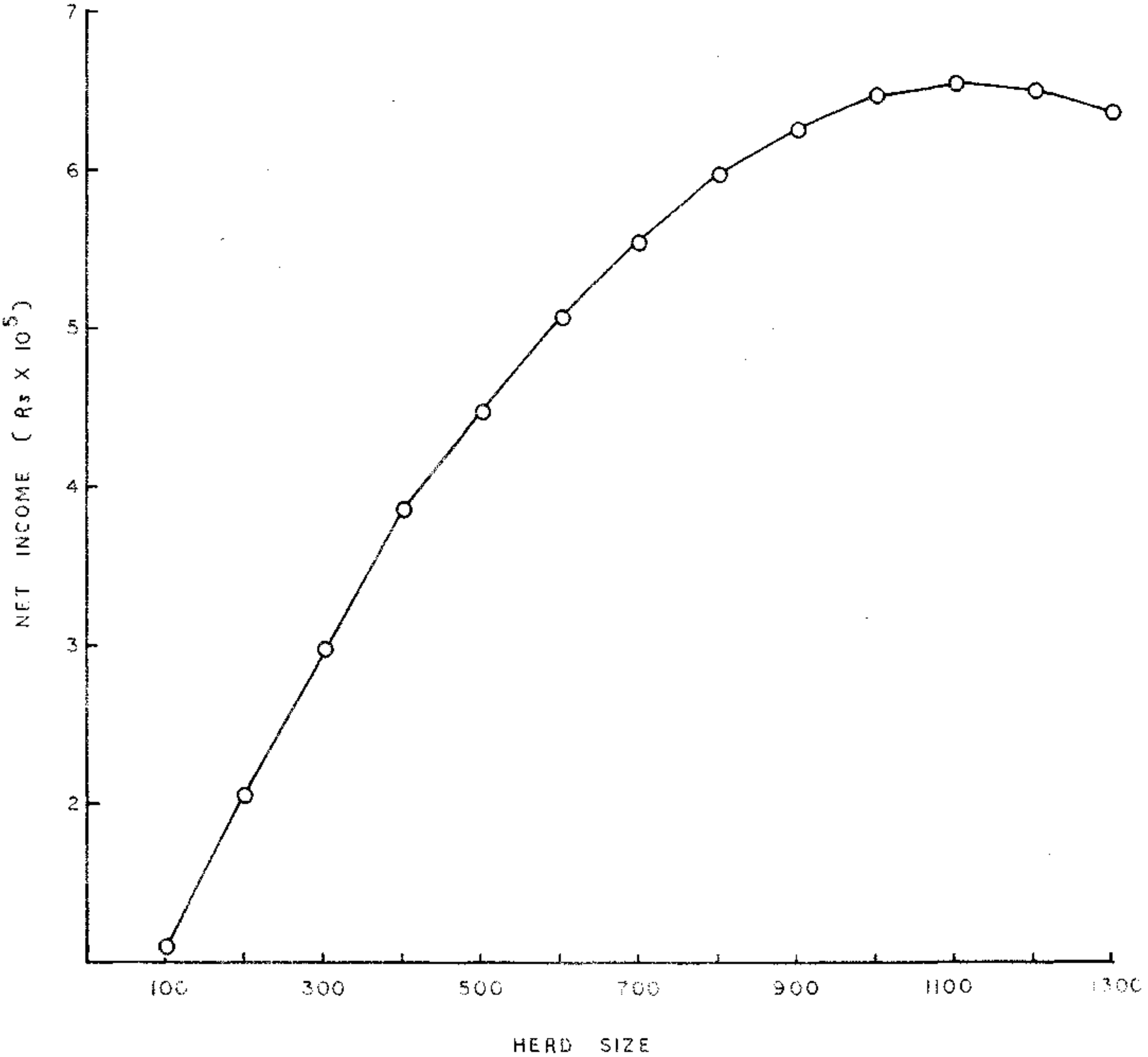

FIGURE - 1

QUADRATIC FORM OF RELATIONSHIP BETWEEN "AVERAGE MILK YIELD AND NET INCOME" IN HOLSTEIN-FRIESIAN CROSSBRED HERDS

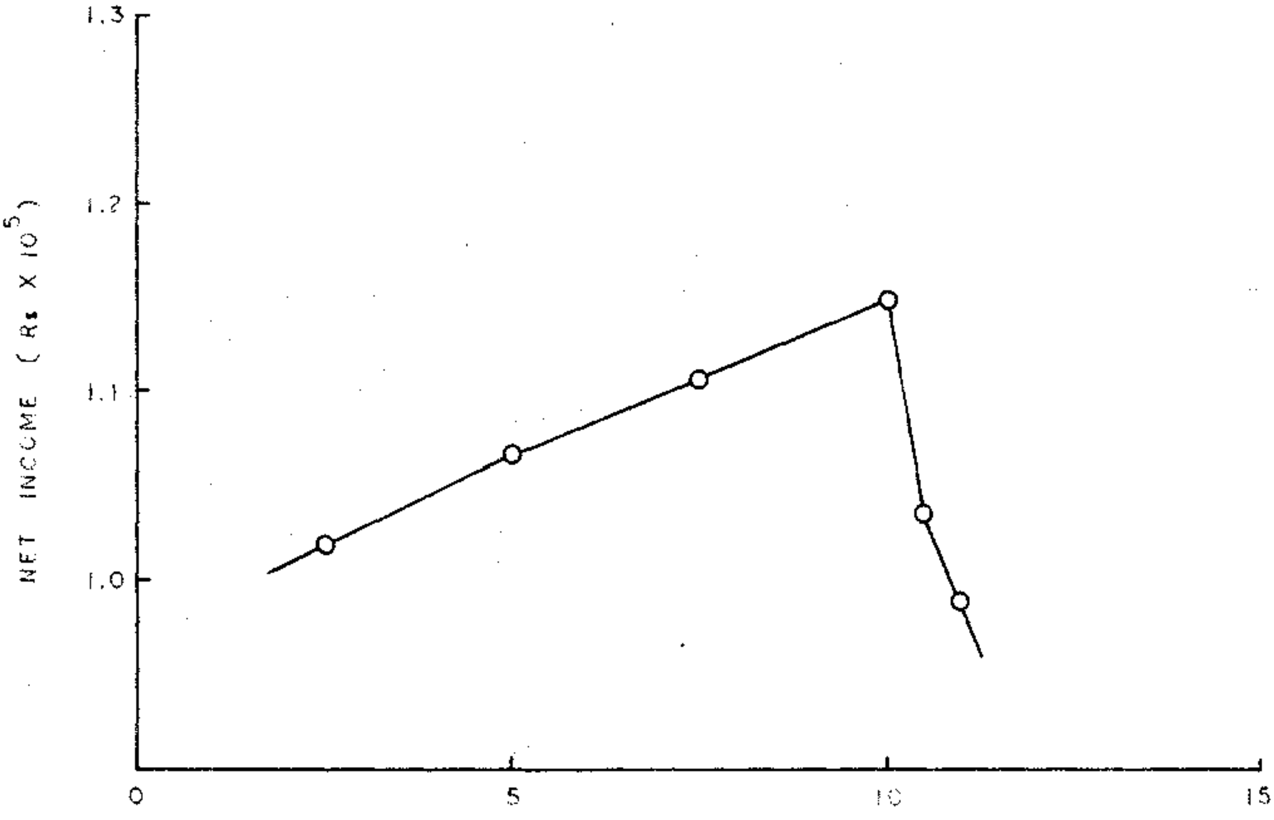

FIGURE - 2

income; grain per cow, percent cows in milk and several other farm management factors were of tertiary importance in explaining in net income, yet grain per cow and percent cows in milk were of primary importance in explaining variation in milk sold per cow. Brown and White (1973) in another similar study reported that increased milk price and milk production accounted for sizable increase in income over fed costs; while feed costs per 45.5 kgs. of milk, other feed costs and grain prices significantly reduced income.

b) Management factors and average milk production :

It needs no elaboration that income accruels from milk are conditioned by the milk productivity of herd. It follows logically also that enhanced milk productivity will be scale-positive and cost-effective. This cost-effectiveness of producing maximum possible milk from given resource-mix, in turn would be conditioned by management of the herd. Miller (1969) and Miller and Dickinson (1968) have shown that management practices related to feeding, particularly amounts of concentrate and reproductive efficiency (percent days in milk) had a higher degree of relevance in predicting herd average milk production in Holstein herds and were the most important characteristics common to higher producing herds. However, only linear relationships were examined by them.

In this present investigation, multiple regression analysis was used to characterize the relationship between various management factors and herd average milk production. The objectives of this study were to characterize the relationship among several herd management variables and to determine the degree of association of the herd management variables with herd average milk yield in H.F. crossbred and Murrah buffalo herds.

Zero-order correlation coefficients as calculated by product-moment method among management factors and with herd average milk production are presented in Table - 9.

In general, mean milk production in H.F. crossbred herds was correlated significantly and positively with amount of succulent fed per cow per year (x_3), number of tillable acres of land (x_8) on the one hand and negatively with dry forage fed per cow per year (x_5) and per kg. milk price (x_7), on the other.

The result illustrates that higher milk producing animals rely more heavily upon succulent feeds and less on dry forage feeding. Finaly the herd average milk production is by and large independent of amount of concentrate feeding.

In Murrah buffalo, unlike H.F. crossbred, herd average was significantly and positively correlated with percent days

TABLE – 9.

Zero-order correlation among herd average variables for H.F.crossbred and Murrah buffalo[a]

		Herd average (Y)	Herd size (x1)	Percent days in milk. (x2)	Succulent fed/cow/year. (x3)	Concentrate fed/cow/year. (x4)	Dry forage per/cow/year. (x5)	Concentrate price/kg. (x6)	Milk price/kg. (x7)	Number of tillable acre of land. (x8)
Herd average	(Y)		-0.0503	0.0493	0.7608**	-0.0898	-0.4352**	0.2005	-0.3592**	0.4232**
Herd size	(x_1)	-0.1403		-0.3642**	-0.1762	-0.1521	0.0398	0.1075	-0.2308*	0.3554
