A COMPARATIVE STUDY ON THE FEED UTILISATION OF LOCAL AND CROSS BRED COWS

By

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C E R T I F I C A T E

Certified that this thesis is a record of research work done independently by Shri Chacko, C.T. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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(C.T. C h a c k o)

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I. INTRODUCTION

I. 1 General Introduction

In a broader sense the term agriculture means a compact system, where soil, crop, animal and man have been interwoven into a highly complex, interdependant and balanced system leading to high standards of agricultural productivity and of human nutrition. Animals contribute to the existance of man over the earth in the form of good quality food, power, clothing and recreation. The role played by animals, which are the best and the cheapest sources of high quality protein, in improving the nutritional status of man, necessitates the improvement of the animal wealth along with the developments in the field of agriculture. The fertility of the soil is reduced after every cultivation and cattle are mainly responsible for improving it by feeding the soil back with their dung and urine. Large quantity of agricultural by-products not fit for human consumption are available in the country. The animals play an intermediate role in converting these by-products into highly nutritious human food-stuffs like milk and meat.

Of all the animals domesticated by man for the purpose of food and clothing, cattle have the maximum capacity to convert roughages efficiently and economically. They are capable of producing 18.0 pounds of edible dry matter as cows milk from 100 pounds of digestible dry matter consumed, where as swine, the second highest economic converter of digestible dry matter, is able to produce only 15.6 pounds of edible dry matter as dressed pork (Olson, 1950). The largest single group of animals, cattle, form 38 per cent of the world's livestock population and are reared mainly for milk, meat and work. Ninety two per cent of the total milk produced in the world comes from cows and the remaining 8 per cent is shared by buffaloes (5 per cent) and goats (3 per cent) (Food and Agriculture Organisation, 1969).

I.2 Position of Indian Cattle

Although India possesses 16 per cent of the world's cattle population, the per capita consumption of milk in the country is very low. There are 26 different breeds of cattle in the country. But 75 per cent of the cattle population is of a non-descript type. Of the different breeds only few are meant for milk production and the others are reared for work or milk and work.

The average production per lactation of a cow in India is 190 kg where as it is 4529 kg in Denmark, 4220 kg in Netherland and 3230 kg in United States (Andersen, 1967). Such a low lactation yield of an average Indian cow is due to a huge number of cattle belonging to the non-descript and low yielding type and because of the acute shortage of feeds and fodders.

Among the milk producing countries, India has been placed as fourth. The 37.21 milking animals including she-buffaloes in India produce 23,100 thousand tonnes of milk annually. This 37.21 million milking animals come from a population of 48.6 million cattle and 26.7 million buffaloes. The per capita availability of milk in the country is only 110 g against the recommended minimum requirement of 280 g. The cattle population of the country is on the increase during the last two decades and there is also a slight increase in the total milk production. But the human population is increasing at a rate faster than the increase in milk production of the animals. With the result there is a decrease in the per capita availability of milk. The daily per capita availability of milk was 113 g during 1965-66 which has dropped to an estimated 110 g during

1973-74 (Khurody, 1974). Although reliable statistics are not available it is estimated by the above author that the dairy quality of our animals is also getting reduced.

The reasons for the low level of production of our animals are:

1. Poor quality foundation stock;
2. Lack of intensive breeding facilities;
3. Inadequate supply of feeds and fodders and
4. Lack of proper facilities for disease prevention.

I.3 Improving the quality of Indian Cattle

According to the production potential of the animals they are grouped into three classes, those producing less than half kg milk a day, those giving half to one kg milk and the third group giving above one kg milk daily. Fifty five per cent of the animals belong to the first group, 40 per cent to the second category and five per cent are classed under the last group. With such a huge number of cattle of low production, the programme of selective breeding will not be successful. Assuming a selection differential of 20 per cent, heritability of 30 per cent and average generation

interval of six years, one has to conclude that the annual genetic gain would be only one per cent even under ideal conditions.

Many attempts have been made to cross European breeds with Zebu cattle, with the object of combining the high milk yield and good dairy temperament of the former with the characteristic heat tolerance and resistance to endemic diseases of the latter. Cross breeding with exotic breeds were practiced in the military farms and some of the coffee and tea estates, as early as 1919 (Maule, 1953). Jersey, Holstein Friesian and Brown Swiss were the important exotic breeds used for cross breeding. Of the Indian breeds it was reported that Red Sindhi has been evidently used for crossing with Jerseys. The studies made by Kartha (1934) have revealed that cross bred cows gave lactation milk yields approximately 60 to 70 per cent above those of ordinary Sahiwals or Sindhis, milked for 2 to 5 weeks longer, had a shorter dry period, had a higher daily life time yield and tended to calve at an earlier age.

I.4 Cattle keeping in Kerala

Kerala, the land of 'Keras' (coconut trees) is one of the smallest states of the Indian Union which is

not much information about the production capacity of these animals but is definitely inferior to that of cattle in other parts of the nation. Cows constitute 51.2 per cent of the total cattle population and the milking cows comprise 21.2 per cent of the total number of cattle (Livestock census, 1971).

The total milk production of the State per year is estimated to be 7.3 million tonnes which gives an average daily per capita availability of 70 g of milk. The existing availability of milk will be just enough to cater to the needs of 25 per cent of the people of Kerala. This indicates that the milk production of the State has to be increased four fold in order to get the bare minimum of milk for the people of the State.

The cattle development programmes of the State have only a short history. Two decades ago the animal husbandry activities of the State were confined to the treatment aspect of the livestock with few centres where stud bulls were made available for natural crossing on a grant-in-aid system. The only concern of the cattle owners was to see that their cows conceived and this was often satisfied by local bulls kept by bull keepers or scrub bulls in the vicinity. Acute shortage of trained personnel, institutions and equipments together

with lack of financial support, made the implementation of the cattle development programmes extremely difficult, during the first five year plan period.

Development schemes aiming at improving the cattle wealth were undertaken only during third five year plan period. During last two decades 16 key village blocks have been established in the State as a part of the National scheme. The accepted policy was one of grading up the local stock with Red Sindhi and simultaneously the cross breeding schemes using Jersey bulls started functioning. The Intensive Cattle Development Projects started functioning in Kerala during early 1968. The functioning of the cross breeding scheme and the Intensive Cattle Development Projects was first like the key village schemes ie., grading up of the local animals with exotic bulls. A joint venture by the Governments of Kerala, India and Switzerland was initiated in 1963 for the development of the cattle in the High ranges of Kerala under a definite programme. The Dairy Development Department has recently started a programme for the development of the cattle in the northern districts using Jersey bulls and those in the southern districts using Brown Swiss bulls. The above mentioned schemes are the important ones envisaged for the development of the local cattle of Kerala.