Percent days in milk	(x_2)	0.4034**	-0.0229		0.2608*	0.1451	0.1957	0.0169	0.1207	-0.1901
Succulent fed/cow/year	(x_3)	0.2707*	0.3287*	-0.0311		-0.1028	-0.3087**	0.2428*	-0.4413**	0.1467
Concentrate fed/cow/year.	(x_4)	0.4125**	0.0303	0.2075*	-0.3868**		0.5700**	-0.1276	0.1705	-0.0468
Dry forage fed/cow/year.	(x_5)	0.3697**	0.0977	0.2812*	-0.2879*	0.6856**		0.0219	-0.0137	-0.0042
Concentrate price/kg.	(x_6)	0.0670	0.0216	-0.065	0.2686*	-0.3541**	-0.2497		-0.2753*	0.1086
Milk price per kg.	(x_7)	-0.0868	0.1308	0.0037	-0.6273**	0.5944**	0.3465**	-0.2270		-0.4238
Number of tillable acre of land	(x_8)	-0.0316	0.6164**	-0.1910	0.4072**	0.0647	-0.0174	0.2546*	-0.0838	

a. H.F. Crossbred correlations above the diagonal, Murrah buffalo below

** = Significant at 1% level.

* = Significant at 5% level.

in milk (x_2), concentrate fed per buffalo per year (x_4) and dry forage per buffalo per year (x_5). Succulent feeds did not exert as powerful an influence with the herd average in Murrah herds as that in H.F. herds. Thus herd average milk production of Murrah buffalo depended more on concentrate feeding and dry forage feeding than green feeding. A closer perusal of the table-9 will, reveal inter-correlations between several management variables. For instance in case of H.F. herds, a strong degree of association was followed between dry forage (x_5) and concentrate feeding (x_4). Similarly to a lesser extent, the positive degree of associations were discernible for succulent fed (x_3) and percent days in milk (x_2), number of tillable acres (x_8) and finally herd size (x_1), succulent fed (x_3) and concentrate price (x_6). Similarly significant negative degree of association were noticeable between milk price (x_7) and succulents fed (x_3), tillable land (x_8) and milk price (x_7). Similarly in case of buffalo herds high correlations (x_1, x_8 and x_3, x_7) were discernible. But in both herds, no correlation coefficient was significant enough (Klein, 1969) to warrant serious multicollinearity and thus coefficient estimation problems. The results are in consonance with Brown and White (1973) who reported that results of a fourteen herd management factors model in Holstein, Guernsey and Jersey herds. Their study revealed that herd average was significantly and positively correlated with succulent feeding and was negatively correlated with dry forage feeding, correlation between herd size and milk production were low and inconsistent among the three breeds. Herd size was significantly and positively correlated with milk price, value of product and income over feed costs.

The data in the present case were employed to generate for both linear and quadratic regression equations specifications for H.F. and as well as Murrah herds. The results are set out in table 10 .

It is clear from table- 10 that under linear specifications all the management together explained respectively about 76 and 64 percent variations in the herd average for H.F. cows and Murrah buffaloes respectively. Under quadratic specification the explanation power of functions increased considerably (90 percent for H.F. herds and about 79 percent for Murrah herds respectively). The results relate herd averages with management variably in better way than those reported by Corley et al. (1964), Stone et al.(1964) and Brown and White (1973).

TABLE - 10

Regression coefficient (b) and standard error (SE) for quadratic model (both linear and quadratic) and linear model with herd average milk production as the dependent variable

Independent variables		Holstein Friesian crossbred cattle				Murrah buffalo			
		Quadratic		Linear		Quadratic		Linear	
		b	SE	b	SE	b	SE	b	SE
Herd size (x_1)	Linear	0.0011*	0.0012	-0.0002	0.0004	-0.0077**	0.0038	-0.0020	0.0010
	Quadratic	Neg.	0.0000			Neg.	0.0000		
Percent days in milk (x_2)	Linear	0.9341**	0.2684	-0.0082	0.0266	0.0146	0.2446	0.0438**	0.0194
	Quadratic	-0.0067*	0.0018			Neg.	0.0019		
Concentrate fed/animal/year (x_3)	Linear	0.0007	0.0005	0.0004**	0.0002	0.0031**	0.0008	0.0010**	0.0002
	Quadratic	0.0000	0.0000			Neg	0.0000		
Succulent fed/animal/year. (x_4)	Linear	0.0002	0.0000	0.0002**	0.0000	0.0002**	0.0001	0.0001**	0.0000
	Quadratic	0.0000	0.0000			Neg.	0.0000		
Dry forage fed/animal/year (x_5)	Linear	-0.0012**	0.0004	-0.0009**	0.0002	-0.0022*	0.0018	0.0004	0.0004
	Quadratic	0.0000	0.0000			Neg.	Neg.		
Milk price (per litre) (x_6)	Linear	-11.3044**	3.3635	0.3301	0.4348	-4.7615**	2.5368	-0.0960	0.3243
	Quadratic	2.3883**	0.4883			0.7203**	0.4087		
Concentrate price (Per kg.) (x_7)	Linear	6.3590*	6.1030	0.9096	0.9754	3.3954	7.2805	1.6063**	0.7910
	Quadratic	0.0000	0.0000			0.0000	0.0000		
Number of tillable acres of land (x_8)	Linear	0.0009*	0.0006	0.0032**	0.0007	-0.0007	0.0018	-0.0021	0.0016
	Quadratic	-2.9908*	[illegible]			-1.4276	3.9567		
	R^2	0.9028			0.7574		0.7880		0.6433

** significant at 1% level. * Sig. at 5% level

Since quadratic response were statistically "best-fit" only their results merit discussion. It for instance can be seen that for H.F. animals, milk price (x_6) was highly significant for both linear and power terms. Other significant variables included percent days in milk (x_2 both linear and power terms) and linear terms of dry forage (x_5), concentrate price (x_7) and number of tillable acres (x_8, both terms). From the results it can be seen that, all the variables conformed to the logic of production theory. However, the significant declining returns were discernible for only percent days in milk, milk price and number of tillable acres. It can thus be concluded that these variables may have been used aheady to the extent where diminishing marginal returns have started operating. The results also indicate that further increase in selly price of milk would be sizably responsive to the augmentation of herd average of H.F. aminals under study.

In the case of Murrah herds it can be seen that banning milk selling price, no variable has allowed the herd average to enter in the rational zone of productivity. Even the linear term which could significantly and positively enter are concentrates feeding and succulents and dry fodder. Any increase in the quantities of these variables excepting dry forage are likely to push up herd average in these animals. Other variables like herd size has to be reduced to permit smooth operationalies of scale economics.

Linear regression showed that herd size and percent days in milk had negative effect on herd average milk production. But concentrate fed, succulent fed, dry forage fed and number of tillable acres of land had positive and significant influence on herd average milk production. Milk price per litre and concentrate price per kg. had positive but nonsignificant effect on herd average. An increase of one unit of milk price per litre or concentrate price per kg. resulted in an average increase of about 0.23 or 0.90 kg. of milk. The positive regression of herd average milk production on concentrate price (0.9096) likely reflected the effect of feeding high quality concentrates. The positive regression of herd average milk production on price of milk reflected the more intensive managerial care of cow which help to increase the milk production. An unit increase of concentrate and succulent fed per cow per year resulted in increase of milk production by 0.004 kg. and 0.0002 kg. Similar study was conducted by Stone et al. (1966), Miller and Dickinson (1968) and Brown and White (1973). They reported that an increase of 1 kg. of concentrate feeding resulted in an average increase of milk production from 0.74 to 1.05 kg. The negative regression of milk yield with herd size is agreed with the finding of Stone et al. (1966), Miller and Diskinson (1968) and Brown and White (1973).

In Murrah buffalo herds, out of the eight independent variables, milk price and concentrate price contributed important influences on milk production. Linear regression analysis indicated that percent days in milk, concentrate fed per buffalo per year, succulent fodder fed per buffalo per year and concentrate price had positive and significant effect on average milk production of the herd. This finding explained that milk yield in buffalo increases with the increase of breeding efficiency, concentrate and succulent fodder feeding. Positive regression of milk yield with concentrate price indicates the feeding of good quality concentrate. Dry forage fed per buffalo per year, herd size, milk price and number of tillable acres of land had non-significant effects on milk yield. Unit increase in percent days in milk, concentrate fed, succulent fed, dry forage fed and concentrate price resulted in increase of milk production by 0.043 kg., 0.001 kg., 0.001 kg., 0.004 kg. and 1.606 kg. respectively. On the other hand an unit increase in herd size, milk price and number of tillable acre of land resulted in decrease of milk production by 0.002 kg., 0.096 kg. and 0.002 kg. respectively.

Fig.-3 presents the result of quadratic regression of percent days in milk on milk production in H.F. crossbred herds. Since days in milk in the majority of herds, ranged from