I.5 Fodder situation of the State

Any programme of cattle development should go hand in hand with schemes for the improvement of the fodder situation. Roughage feeding tends to become more economical these days when the concentrates not only become scarce but also costly. It has been pointed out by Singh *et al.*(1972) that under Indian conditions the economic optimum level of concentrate feeding was 250 g concentrate per kg of fat corrected milk. The Indo-Swiss Project has given due importance to fodder development schemes in its areas of operation. The State Animal Husbandry Department has also started fodder development programmes in the Intensive Cattle Development Project areas. Trials are successfully going on at the Coconut Research Station, Kayamkulam for the cultivation of fodder in coconut gardens without deleterious effects on the coconut plants.

Kerala is one of the major rice producing states of the country. Nearly 875 thousand hectares of land are under paddy cultivation and majority of the paddy fields are under more than one crop annually. Taking a moderate estimate of 3,000 kg paddy straw per hectare, the total annual yield of straw from the paddy fields will be to the tune of 2.625 million tonnes. But the entire amount

of paddy straw produced is not used for feeding cattle. A considerable quantity is used for purposes other than feeding cattle and therefore the availability of straw for feeding cattle becomes less.

Eventhough low in nutritive value, straw is the cheapest of all roughage feeds and many of the marginal farmers of the State rear cattle entirely on paddy straw. Karunakarashetty et al. (1969) observed that feeding of animals entirely with paddy straw brought about a reduction in body weight to an extent of 10 per cent during a period of 110 to 115 days. Paddy straw can also be made more advantageous for feeding cattle by alkali treatment, by adding urea and molasses or by incorporating a certain quantity of green fodder and concentrates. The computation of ration for cattle in Kerala has to necessarily take into account the availability of paddy straw with proper supplementation by way of green fodder and concentrates.

The non-descript animals are traditionally kept on straw and some studies have also been conducted regarding the feeding standards and feeding values of paddy straw in Indian cattle. But only very few reports are available regarding the dry matter intake of cross bred

animals when fed ad libitum straw along with concentrates and green fodder.

It was under these circumstances, the present study was undertaken. Grading up with Jersey bulls have been started on a massive scale in the State and it is the responsibility of the research workers to find out suitable management conditions for rearing the cross breds. The most important item in management of these animals is their feeding. If the cross bred animal is able to utilise the available paddy straw better, the problem of feeding roughage can be faced with a certain degree of confidence. An average farmer with a small area set apart for cultivation of fodder grasses will be able to feed his animals better with some green and certain amount of concentrates in addition to the cheaply available paddy straw.

This problem which is of a practical nature has been given the full recognition while formulating the present study of estimating the feed utilisation efficiency of Sindhi and Sindhi x Jersey cross bred cows. In the present study, cows were fed with paddy straw ad libitum and green fodder and concentrates at restricted levels to meet their protein requirements. A comparative study of the efficiency of feed utilisation was made between Jersey x Sindhi cows and Sindhi cows in milk.

II. REVIEW OF LITERATURE

II.1 Cross breeding programmes

The merits and demerits of different ways of improving the milk production potential of our cattle have to be studied well before chalking out a definite programme for practical implementation. Mason (1968) studied the probability of applying the different methods of improving the milk yield of our cattle. If all selection pressure supported by excellent management were applied to milk yield, progress would be about one to two per cent per year. Rapid improvement can be obtained only by use of semen from temperate dairy breeds to produce improved animals suited to the limitations of food supply, management and climate. By cross breeding with European cattle it was able to combine the high yield and the good dairy temperament of the exotic breeds with the characteristic heat tolerance of the Indian breeds (Maule, 1953).

McDowell and McDaniel (1967) reported that the performance of cross breds exceeded that of their parental mean by 5 to 11 per cent in the yields of milk, fat and protein and by 4 to 5 per cent in their feed efficiency. It was suggested that cross breds do not require any special environmental condition (Bhasin and Desai, 1967). Brandt et al. (1966) observed that non additive

not much information about the production capacity of these animals but is definitely inferior to that of cattle in other parts of the nation. Cows constitute 51.2 per cent of the total cattle population and the milking cows comprise 21.2 per cent of the total number of cattle (Livestock census, 1971).

The total milk production of the State per year is estimated to be 7.3 million tonnes which gives an average daily per capita availability of 70 g of milk. The existing availability of milk will be just enough to cater to the needs of 25 per cent of the people of Kerala. This indicates that the milk production of the State has to be increased four fold in order to get the bare minimum of milk for the people of the State.

The cattle development programmes of the State have only a short history. Two decades ago the animal husbandry activities of the State were confined to the treatment aspect of the livestock with few centres where stud bulls were made available for natural crossing on a grant-in-aid system. The only concern of the cattle owners was to see that their cows conceived and this was often satisfied by local bulls kept by bull keepers or scrub bulls in the vicinity. Acute shortage of trained personnel, institutions and equipments together

effects were not important for production traits in crosses among Guernsey, Holstein and Brown Swiss breeds. In a detailed study by Touchberry and Benbereskin (1966) it was noted that positive effects of cross breeding were significant in 21 out of 30 cases and the effects decreased linearly as the age of the animals increased. They have also observed that at all ages calves born for Holstein dams were approximately 20 per cent heavier than those for Guernsey dams.

Prudov (1974) observed that the F_1 crosses with Semmental and Jersey in U.S.S.R. yielded 2338 kg milk testing 4.97 per cent fat per lactation. Buvanendran (1974) recorded an average lactation yield of 4243 pounds for F_1 Jersey x Sindhi crosses (50:50) and 2453 pounds for F_2 Jersey x Sindhi crosses (75:25). In a study conducted at the Indo-Swiss Project, Mattupatty (Ramachandran, 1973) it was observed that the average lactation yields of local, 50 per cent Brown Swiss and 50 per cent local and 75 per cent Brown Swiss and 25 per cent local were 716 kg, 1958 kg and 2499 kg respectively.

II.2 Feeding of cross bred cattle

Any programme for improving the genetic quality of our animals should be backed by schemes for supplying

adequate feeds and fodders for the animals. The availability of different feeds and fodders in India are as follows (Whyte and Mathur, 1968).

	Availability in '000 tons	Requirement in '000 tons	Shortage in '000 tons
Dry fodder	153,188	869,785	716,597
Green fodder	141,550	637,383	495,883
Concentrates	17,361	95,403	78,042

From the above table, it could be seen that the roughage and concentrate productions have to be increased by 57 and 55 per cents respectively to meet the requirements of our cattle.