PARTIAL REGRESSION OF HERD AVERAGE MILK PRODUCTION ON AVERAGE PERCENT DAYS IN MILK IN HOLSTEIN-FRIESIAN CROSSBRED HERDS

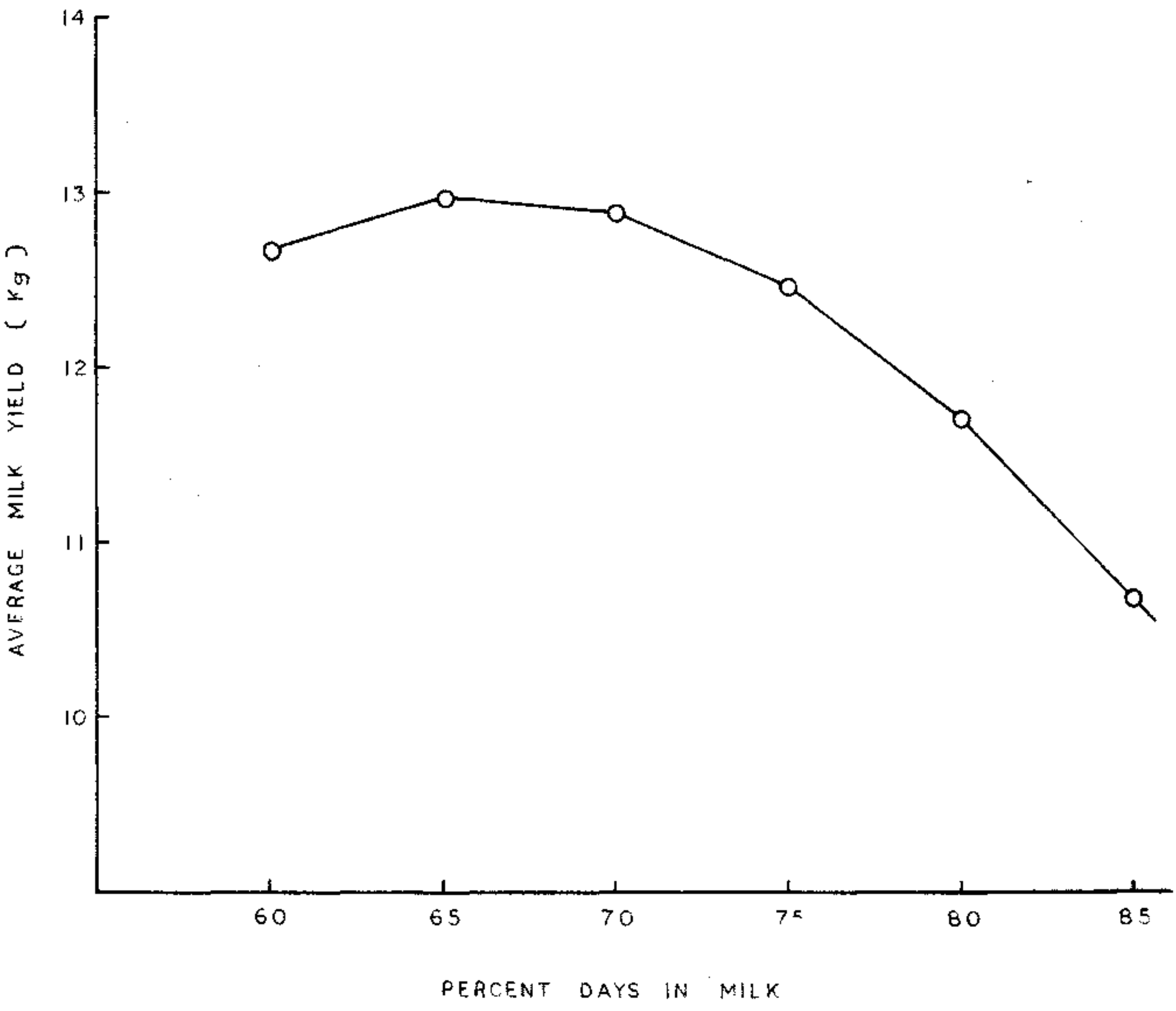

FIGURE - 3

60 to 85% quadratic model was an accurate estimate of the influence of this variable on production. From the nature of the curve, it is evident that short percent days in milk did not promote the milk production. On the other hand, an excessive long percent days in milk was also not conducive to milk production. The optimum period in milk production was estimated from the data by equating $\frac{dy}{dx}$ to zero which gave 69.71 percent days in milk. This value was lower than the value reported by Miller and Dickinson (1968) and Brown and White (1973). However, the detrimental affects of low percent days in milk appeared to have been seriously under estimated by many workers studying only linear relationships. Low percent days in milk usually indicates poor management and high values show short dry periods, high reproductive efficiency and often intensive culling.

Amount of succulent feeding and number of tillable acres of land in H.F. crossbred and percent days in milk, concentrate, dry forage and succulent feeding in Murrah buffaloes were significantly related to milk production.

Thus in H.F.crossbreds, large increase in production can be accomplished by increase of green fodder feeding. Unlike H.F. crossbred, milk production in Murrah buffalo can be increased by feeding more concentrate and dry forage.

III. Efficient use of various farm resources for Optimum production efficiency and profit from dairying enterprise.

a) Production functions :

The mechanics of resource combination in dairy farming can be understood if the fundamental input-output relationships underlying the milk production process are examined. The input-output relationships, in turn, depend on the institutional attitude. The resource use pattern on private commercial dairy farms would be quite different than the same on institutional dairy farms. The organizational and management factors play a dominant role on the decisions about resource milk and the latter in turn, determine the milk production possibility frontiers. In order to ascertain the influence of certain relevant parameters affecting milk production, the production function analysis was carried out.

Specification of the milk production function :

The milk production of dairy cattle is conditioned by interplay of a number of genetic, nutritional, physiological, economic and environmental and management factors. However, in practice, a production function can not hope to take account of all the multitude of factors responsible for milk production. Thus, little is known about the nature of the production surface and type of mathematical equation needed in describing production process. To circumvent this problem, linear, Cobb-Douglas and quadratic production functions were fitted to the same input-output data. The relationship was established between annual milk yield (litre) per adult animal and different variable factors like tons of hay equivalent fed per adult animal per annum (x_1), kg. of concentrate mix fed per year per adult animal (x_2), number of labour employed per year per adult animal (x_3), number of tillable acres of land per year per adult animal and annual operational cost other than x_1 to x_4 . The correlation coefficients between dependent and independent variables and among independent variables have been presented in matrix form in Appendices 3 & 4 for H.F. crossbred and Murrah buffaloes.

The equations of the different production functions are set out in table 11 for H.F. crossbred and Murrah buffalo herds. The relevant statistics for these three functions are given in table -12 . The t-values are for the regression coefficients in their respective order within the equations. In H.F. crossbred and Murrah buffaloes from 78.67 to 94.76 and 75.13 to 91.93 percent of the total variance, in milk production are accounted for in the five variables, depending on the function. This was further statisfically tested by analysis of variance presented in table-13. The F-ratios of different equations are highly significant ($P < 0.01$).

TABLE - 11

Production Functions for H.F.crossbred and Murrah buffalo herds.

a) LINEAR:

Cattle:

$$Y = 897.5684 + \underset{(33.8299)}{152.4252X_1} - \underset{(0.0646)}{0.1465X_2} - \underset{(717.6319)}{711.8031X_3} + \underset{(102.1324)}{297.0081X_4} + \underset{(0.1324)}{0.3564X_5}$$

Buffalo:

$$Y = 68.4820 + \underset{(7.1240)}{59.0668X_1} + \underset{(0.0564)}{0.0563X_2} - \underset{(154.8295)}{501.2801X_3} - \underset{(27.9008)}{54.0903X_4} + \underset{(0.0987)}{0.3167X_5}$$

b) COBB-DOUGLAS:

$$\text{Cattle: } Y = 0.8210\ \underset{(0.0547)}{X_1^{0.1702}}\ \underset{(0.0324)}{X_2^{-0.0859}}\ \underset{(0.0698)}{X_3^{-0.1596}}\ \underset{(0.0255)}{X_4^{0.0543}}\ \underset{(0.1320)}{X_5^{0.8330}}$$

$$\text{Buffalo: } Y = -0.0696\ \underset{(0.0461)}{X_1^{0.2710}}\ \underset{(0.0399)}{X_2^{0.0563}}\ \underset{(0.0649)}{X_3^{-0.2311}}\ \underset{(0.0200)}{X_4^{-0.0361}}\ \underset{(0.1141)}{X_5^{0.8710}}$$

c) QUADRATIC:

$$\text{Cattle: } Y = 234.5463 + \underset{(135.6413)}{1091.2221X_1} + \underset{(0.2882)}{0.5789X_2} + \underset{(2481.0294)}{7032.6391X_3} + \underset{(424.2820)}{248.4164X_4} - \underset{(0.6259)}{1.8513X_5} + \underset{(15.5755)}{18.3782X_1^2} + \underset{(0.0001)}{0.0001X_2^2} +$$

$$\underset{(4283.2354)}{17698.8581X_3^2} + \underset{(154.0303)}{504.0303X_4^2} + \underset{(0.0002)}{0.0001X_5^2} - \underset{(0.0350)}{0.1377X_1X_2} + \underset{(494.0488)}{246.1193X_1X_3} + \underset{(74.4133)}{53.0680X_1X_4} + \underset{(0.1125)}{0.3405X_1X_5}$$

$$- \underset{(0.7988)}{1.9942X_2X_3} + \underset{(0.1537)}{0.2764X_2X_4} + \underset{(0.0002)}{0.0005X_2X_5} - \underset{(1747.2445)}{7495.5034X_3X_4} + \underset{(1.7571)}{6.0273X_3X_5} + \underset{(0.2993)}{1.1855X_4X_5}$$

$$\text{Buffalo: } Y = -96.3654 + \underset{(165.8007)}{333.2152X_1} + \underset{(0.4575)}{0.7783X_2} - \underset{(1432.1917)}{3223.4058X_3} - \underset{(248.921)}{142.8459X_4} + \underset{(0.7154)}{0.6067X_5} + \underset{(3.3664)}{3.0292X_1^2} - \underset{(0.0001)}{0.0001X_2^2}$$

$$- \underset{(2859.9905)}{521.8135X_3^2} + \underset{(40.4461)}{24.2057X_4^2} + \underset{(0.0002)}{0.0001X_5^2} + \underset{(0.0559)}{0.0343X_1X_2} + \underset{(90.9000)}{114.2635X_1X_3} - \underset{(21.9395)}{49.0854X_1X_4} - \underset{(0.1004)}{0.1970X_1X_5}$$

$$- \underset{(1.5270)}{0.8232X_2X_3} - \underset{(0.0914)}{0.1048X_2X_4} - \underset{(0.0002)}{0.0005X_2X_5} - \underset{(505.9138)}{258.1050X_3X_4} + \underset{(2.0385)}{2.1604X_3X_5} + \underset{(0.1761)}{0.9998X_4X_5}$$

Figures in parentheses indicate standard error of the corresponding regression coefficient.

TABLE - 12

Coefficients of determination (R^2) and t values for production function equations

Equations	R^2	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}
Cattle.	0.7867	4.507**	-2.265*	-0992	2.908**	6.317**					
Linear Buffalo.	0.8369	8.291**	0.998	-3.338**	-1.939	8.274**					
Cattle	0.8272	3.110**	-2.652*	-2.284*	2.129*	6.310**					
Cobb-Douglas Buffalo.	0.7513	5.875**	1.408	-3.557**	-1.802	7.634**					
Cattle	0.9476	8.045**	2.008*	2.828**	0.585	-2.959**	-1.180	-2.023*	-4.132**	- 3.272**	-0.486
Quadratic Buffalo.	0.9193	2.010*	1.701	-2.251*	-0.575	0.848	-0.900	0.768	0.183	- 0.598	0.218

VALUES OF t IN ORDERS OF b's IN EQUATION (continued)

Equations	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}
Cattle.										
Linear Buffalo.										
Cattle										
Cobb-Douglas Buffalo.										
Cattle	-3.932**	0.498	0.713	-3.027**	-2.497*	1.798	2.853**	-4.290**	3.430**	3.[illegible]
Quadratic Buffalo.	0.613	1.258	-2.237*	-1.963	-0.539	-1.147	-2.004*	-0.510	1.060	2.[illegible]

** $p < 0.01$

* $p < 0.05$

TABLE - 13

ANALYSIS OF VARIANCE

Source of Variation	d.f.	Mean sum square			F-ratio		
		Linear	Cobb-Douglas	Quadratic	Linear	Cob-Douglas	Quadratic
H.F. crossbred							
Due to regression on X_1 through X_5	5	1.0380×10^7	0.4355	3.1255×10^6	43.5447**	50.7624**	39.8342**
Residual	59	238371.8489	0.0086	78463.8603			
Murrah buffalo							
Due to regression on X_1 through X_5	5	2.5055×10^6	0.2423	688023.8439	48.2642**	28.3965**	18.2385**
Residual	47	51913.0700	0.0085	37723.6063			

** $P < 0.01$

In H.F. crossbred herds, majority of the regression coefficients are acceptable either at 1 percent or 5 percent level of probability. But in Murrah buffalo herds , number of regression coefficients aceeptable either at 1 percent or 5 percent level of probability is some what less.

The linear production function indicates that the milk yield increases with hay equivalent (x_1), number of tillable acres of land (x_4) and operational cost (x_5) in H.F. crossbred and hay equivalent (x_1), concentrate feeding (x_2) and operating cost (x_5) in Murrah buffalo herds. Concentrate feeding (x_2) in H.F. crossbred and number of labour (x_3) in Murrah buffalo have a negative influence on milk yield. Kumar <u>et al</u>.(1975) reported that feed was the major and the most significant factor influencing milk production. Depreciation on cows and miscellaneous items of expenditure were also found positive and significant, broadly indicating that the higher initial investment in milch stock was important for increasing milk productivity. Singh and Jha (1975) also showed high association between the inputs and milk output. They used Cobb-Douglas type of production ~~function~~ function and found that the independent variable explained 60 to 77 percent of variation in the milk yield in Murrah buffaloes. For non-descript buffaloes the range in explained variation was 72 to 82 percent. The labour inputs were highly significant in all the cases followed by concentrate feeding.