The cost of milk production can be brought down to 60 to 70 per cent of the consumer's price by supplying most of the nutrients through quality fodders. Fodder development is thus the key to the better production of milk. In a country where the human population is on an increase at a rate faster than the rate of increase of animals, allotting more area for cultivation of fodder crops will not be feasible, as the need for cultivation of food crops for human consumption is more. So the only possible way is the intensive utilisation of the available land for fodder production. The use of suitable fodder

crops in mixed farming, multiple cropping or crop rotation programmes particularly with leguminous crops like berseem, cowpea etc. have been advocated. Relwani (1972) found that 150 to 200 tons per hectare of good quality forage could be grown in an year which will be sufficient for 8 to 10 cows at the rate of 50 kg a day.

The improvement of the fodder situation of the country will take time and so until self sufficiency in respect of fodder production is attained, the better yielding cows may be given priority for obtaining good quality roughages and concentrates to their requirements (Nair and Balakrishnan, 1973). The above authors have further stated that on a national level it is absolutely inevitable that a large number of unproductive animals will be undernourished until and unless the required quantity of feeds and forages are produced. According to Whyte and Mathur (1968) the average daily availability of feeds for a milking cow is 0.288 kg concentrates, 4.444 kg green fodder and 3.540 kg dry fodder.

II.3 Nutritive value of local feeds and fodders

The common feeds and fodders for cattle in the State are ground nut oil cake, gingely oil cake, coconut cake, tapioca, cotton seed cake, rice bran, wheat bran,

paddy straw and grasses like napier, guinea and para. The chemical composition of these feeds and fodders estimated by Sen and Ray (1964) are given in Table 20. Several cattle feed manufacturing companies in and outside the State are compounding cattle feeds which as per I.S.I. standards should contain a minimum of 20 per cent crude protein and not more than 13 per cent crude fibre.

II.4 Paddy straw as a roughage for cattle

Although the inferiority of straw as a feed for cattle is well recognised, it is impossible to replace the straw by better feeding stuffs in this country for many years to come. In agriculturally advanced countries cereal straws do not ordinarily constitute more than a portion of roughage for livestock. In India, however, the cereal straws assume special significance in as much as they constitute by far the largest proportion of roughage and most animals subsist on this alone.

Paddy straw is considered as the cheapest of all roughages. Karunakarashetty *et al.* (1969) observed that feeding of 4 to 5 kg green along with paddy straw compensated the loss of weight occurred while feeding straw alone. The quantity of paddy straw consumed by an animal weighing 186 kg when fed *ad libitum* was found to be 3.204 kg along with 0.420 kg of concentrates (Nath *et al.*, 1969).

The feed values of paddy straw, barley straw and corn stalks fortified to equivalent nitrogen, phosphorus and sulphur levels as compared with alfalfa were studied by Oh et al. (1971). Dry matter intake, digestibility, digestible energy, rumen fermentation and microbial protein data indicated that the relative feed values of these feeds were from highest to lowest in the order of alfalfa, corn stalks, paddy straw and barley straw. Owen et al. (1969) concluded after conducting a study on the effect of the level of inclusion of milled straw in cattle rations, that milking animals can be kept for long periods without access to long roughages if milled straw was made available.

The nutritive value of straw can be enhanced by artificially spraying it with urea and molasses (Khajuria and Mudgal, 1971). Lal and Mudgal (1967) reported that ensiling of straw with berseem improved the quality of the roughage. Other methods of improving the quality of straw by ensiling are with tree leaves (Ranjhan, 1973) and with certain weeds which are not normally nutritive (Chibbar and Singh, 1971). Nath et al. (1969) found that water washing and lime or calcium carbonate supplementation were promising methods to combat the negative calcium balances encountered frequently on paddy straw rations.

The effects of three different proportions of straw and concentrate mixture on cows in mid lactation were studied by Halevi et al. (1973). It was found that the milk yield and composition were similar with all the three proportions. Andrews et al.(1972) studied the influence of energy and protein supplements on the feed intake and performance of cattle fed on cereal straws. The intake of straw was less at all energy levels and the body weights were not increased by energy supplements. They have also stated that there is no difference in the performance of the animals maintained on oat and barley straw rations. Misra and Tripathy (1963) studied the disturbances in rumen digestion when animals were fed with straw alone. They have observed a deterioration in the condition of the animals and it was attributed to disordered rumen digestion.

II.5 Dry matter intake by cattle

The dry matter intake of cattle is variable depending upon factors such as quality and quantity of feed, type of animal, its breed, age and stage of lactation.

The observations made by Holmes et al.(1960) revealed that the dry matter consumption decreased with reduction in the proportion of concentrates in the ration.

The dry matter consumption expressed as the percentage of body weight increased from 2.26 when the major portion of the ration was roughage to 3.03 when concentrates contributed to the major portion of dry matter. There was a general decline in dry matter consumption from period to period associated mainly with reduction in concentrate allowance. They have also observed that when concentrate dry matter consumption was increased by one pound, the consumption of dry matter from bulk feed was reduced by 0.18 to 0.22 pounds, but the total fibre intake remained constant.

Supplementation with concentrates decreased the voluntary intake of pasture dry matter by 0.63 and 0.66 kg per kg of concentrate dry matter fed at the lower and higher levels of concentrate feeding respectively (Taparia and Devey, 1970). The effect of adding concentrates to the rations of cows has been studied (Murdoch, 1967) and it was found that concentrates seemed to have a greater depressing effect on hay intake.

Elliot (1967) studied the voluntary intake of low protein hay when fed alone, in Africander and Mashona heifers and found that it was similar; but the intake increased with protein supplementation. The above author

has also reported that increased allowance of dietary proteins and concentrates generally corresponded with higher intake of total food and digestible energy.

Campling and Murdoch (1966) have studied the effect of addition of concentrates on the voluntary intake of roughages by cows. The daily addition of 6 kg concentrates to the ration of cows receiving ad libitum hay caused little changes in the intake of hay but brought about a slight increase in the intake of barley straw. When the concentrate allowance was increased to 8 kg there was a reduction in the intake of hay by 0.2 to 0.4 kg per kg concentrate dry matter given. The effect of two rations containing roughage and concentrate in the proportion of 50:50 and 75:25 respectively on the growth rate of Holstein, Holstein x Hariana and Hariana calves reared in tropical zones were studied by Ranjhan and Daniel (1972). The dry matter intake expressed as per cent of body weight was 3.1 in Holstein x Hariana and Hariana breeds and 2.6 to 2.8 in Holstein breed. Owen et al. (1968) found that the dry matter intake was lower when fed barley straw along than when concentrates were offered along with barley straw.