The elasticity of production represented by each of the regression coefficients in Cobb-Douglas type of equations for H.F. crossbred and Murrah buffalo is less than unity showing thereby that the marginal productivity of each resource is decreasing while the other resources are kept constant at their mean values. The sum of b's is less than one in both the species, which exhibits decresing returns to scale. This agrees with the finding of Mishra (1975) who applied Cobb-Douglas function for Desi cows. The eofficient of determination for quadratic equation is highest among all for both the species, indicating that the major portion of variance in milk yield is explained by five independent variables employed. Thus quadratic equation appears to be "best-fit" production function on the basis of statistical significance alongwith biological, physical and economic logic.

b) Milk production maximizing quantities of inputs :

Recommendations in agriculture ordinarily are in terms of inputs. An experienced dairyman suggests quantity of fodder, concentrate, dry forage, labour unit to apply for a dairy cow. Hence, specification of the magnitude of optimum inputs rather than direct specification of optimum outputs is utmost important in dairy farming. Obviously, specification of the optimum inputs implies designation of the optimum output and vice-versa.

The table-14 represents the optimal and existing levels of inputs per adult animal per year for H.F. crossbred and Murrah buffalo. The optimal quantities of different inputs were calculated by taking the overall prices of inputs for five years.

The optimum quantities of different inputs per farm per year which maximize the milk production are presented in table-15. The optimal level of inputs were obtained by multipling the optimum quantities of different inputs per adult animal per year by mean herd adult size.

It was observed that level of hay equivalent (green and dry) increased from 4.444 to 5.530 and 4.838 to 6.32 tons per adult animal per year for H.F. crossbred and Murrah buffalo. But concentrate feeding in both the species has decreased from 2099 to 2008 and 1659 to 1346 kgs. The number of labour employed has slightly increased for both the species. Land requirement and operational cost decreased from 0.45 acre and Rs.1241.01 in the existing situation to 0.27 acre and Rs.1189.89 for H.F. crossbred cattle and in case of Murrah buffalo from 0.48 and Rs.872.17 in the existing plan to 0.30 acre and Rs.773.87 in the optimal plan.

TABLE - 14

OPTIMAL AND EXISTING LEVELS OF INPUTS PER ADULT ANIMAL PER YEAR

H.F.Crossbred cattle	Hay equivalent (tonnes)	Concentrate (Kg.)	Labour	(Land (acre)	Operational cost (Rs.)
Existing level	4.444	2099	0.18	0.45	1241.01
Optimal level	5.530	2008	0.22	0.27	1189.89
Murrah buffalo					
Existing level	4.838	1659	0.18	0.48	872.17
Optimal level	6.132	1346	0.19	0.30	773.87

TABLE - 15.

OPTIMUM QUANTITIES OF DIFFERENT INPUTS FOR AVERAGE FARM PER YEAR

Inputs	H.F.crossbred cattle (444)	Murrah buffalo (228)
Hay equivalent in tonnes	2455.320	1398.096
Concentrate fed in Kgs.	891552	306888
Number of employed	98	43
Number of tillable acres of land	119.88	68.40
Annual operating cost(Rs)	528311.16	176442.36

c) <u>Maximization of milk yield through resources adjustment :</u>

To examine the extent of increase in annual milk yield per cow through the optimal allocation in inputs, the optimally allocated quantities worked out were fed back into the equations for both the species and then milk yield per cow per year were obtained. These outputs were compared with the milk yields per cow per year estimated by substituting the existing quantities of inputs in the equations. The results are presented in Table-16.

It was observed that increase in milk yield per cow per year and income from milk through the adjustment of inputs was 9.80 percent in H.F. crossbred and 26.34 percent in Murrah buffalo. This suggested that in Murrah buffalo better possibilities of increase in milk yield through input adjustment. These figures are slightly higher than the figures given by Singh and Jha (1975).

Thus in general, the cattle and buffalo should be offered more roughages rather than concentrate. The land should be intensively cultivated for fodder production so that more number of animals can be kept per unit of land. From the table 15 and 16 we can further conclude that the optimal level of annual milk production per man employed, profitable volume of annual milk production per adult cow and lowest possible capital investment

TABLE - 16

INCREASE IN MILK YIELD AND INCOME THROUGH ADJUSTMENTS IN RESOURCES

Species.	ESTIMATED		AFTER ADJUSTMENT OF INPUTS		PERCENT INCREASE IN	
	Income (Rs.)	Milk Yield (Litre)	Income (Rs.)	Milk yield (litre)	Income	Milk yield
Holstein Friesian crossbred cattle	4449.78	6.22	4886.18	6.83	9.80	9.80
Murrah buffalo	2874.37	3.37	3631.75	3.98	26.34	26.34

per adult cow are 11218.27 and 7640.20 litres, 2492.95 and 1452.70 litres and Rs.2974.74 and Rs.1934.68 for H.F. crossbred cattle and Murrah buffalo respectively. From the above production and expenditure levels, the optimal margin of annual net returns are Rs.1911.44 and Rs.1697.07 for H.F. crossbred cattle and Murrah buffalo.

d) Maximization of profit

Linear programming :

Maximisation of profit is major objective of any enterprise guided by economic and commercial considerations. With this objective the decision maker must decide which enterprises to include in the production line and what should be the size of operation. Since the pioneering work of linear programming Dantzig (1951) the post war economic solutions were sought to be solved by employing programming techniques. Since then, linear programming has extensively been used by agriculturist as an aid for rational resource utilisation for maximination of profit objective. It has been sucessfully used for achieving the objectives of profit maximization or cost minimization in the difference manufacturing concern and the dairy farming is not exception. Murthy (1964) was the first to employ linear programming technique in animal feeding problem in India.

Linear programming was used by Nisar and Flterich (1972) for optimum organization of large-size dairy farms on the Delmarva Peninsula. Similarly, Nott (1977) employed programming technique for efficient dairy farm planning and system analysis. Further, Linear programming has been extensively employed for efficient resource utilization (Dhawan and Kahlon, 1977), optimal determination of farm enterprise-mix (Verma and Pant, 1978 and Sirohi et al. (1980) and devising feeding management systems for economic decision making on dairy farms (Jones et al. 1980) In the present study, linear programming technique was used for seven farms separately to know the relative economics of the H.F. crossbred cattle and Murrah buffalo. Here it was assumed that all the inputs were met within the farms, no inputs were bought from outside. The existing and optimal production patterns, developed at the recommended level of technology, are given in table-17. It can be seen from table-17 that the existing plans of different farms were the average for the years for which the two species of cattle reared in the farms. In order to determine the optimal programme for different farms sizes, H.F.crossbred cow and Murrah buffalo were treated as two alternative activities. An adult cow or buffalo was considered one activity. The resource constraints included availability of land, dry matter of feed and fodder, labour employed and operating cost.

A close perusal of the table - 17 reveals that Murrah buffaloes did not figure at all in the optimal plans pertaining to the resource use in production in milk. This might be attributed to higher cost of rearing of Murrah buffaloes. Alternatively, selling price of buffalo milk may not be comparatively as remunerative as of milk from H.F.crossbred cows. This finding agrees with the work of Kalyankar (1980), Acharya and Powar (1980) and Singh (1980) .

Except some dairy farms under private managements, all other farms showed inadequate use of the land for production of milk. The inadequate use of land on all farms, except 6th and 7th, could be attributed to low intensive land use for fodder cultivation. Thus optimum land use pattern warrants some drastic changes in the existing land use pattern. Feeds and fodders in farm Nos. 1, 2, 4 and 5 do not need any change. However, on all other farms, the optimal organization would warrant minimization of feed consumption. The farms where feeds were used productively to the maximum extent, showed dependence more on green feeding rather than on concentrate and dry forage feeding. The results revealed a consistent tendency of excessive operating expenditure on all farms. Under optimal plans, the organizations need to cut down operational expenditures. The results also indicate that percentage of optimum operating expenditure to the existing expenditure are higher in those farms where feeds and fodder utilised did show no difference between optimal and existing plan (table-17) These farms were dependent mostly on green fodder feeding to the animals. The excessive operating expenditure was probably due to the concentrate feeding. All situations except one (Farm No:3) indicated a curtailment in labour use for milk production. Employing more labour than the requirement was one of the reasons for over-commitment of operating expenditure.

For optimal use of resources under present situation, a sizable increase in H.F. crossbred cattle with complete decline in Murrah buffalo was suggested. The results clearly revealed that increasingly efficient production of milk on these farms may be forth-coming by complete replacement of buffaloes by H.F. crossbred cattle, these findings agree with the work of Kahlon et al.(1975) who investigated a similar study in Punjab State and reported that farmers could earned more money by keeping crossbred cattle than buffalo.

The returns over variable expenses are presented in table-18. The incomes were considerably increased after the farm resources adjustment on farm Nos. 1 and 5 where feeds and fodder were completely utilized. Minimum percent decrease in income was found on farm No.4. This may due to the fact, that this farm could sell the milk at comparatively higher rate than other farms where returns

TABLE - 18

Returns to fixed farm resources after adjustment

Farm Code nos.	Income from existing plan (Rs.)	Income from optimal plan (Rs.)	Percentage increase/ decrease in income over existing plan.
1.	1965773.42	5428360.64	176.17↑
2.	922633.18	828933.12	10.15↓
3.	4047350.76	1859343.04	54.06↓
4.	2916348.38	2797649.28	4.07↓
5.	1412730.46	1842073.60	30.39↑
6.	343918.00	138155.52	59.82↓
7.	1408822.66	86347.20	93.87↓

↑ indicate increase over existing plan

↓ indicate decrease over existing plan.

to fixed farm resources registered a decline after resource adjustment. Additionally, cost of rearing of animals was low in this farm, In farm Nos. 2, 3, 6 and 7 the range for reduction of income after resource adjustment are 19.15 to 93.87%. In these farms, except the limiting resource other resources were used considerably at lower percentages. These surplus resources could be utilized fully by adding more limiting resource. Alternatively, they could be utilized in other productive purpose.

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CHAPTER - V.

SUMMARY
A
N
D
CONCLUSION

= SUMMARY AND CONCLUSION =

The data for the present investigation were collected from 4 Military, 6 Institution/ University, 2 State Government and 4 Private Dairy farms. The collection of data was restricted to only Holstein X Zebu Cattle (H.F. crossbred) and Murrah buffaloes. The input-output information of milk production was collected for a period of five years (1975-1979). Management practices with regard to feeding, breeding, milking, calf rearing, labour utilization etc. were also documented. In addition, information on some village Murrah buffaloes under the supervision of Operational Research Project of National Dairy Research Institute were also collected for one year.

The herds were divided into two categories : High (average milk yield more than 6 litres for H.F. crossbreds and 3 litres for Murrah buffaloes) and average (6 or less litres for H.F. crossbred and 3 or less litres for Murrah buffaloes) milk production herds.

The major differences in management practices between high and average production herds lies in extra care exercised in case of the former. The extra care is characterised by early milking, reliance on green fodder feeding, group feeding, weaning of calves, dehorning, branding and deworming of calves, separate milking facilities, provision of loose housing system, provision of sufficient good quality feeds and fodder, less animals per man power and intensive fodder cultivation.

The management was quantified by production function and percent return on capital investment procedures over five years (1975-1979). In production function, estimated income was dependent variable whereas independent variables were : number of cows, total labour cost, operating cost, non-animal capital, hay equivalent in tons and tons of concentrate. The residual as computed by substracting the logarithm of estimated income from the logarithm of the actual total income received was used as a measureof management performance. The ranking of farms by two methods was then compared. A rank correlation test showed a significant relationship at 1% level of probability in each of the five years. The coefficient of concordance was used to test the hypothesis that the annual ranking was random, against the hypothesis that there was consistent year-to-year pattern in the rankings. The W-values for H.F. crossbred and Murrah buffaloes were significant ($P < 0.01$) . Thus, there is a strong evidence that the dairy farms which were superior were consistently superior from year-to-year.

Multiple regression procedures of linear as well as nonlinear specifications were established to study the relationship between various management factors and both herd average milk production as well as net income of dairy farms. Quadratic form showed higher R^2 - value than linear form in both the species. In H.F. Crossbreds herd size, annual milk production, succulent fed per cow per year, feed cost per cow per year, concentrate price, milk price, number of men employed and number of tillable acres of land were significant in determing the net income in the quadratic form. In linear regression analysis, except the annual milk production all the independent variables were important in determining the net income although the herd size, annual milk production and number of men employed were significant. One unit increase of herd size or labour employed resulted in Rs.1155.35 or Rs.3890.48 decrease in net income. In Murrah buffaloes herd size, milk yield per buffalo, percent days in milk, concentrate fed per buffalo per year, dry forage fed per buffalo per year, feed cost per buffalo per year, feed cost per 50 kgs. milk produced, fat percentage of milk, number of men employed, number of tillable acres of land and number of animals per man employed were significant in quadratic form. In linear regression analysis like H.F. crossbred cattle all variables except annual milk production were important although feed cost per 50 kgs. milk produced, milk price and fat percentage of milk turned out to be significant in explaning the variance in the net income.

In herd average milk production too, the quadratic form of regression equation for both the species was best fitted than the linear form. In quadratic equation, herd size (both linear and power terms), percent days in milk (power term), concentrate fed per cow per year (linear term), dry forage fed per cow per year (power term), milk price (both linear and power terms), concentrate price (linear) and number of tillable acres of land (both linear and power terms) were significant either at 0.01 or 0.05 probability level in H.F. crossbred herds. In linear equations, concentrate fed per cow per year, succulent fed per cow per year, dry forage fed per cow per year and number of tillable acres of land were significant ($P < 0.02$). Dry forage fed per cow per year had a negative influence while concentrate fed per cow per year, succulent fed per cow per year and number of tillable acres of land had positive influence on herd average milk production.