Waldo et al. (1965) observed that silage fed animals had a lower energy intake, lower weight gain

and required more energy above maintenance per unit gain than hay fed animals. They have also found that hay fed animals consumed more dry matter and gained more weight. It was reported (Owen et al., 1956) that cows receiving orchard grass hay had a significantly lower intake of dry matter than those fed with mixed clover and thimothy. Contradictory to the above observation McCullough (1970) found that the quality of hay did not significantly affect the dry matter intake but high quality hay increased the metabolisable energy intake. Marsh et al.(1971) noted that the mean daily intake of dried grass by cattle was higher than that of poor quality seed hay.

The dry matter consumption was found to be affected by the physical state of the feed given. Campling and Milne (1972) suggested that the potential of the processed roughages cannot be fully assessed until the limits of the intake are known and it is pointed out that more information is needed on the effect of particle size on voluntary intake. The total dry matter intake was more in the case of low dry matter silage fed ad libitum than that of highly wilted silage (Brown, 1966). It was observed by Schneeberger (1966) that cows consumed more chopped grass than long cut grass produced in the same field and cut at equal intervals.

McLeod et al. (1970) observed that addition of sodium bicarbonate to increase the pH of silage from 4.0 to 5.4 resulted in significant increase in the intake of dry matter where as addition of sodium chloride did not alter the dry matter intake. Effect of urea on the voluntary dry matter intake from oat straw was studied by Campling et al. (1962). They have observed a mean increase of 40 per cent in the voluntary dry matter intake from oat straw by incorporation of 75 to 150 g of urea per day and 26 per cent by adding 25 g of urea per day.

The dry matter intake from roughages by dairy cows during pregnancy under various conditions have been studied by Marsh et al. (1971), Campling (1966) and Forbes (1970). Marsh et al.(1971) showed that the roughage intake was approximately constant during late pregnancy except the week immediately before parturition when a significant decline in roughage intake occurred. Campling (1966) studied the dry matter intake of five pairs of monozygotic twin cattle. It was found that pregnant animals consumed three per cent less hay than their non pregnant mates. In a review, Forbes (1970) stated that due to increase in volume of uterus there was a depression in the voluntary intake of roughages in pregnant animals. He further remarked that oestrogen also had some influence in the reduction of the appetite of these animals

The dry matter intake of cattle is found to be more during lactation (Cole, 1966). In a study with five pairs of monozygotic twins, Campling (1966) observed that the lactating animals consumed 29 per cent more hay than their non lactating mates. It has been found by Brown and Beal (1960) that the lactating cows consumed more feed at the early stages of lactation in order to recoup the energy lost during pregnancy and calving. The higher nutrient requirements as well as an increase in the abdominal capacity of the animals after parturition are suggested as reasons for the increased food intake in the early lactation (Forbes, 1970). A study conducted by Marsh et al. (1971) indicated an increased roughage intake of 20 to 30 per cent throughout the first six weeks of lactation than during the later stages of pregnancy. Kruger et al.(1955) found a relationship between the quantity of fodder consumed and milk yield per lactation but no relationship was observed between fodder consumed and daily milk production. The peak consumption was reached only five days after the peak yield. The dry matter intakes by cows and heifers in advanced stages of pregnancy as well by cows giving different milk yields were studied by Piatkowski (1966). The dry matter intake per 100 kg body weight by different types of animals studied were 1.58 kg, 1.54 kg, 2.51 kg

and 2.99 kg respectively for pregnant heifers, pregnant cows, cows yielding 15 to 20 kg milk daily and cows yielding above 20 kg milk daily.

Journet et al.(1965) observed an increase in the intake of dry matter with increase in milk yield at the rate of 280 g per kg fat corrected milk and with advance in lactation number. It was reported (Hoogendoorn and Grieve, 1970) that with increase in roughage and digestible energy content of the ration there was corresponding increase in the dry matter intake, more towards the end of lactation.

Elliot (1967) found that the dry matter intake of Africander and Mashona breeds of cattle were similar. But Nelloor steers on feed lot trials, were found to consume less dry matter than similar animals of European breeds (Vellose and Rigueiredo, 1972). According to Phillips (1959) the European cattle were found to consume more hay and water than Zebu cattle. It was observed by Wagon et al. (1974) that on ad libitum feeding of green berseem the dry matter consumption of Sahiwal and Sindhi were similar (2.5 per cent of the body weight) and it was 3.9 per cent of the body weight in the case of their crosses with Brown Swiss.

Singh and Mudgal (1967) observed that Brown Swiss x Sahiwal heifers consumed more dry matter than Murrah buffaloes. But according to Johnson et al. (1968) the voluntary intakes per unit live weight were not found to be significant between Holstein cows and water buffaloes. Ayyaluswami et al. (1966) found the dry matter consumption of Tharparkar, Murrah and Kangayam breeds to be 1.567, 2.395 and 2.129 per cent of the body weight respectively when fed with limited concentrates and ad libitum straw. The amounts of straw consumed were found to be 4.33 kg, 7.66 kg and 4.32 kg respectively in the case of the three breeds.

McCullough and Neville (1959) observed correlations between dry matter intake and average daily gain and between body weight and dry matter intake. It was reported (Bines and Devey, 1970) that the level of roughage had no effect upon the dry matter intake but the time spent on eating and ruminating increased with increase in roughage in the ration. Vohnout and Bateman (1972) found that the daily intake of dry matter and digestible energy were lower during warm environment because the animals spent more time for resting.

The voluntary intake of dry matter by cattle is more when fed on a ration consisting of concentrates and

roughages than on roughages alone (Foley et al., 1972). A comparative study on the effects of ad libitum grain and restricted roughage feeding with conventional dairy cattle feeding practices was made by Olson and co-workers (1965). The control group was maintained on a ration consisting of ad libitum alfalfa hay, 3 kg silage per 100 kg body weight and 1 kg protein grain supplement for every 3.5 kg fat corrected milk. The experimental ration consisted of 0.5 kg hay and 1.5 kg silage per 100 kg body weight and ad libitum protein grain mixture. It was observed that the hay intake was more in the control group but the total digestible nutrient and metabolizable energy intake were similar in both groups. The cows on low roughage ration exceeded their mates in production of fat corrected milk. The air dry feed intake was 3.5 kg per 100 kg body weight for all breeds.

Johnson et al. (1966) studied the influence of lactation, gestation, body weight and frequency of feeding on the voluntary intake of forage. A significant correlation between forage dry matter intake and 4 per cent fat corrected milk was noticed. 35 per cent of the difference in the forage dry matter intake was reported to be due to change in milk yield. Age, body weight changes, stage of gestation and body condition had little effect

on forage dry matter intake but stage of lactation and dry period had.

Food intake of cows fed ad libitum was found to be 50 per cent higher than of those kept on restricted diets (Amir et al., 1968). The effect of increased dry matter intake with ad libitum feeding was mainly on weight gains than on milk yield although the milk contained more solids not fat. Ekern (1972) studied the effect of ad libitum versus restricted forage feeding on milk yield and composition. Restricted feeding was found to lower the 4 per cent fat corrected milk yield, butter fat and protein percentages significantly. It was observed (Bush and Vetter, 1956 and Barber et al., 1956) that consumption of bulk fodder offered ad libitum was not related to milk yield when milk production remained relatively constant. The above workers also found that the quantity of fodder consumed by individual cows varied upto 50 per cent from day to day and some times low yields were associated with high consumption of fodder.

Hutton et al. (1964) studied the differences in voluntary intake, milk production and apparent digestibility of energy consumed by fistulated and non-fistulated twin cattle. The intake of dry matter and milk production were found to be low in fistulated animals.

Holmes et al. (1966) observed the voluntary feed intake similar in two groups of cattle maintained on two rations namely, pasture alone and concentrates providing one third of the dry matter and half the quantity of pasture. The study revealed that there was no significant difference between the two treatments in the yield of fat corrected milk as well as in the weight gain of the animals.

II.6 Digestibility of feeds and fodders

The studies conducted by Conrad et al.(1964) revealed that with increased digestibility of the feed, the physical and physiological factors regulating feed intake became less important. Crampton (1957) observed an increase in the dry matter intake with the increase in the percentage of dry matter digested. After analysing a number of data Brown (1966) concluded that there was a depression in apparent digestibility as the level of dry matter intake increased. The depression was found to be more pronounced when the forage was given ground or pelletted.

The other factors found to influence the dry matter digestibility were the quality of roughage, kind of grain mixture, hay grain ratio and plane of nutrition of the animals (Brown, 1966). Ranjhan and Daniel (1972)

observed that the digestibility decreased with increased intake of wheat straw. It was reported (Baumgardt et al., 1964) that the dry matter digestibility showed a significant increase with increase in proportions of corn in a ration containing alfalfa meal. It was observed by Bloom et al. (1956) that there was an increase in the dry matter digestibility when the ration contained lower levels of hay. They have also found that neither the genetic aspects nor the feeding levels significantly affected the digestibility. The relative amount of digestible dry matter consumed by cows decreased as the percentage of grain in the ration increased above 50 per cent of the dry weight of the ration (Conrad et al., 1966).

It was reported by Mathur et al. (1963) that the protein digestibility increased with the inclusion of para grass in the ration. Baker et al. (1951) found that the beef steers of high feed efficiency were superior in the digestion of crude fibre. Conrad et al.(1966) studied the association between dry matter intake and cellulose digestibility in cows. The positive deviation in the productive energy value of the ration per unit of intake above that attributable to increased digestible nutrient intake was almost completely accounted for, by adjusting for the decrease in cellulose digestibility.

Studies with Zebu cattle and buffaloes fed on treated and untreated wheat bhusa, paddy straw and maize straw, indicated that the dry matter intake and digestibility coefficients were higher in straws treated with urea and molasses (Rakib et al., 1971). But the digestibility coefficient of crude fibre was not altered due to the treatment. They have also observed a loss of body weight in animals fed with untreated straws. Sharma et al. (1972) found that the addition of urea at the rate of 13 g per kg straw increased the digestibility of crude protein, crude fibre, availability of total digestible nutrients, nitrogen retention and live weight gains.

II.7 Efficiency of utilisation of feeds

The energy and protein utilisation from forages fed to dairy cows were studied by Leahey et al.(1973). They have observed that the percentage of undigested gross energy and nitrogen lost in faeces were higher for animals fed hay than for those fed silage. The body retention of gross energy was higher with corn silage than with hay crop. Bloom et al.(1956) observed that animals vary in their efficiency to utilise nutrients but the differences in digestion and absorption were less marked.

The utilisation of non protein nitrogen by ruminants were studied by Abe and Kandatseu (1968) on

the basis of the 15_N excretion in milk and they have found that it was 8.74 per cent for ammonium citrate and 8.79 per cent for urea. It was reported by Yamdagni et al. (1967) that feeding concentrates in pellet or ground pellet form with roughage at either 1.0 or 1.5 kg hay equivalent per 100 kg body weight resulted in a slightly but significantly lower butter fat percentage than when concentrates were fed in meal form. The percentage of butter fat was found to be significantly higher when complex concentrate mixtures were fed. O'Dell et al. (1968) observed that the butter fat percentage declined significantly in cows fed pelletted lucern hay as compared with baled lucern hay. Their further studies on the effect of feeding pelletted hay two times and four times daily, on butter fat percentage, revealed that there was a depression of 0.4 per cent of fat in the milk of the cows given the first treatment. The studies conducted by Moe (1965) showed that 0.3 pound of total digestible nutrients was required for every one pound of energy corrected milk in addition to requirements for maintenance and pregnancy.

Different methods are employed to find out the utilisation of energy by cattle. Flatt et al.(1964) using respiration trials and energy balance measurements, determined the efficiency of energy utilisation for

lactation. Regression analysis showed that the efficiency of utilisation of metabolizable energy for milk production varied with different rations but the maintenance requirements did not differ significantly on different rations.

A comparative study was made by Bessonov et al. (1968) with standard recommended ration and with a ration containing 21 per cent less energy. It was found that the feed conversion efficiency was 18.8 per cent higher in the less energy group while the body weight and the milk production were higher in the group fed with standard recommended ration. Labuda and Knotex (1968) observed that cows given grass silage as roughage in a balanced ration, produced more milk with higher fat content than cows given maize silage and hay. They consumed 28 to 31 per cent more roughage per unit body weight and required 12.75 per cent less digestible crude protein and 7.27 per cent less starch equivalent per kg fat corrected milk.

Gracek (1966) reported that the milk yield was higher when the ratios of concentrate to roughage was 1:1.62 and 1:3.8 than when it was 1:14.9. Coppock et al. (1964) calculated the effect of hay to grain ratio on utilisation of metabolisable energy for milk production. Three rations containing 50, 75 and 100 per cents alfalfa

hay respectively were used based upon the estimated net energy values. More metabolisable energy was required for milk production from the 100 per cent alfalfa ration than from the alfalfa concentrate rations. The mean efficiencies of converting the available metabolisable energy to milk were 65, 61 and 54 per cents respectively.