In Murrah buffalo herds, herdsize (quadratic term), concentrate fed per buffalo per year (linear term), succulent fed per buffalo per year (linear term) dry forage fed per buffalo per year (linear term) and milk price (both linear and quadratic terms) were significant in determining the herd average milk production. In linear equation, percent days in milk, concentrate fed per buffalo per year, succulent fed per buffalo per year and concentrate price had positive influence on milk production.

Production functions, namely, linear, Cobb-Douglas and quadratic were fitted separately for both H.F. crossbred cattle and Murrah buffaloes for optimization of resource utilization. The dependent variable was annual milk production in litre per adult animal whereas independent variables were tons of hay-equivalent fed, kilogrames of concentrate mixture fed, number of labour employed, number of tillable acres of land required and operating cost per year per animal. It was found that quadratic form of production function was " best-fit " on the basis of statistical and economic logic. The quantities of different inputs which maximized the milk production was calculated with the help of marginality principle. It was found that an adult H.F. crossbred cattle needed 5.530 tons of hay equivalent (green and dry), 2008 kgs. of concentrate, 0.22 unit of labour, 0.27 acre of land and Rupees 1189.89 of operational cost per year. Likewise an adult Murrah buffalo needed 6.132 tons of hay-equivalent, 1346 kgs. of concentrate, 0.19 unit of labour, 0.30 acre of land and Rs.773.87 of operational cost per year. The optimal quantities of different inputs worked out were fed back into the production function equation and then optimal milk yield per animal per year were obtained which were 2646.79 litres and 1452.70 litres for H.F. crossbreds and Murrah buffaloes respectively. It was further found that optimal level of annual milk production per man employed and lowest possible capital investment per adult animal were 11218.27 litres and 7640.20 litres and Rs.2974.74 and Rs.1934.68 for H.F. crossbred and Murrah buffalo. The optimal margin of annual net returns from a H.F. crossbred cattle and a Murrah buffalo were Rs.1911.44 and Rs.1697.07 respectively.

Linear programming technique revealed that Murrah buffaloes did not figure at all in the optimal plan pertaining to the resource use in production of milk from mixed stock. For optimal use of resources, a sizable increase in H.F. crossbred cattle with complete decline in Murrah buffalo was suggested.

Conclusion :

From this study, it is apparent that the management practices have significant influence on herd average milk production. Increased milk price and milk production accounted for sizable increase in net income while ~~incharged~~ increased feed costs per 50 kgs. of milk production, other feed costs and labour costs significantly reduced net income. Succulent feeding, concentrate feeding, percent days in milk were significantly related to milk production in both the species. Herd size in both the species was negatively related to milk production. The quadratic type of production function was found to be " best-fit " in this present study for determining the optimum quantities of different inputs for milk production. The highest level of milk production per man employed and profitable volume of milk production per adult unit were found to be 11218.2 litres and 2492.95 litres for H.F. crossbred cattle. Lowest possible annual capital investment and proper margin of net return per cow were Rs.2974.74 and Rs.1911.44. For Murrah buffalo herds, the highest level of milk production per man employed and profitable volume of milk production per adult unit were 7640.20 litres and 1452.70 litres respectively . The optimal margin of annual net returns from a crossbred and a Murrah buffalo were Rs.1911.44 and Rs.1697.07. For profitable dairy enterprise, only H.F.crossbred cattle should be reared with complete decline in Murrah buffaloes.

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END

APPENDIXES

APPENDIX - I.

RATIOS OF ACTUAL INCOME TO ESTIMATED INCOME IN H.F.CROSSBRED HERDS

Farm Code No.	1975 $X10^{-3}$	1976 $X10^{-3}$	1977 $X10^{-3}$	1978 $X40^{-3}$	1979 $X10^{-3}$
1.	-66.44	61.42	-164.50	104.45	121.711
2.	-80.68	-15.54	- 3.12	- 0.14	47.86
3.	-32.21	67.12	81.84	115.83	205.59
4.	-99.73	-34.24	64.02	-20.63	-52.62
5.	-84.10	- 2.81	8.27	-25.59	13.56
6.	-515.14	-310.00	-252.27	-167.89	-225.11
7.	-108.02	-63.64	21.37	42.60	64.59
8.	-116.83	-90.41	-200.17	-213.65	-276.63
9.	-118.70	-80.64	-227.86	-108.81	-240.74
10.	33.76	-10.19	- 12.52	60.61	70.06
11.	10.89	104.40	57.97	67.65	116.34
12.	37.01	16.31	66.85	121.05	153.88
13.	166.94	212.03	214.74	217.88	333.31

APPENDIX - 2

Ratios of Actual Income to Estimated Income in Murrah buffalo herds

Farm Code No.	1975 $X10^{-3}$	1976 $X10^{-3}$	1977 $X10^{-3}$	1978 $X10^{-3}$	1979 $X10^{-3}$
1.	-30.92	-29.70	-25.38	-9.09	4.38
2.	51.96	13.60	75.62	NA	NA
3.	4.66	32.10	-16.14	-15.60	NA
4.	8.24	57.03	48.65	65.14	109.01
5.	-14.36	-12.74	4.24	-32.89	-10.65
6.	35.74	5.82	27.42	41.98	0.70
7.	-89.19	-95.38	-37.99	-32.83	31.73
8.	-160.00	24.21	-31.80	39.09	80.72
9.	-43.41	-53.51	-95.04	-49.66	55.15
10.	-104.48	-11.86	43.60	-64.53	-49.26
11.	NA	NA	NA	NA	43.21
12.	NA	NA	NA	NA	81.91
13.	NA	NA	NA	NA	11.84
14.	NA	NA	NA	NA	7.88
15.	NA	NA	NA	NA	28.31
16.	NA	NA	NA	NA	58.30

APPENDIX - 3.

ZERO ORDER CORRELATION MATRIX FOR H.F. CROSSBRED

	Y	X_1	X_2	X_3	X_4	X_5
Y	1.0000					
X_1	0.7422	1.0000				
X_2	-0.1061	-0.1712	1.0000			
X_3	0.0321	0.1661	0.2525	1.0000		
X_4	0.6070	0.4619	0.1018	-0.2385	1.0000	
X_5	0.7189	0.5020	0.2236	0.2817	0.4063	1.0000

APPRENDIX - 4

ZERO ORDER CORRELATION MATRIX FOR MURRAH BUFFALO

Y	1.0000					
X_1	0.3910	1.0000				
X_2	0.4040	-0.4260	1.0000			
X_3	-0.0479	0.3237	-0.0891	1.0000		
X_4	-0.0701	0.0879	-0.0793	0.4054	1.0000	
X_5	0.7252	-0.1079	0.7060	0.0549	0.1366	1.0000