The efficiency of feed conversion in milk production was found to be significantly affected by the composition of the ration (Coppock et al., 1964). The gross milk production efficiency of Jersey and Guernsey cows were found to be 0.95 kg four per cent fat corrected milk per kg total digestible nutrient (Olson et al., 1965). Semenyutin (1973) proposed milk production energy index (P.E.I.) as a criterion of milk production efficiency. He calculated the P.E.I. as:

$$\frac{10M\ (9.23F + 5.828P + 3.952L)}{365U}$$

Where M is the annual milk yield in kg,
F,P and L are the percentages of mean fat, protein and lactose respectively and
U is the mean daily intake of maintenance ration in feed units.

Sahiwal, Red Sindhi and their crosses with Brown Swiss were experimented for a complete lactation by Wagon (1971). The gross efficiency of feed conversion was

found to be 26.63 ± 1.66 for straight breds and 30.12 ± 2.07 for cross breds. Singh and Mudgal (1967) reported that Murrah buffalo heifers and Brown Swiss x Sahiwal heifers utilised good quality lucern hay with equal efficiency except that the digestibility of crude fibre was significantly higher in buffaloes than in cattle.

The gross efficiency of energy utilisation was found (Hashizume et al., 1965) to be 26.8 for an all roughage ration with meadow grass, rice straw and corn silage and 27.7 for a ration consisting of half of the above roughage plus concentrates. Exotic cattle are generally more efficient in converting food into body weight and cross bred were intermediate in this respect (Ledger et al., 1970). It was reported by Panaytov and Michev (1970) that cows with moderate milk production showed a higher efficiency of feed utilisation when fed semi concentrates and the increase in concentrate allowance did not raise the efficiency in these animals.

In a comparative study between low fat group and high fat group cows fed on rations containing sugar beet pulp, silage and meadow hay, it was observed that the former produced more milk and used significantly fewer oat units per kg milk (Nowicki, 1967). The efficiency

of nutrient utilisation by cows of different milk production capacity was studied by Plesnik (1966). The average intake of digestible protein and starch equivalent per kg fat corrected milk were 93 g and 625 g respectively. Studies on the regression coefficient showed that with every 1,000 kg increase in fat corrected milk per 300 days, the requirements of digestible protein and starch equivalent decreased by 10 g and 82 g respectively per kg fat corrected milk.

Burgess (1968) showed that the efficiencies of energy and protein utilisation were more closely associated with milk yield at different stages of lactation than between lactations. They have further noticed that the efficiencies of energy and protein utilisation decreased linearly as the milk production decreased with advancing stage of lactation. It was observed by Baumgardt (1967) that maximum efficiency of milk production will be achieved on rations giving a rumen acetate propionate ratio of about 1:2.75.

While studying the effect of body weight on milk production in Holstein x Sindhi cross breds, Singh and Desai (1966) observed a partial regression of milk yield on body weight independent of age. They have also indicated

an optimum body weight of 751 to 850 pounds for efficient milk production in these crosses. Berruecos and Robles (1966) reported a correlation coefficient of 0.076 for Holstein Freisian cows between mean body weight and 360 day lactation and mean daily milk yield. It was reported by Csomos (1969) that the cannonbone circumferance is the only one of the seven measurements which is correlated with milk yield. According to the above author body weights during the first and third lactations and milk yields are not significantly correlated.

Miller et al. (1973) observed that body weights at the beginning and end of lactation were better suited for predicting the milk yield, feed intake and feed efficiency. Higher body weights in the beginning of lactation were associated with increased milk yield and higher weights at the end of lactation with low milk yield.

Many reports are available on the genetic aspects of the efficiency of feed utilisation in animals (Mather, 1959; Lamb and Anderson, 1966 and Freeman, 1967). Mather (1959) stated that quantities of roughage intake are repeatable to the extent of 0.5 and are probably inherited. Gross feed efficiency in different sire groups was calculated by Lamb and Anderson (1966). The gross efficiencies were calculated in terms of kg fat corrected milk per kg

digestible dry matter and 750 g kg fat corrected milk divided by KCal energy consumed. The gross efficiency values were 1.24 to 1.50 and 0.22 to 0.26 respectively when fed with an all roughage ration and 1.42 to 1.73 and 0.25 to 0.30 respectively when fed with ad libitum roughage plus 1 kg concentrate per 3.5 kg fat corrected milk. Freeman (1967) found a high genetic correlation between milk yield and feed efficiency. The ratio of the heritabilities of these traits being approximately equal selection for milk yield will automatically select for increased efficiency at about 70 to 95 per cent effectiveness.

III. MATERIALS AND METHODS

III.1 General considerations

The experiment was conducted at the University Livestock Farm, Mannuthy during the months of October, November and December, 1974. The animals used for the experiment were Sindhi and Sindhi x Jersey cross bred cows reared at the farm.

III.2 Selection of animals

The records of all the milking animals in the farm were examined prior to selection of the animals. Since it was not possible to obtain twelve animals in the same stage of lactation and with the same lactation number, a pair-wise comparison was designed. In selection of the animals care was taken to obtain two animals, one each from both the groups having similar characteristics with respect to stage of lactation and lactation number. The body weight of the cows was not taken into consideration while pairing them. The six pairs of animals selected for the experiment were in the second, third or fourth lactations and were in the middle of their lactation.

III.3 Description of the animals

The study was conducted on twelve cows, six from Sindhi breed and six from Sindhi x Jersey cross

bred. The animals were paired and each pair consisted of one animal from each group which went identical in respect of stage of lactation and lactation number. The data regarding the age of the cows, lactation number and date of last calving were collected from the herd book and are given in Table 1. The live body weight of the animals, heart girth, body length and height at withers were taken before the commencement of the experiment and are presented in Tables 16 to 19.

III.4 Management practices

The animals were stalled in a single shed constructed in east west direction . All the twelve animals were accommodated in a single row. The shed had individual mangers and G.I. pipe partition to a height of 90 cm from the floor level and extending lengthwise upto 1.2 m in the standings. The width of each standing was 1.2 m. The cows were secured by means of iron neck chains tied to the posts on either side. These arrangements restricted the movement of the cows from their standing space and prevented them from getting at the feed of the adjacent cows. Stall feeding was practiced throughout the period of the experiment.

III.5 Pre-trial period

The animals were observed for the feed intake, milk yield and dung voided for a period of fifteen days before the commencement of the experiment. The concentrate ration as well as the roughages normally fed to these animals were analysed for the proximate principles and the ration was formulated according to the National Research Council Standards, 1971. In addition, paddy straw was fed to the animals ad libitum. The composition of the ration given to these animals is presented in Table 3. The animals were kept on this ration for a period of fifteen days before the actual commencement of the experiment. During the pre-trial period observations like body measurements, body weight, milk yield and feed consumption by the individual animals were recorded.

III.6 Observations made

The following observations were made during the experimental period:

(a) Daily milk yield - both morning and evening;
(b) Amount of daily feed intake;
(c) The weight of the dung voided daily;

(d) Fat and total solids contents of the weekly composite samples of milk from individual cows;

(e) Analysis of the concentrates and roughages for proximate principles by taking samples at the commencement, middle and close of the experiment;

(f) Body weight, heart girth, body length and height at withers of the animals at the commencement, middle and close of the experiment; and

(g) General health of the animals.

III.7 Feeding of the animals

The crude protein requirement of the animals were calculated as per the National Research Council Standards of 1971. The feeding material consisted of a concentrate part and a roughage part. The concentrate mixture used for feeding was the "Livestock and Poultry" (L.&P.) brand of cattle feed, manufactured by the State owned feed factory at Malampuzha, Kerala. The feeds were analysed for proximate principles using standard methods (A.O.A.C., 1965). The crude protein requirement was calculated for individual animals and concentrate feed was given to meet this. The concentrate

portion of the ration was not balanced for total digestible nutrients, since the concentrates and roughages provided it in excess.

The day's requirement of concentrates was calculated taking into account the body weight of the individual cows, its milk production and the percentage of milk fat. The total requirement of concentrates for the entire period of the experiment was estimated well in advance and a consignment of concentrates from a single lot was procured and stored. A day's ration to each cow was divided into two portions and fed at 9.00 hours and 13.00 hours. Water was provided to the animals according to requirements.

The roughage part of the ration consisted of a restricted quantity of green fodder and paddy straw ad libitum. The green fodder given was guinea grass (Pamicum maximum) cultivated in the farm. Guinea grass at the rate of 10 kg per day was fed to each cow in the morning. Any grass left over by the cows was collected and weighed separately. This was substracted from the quantity given to each to obtain the quantity of grass consumed by individual cows.

During the pre-trial period the approximate quantity of paddy straw consumed when fed ad libitum by individual animals in addition to the concentrate and grass was assessed. At the commencement of the experiment weighed quantity of the straw was fed to individual cows at a rate of about 1.5 kg in excess than the actual consumption. Paddy straw for each cow for a day was weighed separately and was kept in separate bundles in the feeding passage in front of the respective cows. The paddy straw was fed to the cows in four instalments in the day. Special care was taken to see that a certain quantity of paddy straw remained in the manger of each animal throughout the day. The quantity of straw left in the next morning was completely removed from each manger and weighed separately. The quantity of straw if any left by the cows in the standing space was weighed along with the left overs in the manger. From these two weighings the actual amount of paddy straw consumption by individual animals when fed ad libitum was calculated.

III.8 Feeds

The proximate principles of paddy straw, guinea grass and"L.&P." cattle feed were analysed

using standard procedures as described in A.O.A.C. (1965). Great care was taken in the sampling of concentrates, guinea grass and paddy straw in order to obtain a true representative sample. Samples of feed were collected and analysed during the commencement, middle and close of the experiment. The average of the three analyses was taken as the proximate composition of the feeds.

III.9 Milk recording

In both the groups of animals, milking was done twice daily at 5.00 hours and 14.30 hours. The time of milking was maintained regularly. Hand milking was practiced for all the cows and as far as possible the same milker was employed for milking all the cows during the entire period of the experiment. The total quantity of milk obtained at each milking was weighed using a spring balance having an accuracy of 0.1 kg. From the milk recording data, the following were calculated.

(a) The total production of milk by each cow during the experimental period;

(b) Daily average milk production of each cow;

(c) The daily average milk production for the two groups of animals; and

(d) Daily average production of four per cent fat corrected milk by individual cows.

The quantity of butter fat and total solids in milk was calculated on the basis of the percentage of fat and total solids in milk.

III.10 Analysis of milk

Weekly composite samples from each cow were obtained for the analyses. The samples were preserved with potassium dichromate at a concentration of 60 mgm per 100 ml milk.

The specific gravity, percentage of fat and percentage of total solids were found out for the composite samples from individual cows. All the samples were brought to a temperature between 50 and 70°F before taking the lactometer reading. Quevenne's lactometer was used for determining the specific gravity of the milk and the temperature of the samples were recorded using a Farenheit thermometer. The samples were tested for butter fat using Gerbers method (Davis and MacDonald, 1953). From the corrected lactometer reading and the

butter fat percentage, the percentage of total solids was calculated using the Richmonds formula (Davis and MacDonald, 1953).

III.11 Collection of dung

The dung voided by individual animals was collected in separate buckets assigned to each. The dung as and when passed by individual cows was removed to these buckets. The total quantity of dung voided in a period of 24 hours time was weighed and recorded. The total dung voided during the experimental period and the daily average dung output were calculated from the recordings. Samples of dung from individual cows were collected from freshly voided dung after thoroughly mixing a single dropping. Care was taken not to incorporate any urine or other particles while collecting samples. Approximately 20 to 30 g of dung was collected from each cow in separate petri-dishes. Samples of dung were taken from individual cows at the beginning, middle and close of the experimental period. Estimation of the percentages of dry matter and crude protein was done on the same day of collection of the dung samples and the other proximate principles were estimated on subsequent days. The analyses were done according to standard methods (A.O.A.C., 1965).

III.12 Body weight and body measurements

The body weights of the animals were recorded first at the commencement of the pre-trial period and later at the beginning, middle and end of the experimental period. The weights were recorded before feeding and watering of the animals in the morning.

The body length of each animal was measured from the point of shoulder to the extremity of the pin bone in a straight line using a measuring tape with the animal standing squarely on its four limbs.

The height was measured at the withers using a Hauptner type measuring rod with vertical arms and sliding graduated rods. The animals were made to stand squarely on a level ground while taking the measurements.

The heart girth was taken at a place just behind the withers, by passing a measuring tape around the trunk with the fore limbs parallel and the head kept in the normal position.

All the three measurements were taken in the metric system and on the same day of weighing.

III.13 Observations on the health of the animals

The animals were also observed daily for any type of ailments like mastitis, indigestion etc. and for the onset of oestrus. Out of the twelve cows one had an infection of the right fore quarter of the udder 41 days after the commencement of the experiment. So the milk recording of this cow and its pair was done only for the first 40 days of the experimental period. The animal was cured after six days of treatment but it did not came to normal production until the experiment came to a close.

III.14 Statistical analyses

The data obtained from the experiment were arranged in Tables for statistical analyses. Statistical analyses were done according to standard methods (Snedecor and Cochran, 1967). The date from the two groups of animals on total dry matter consumption, milk yield, butter fat percentage and percentage of total solids were compared using analysis of variance technique. Same method was also employed for analysing the data on increase in body weight and body measurements. Students 't' test was applied to find out whether there are any significant differences,

between the two groups as well as within each group at different stages of the experiment, in the increase in body weight and body measurements.

Differences in digestibility coefficients of dry matter, crude protein, crude fibre, ether extract and nitrogen free extract between the two groups were tested using Students 't'. The comparison of gross efficiency of feed utilisation between Sindhi cows and the Sindhi x Jersey cross bred cows was done using Cochran's 't' test.

IV. RESULTS AND DISCUSSION

IV.1 Dry matter consumption

The total dry matter consumption was calculated as percentage of the body weight. The average values were found to be 3.33 and 3.61 per cents respectively for Sindhi and Sindhi x Jersey cross bred cows when fed with straw ad libitum and concentrates and green grass in restricted quantities. The dry matter consumption from roughage part of the ration was calculated separately. It was observed that Sindhi cows consumed on an average 2.04 kg of dry matter per 100 kg body weight from roughage and the value for Sindhi x Jersey cross bred cows was 2.10 kg per 100 kg body weight. The details of the dry matter consumption are presented in Table 2. Statistical analyses of the data on the consumption of total dry matter and that from roughage alone are given in Tables 21 and 22 respectively. Eventhough the cross breds consumed 0.28 kg dry matter more than the Sindhi cows per 100 kg body weight, the difference was found to be non-significant on statistical analysis.

The dry matter consumption of the two groups of cows was found to be in agreement with the results reported by Ranjhan and Daniel (1972) for Zebu breeds

and their exotic cross bred calves fed with equal proportions of concentrates and roughages. Wagon* et al. (1974) found the dry matter intake of Sahiwal and Red Sindhi cows to be 2.6 per cent of the body weight and it was 3.9 per cent for their crosses with Brown Swiss. The above authors maintained the animals solely on a green berseem ration fed ad libitum. In the present study Sindhi cows consumed more dry matter than that reported by Wagon et al. (1974). The incorporation of a high proportion of concentrates in the ration could be the reason for the higher dry matter consumption.

The dry matter consumption of the cows under the present study was found to be higher than the values obtained by Kunjikutty (1969) and Ali (1970). The dry matter intakes were found to be 2.55 per cent of the body weight in Sindhi x Jersey cross bred bullocks (Ali, 1970) and 1.85 per cent in Red Sindhi bullocks (Kunjikutty, 1969). These animals were fed with a ration consisting of paddy straw and ground nut cake, the former contributing to about 90 per cent of the ration.

The higher values of dry matter intake by the cows under the present study might have been due to the following.

1. A higher proportion of concentrates in the ration. In the present study approximately 40 per cent of the ration consisted of concentrates. A moderately high proportion of concentrates was necessary in order to meet the protein requirement of the cows since the roughage part contained only little protein. Holmes et al. (1960) and Elliot (1967) reported an increase in dry matter consumption when the major portion of the ration was concentrate. Foley et al. (1972) stated that the voluntary intake of dry matter by cows was more when fed on a ration consisting of concentrates and roughages than when fed on roughages alone. Campling and Murdoch (1966) observed that the addition of concentrates increased the intake of barley straw.

2. Ad libitum feeding of roughages was found to increase the dry matter consumption (Amir et al., 1968).

3. The animals were lactating. The dry matter consumption was found to be more during lactation (Cole, 1966). Campling (1966) observed that the lactating animals consumed 29 per cent more hay than their non-lactating mates.

IV.2 Digestibility coefficient of the feeds given

The digestibility coefficient was calculated for different nutrients in the ration fed to the experimental cows. A summarised data on the digestibility

coefficients of dry matter, crude protein, crude fibre, nitrogen free extract and ether extract are presented in Table 13. The intake of the different nutrients by the individual cows was calculated and is presented in Table 4. The results of the analyses of the individual dung samples for proximate principles are presented in Table 5. From this the total loss of the different nutrients through dung was calculated. The values are tabulated and given in Table 6. The digestibility coefficients of the different nutrients were calculated from Tables 4 and 6.

The average digestibility coefficients of dry matter were found to be 44.33 and 47.36 respectively for Sindhi and Sindhi x Jersey cross bred cows. The details of the calculation are presented in Table 8. The cross bred cows digested more of dry matter than the Sindhi cows even though there was no significant difference between the two groups.

The average crude protein digestibility for the Sindhi and cross bred cows were found to be 78.96 and 83.04 respectively (Table 9). The cross breds were found to be more efficient in digesting the crude protein than the Sindhi cows but the difference was not statistically significant.

In the case of digestion of nitrogen free extract the cross bred cows were found to be superior to the Sindhi cows. The coefficient of digestibility of nitrogen free extract was 54.10 for Sindhi cows and 56.78 for cross bred cows (Table 11). On statistical analysis, it was found that the two groups did not differ significantly.

The digestibility coefficient of ether extract was 60.99 and 60.56 respectively for Sindhi cows and Sindhi x Jersey cross bred cows. The details of the calculation of the digestibility coefficient are given in Table 12. The difference between the two groups were tested by Students't' and was not found to be significant.

The digestibility coefficients of the above nutrients for the two groups of animals were worked out on a ration consisting of ad libitum paddy straw and limited quantities of guinea grass and concentrate feed. It was observed that the digestibility coefficients of all the nutrients except crude fibre were higher for the cross breds than for the Sindhi cows. The digestibility coefficient of dry matter was lower than that reported by Kunjikutty (1969). A lowered digestibility coefficient of dry matter might be due to an increased

dry matter intake. Similar findings have been reported by Brown (1966) and Ranjhan and Daniel (1972).

IV.3 Changes in body weight and measurements

The body weight recordings of individual cows are given in Table 16. Significant differences in body weights were noted between the pre-trial body weight and the body weights at the commencement, middle and close of the experiment. The average body weights gradually increased from 265.66 kg at the start of the pre-trial period to 267.83 kg at the close of the experiment in Sindhi cows and it increased from 277.16 kg to 277.42 kg in the cross bred cows.

Results of the statistical analyses of the data on body weights of the Sindhi cows are presented in Table 26 and that of the cross breds in Table 27. It was observed that there was significant difference ($P < 0.01$) between the body weights at different stages in Sindhi cows whereas no significant difference was noted in Sindhi x Jersey cross bred cows. The 't' values for comparing the body weights of Sindhi cows at different stages of the experiment are included in Table 34. It was found that the Sindhi cows gained weight significantly during the experimental period.

The comparison of the gain in body weight between the two groups of animals was done using Students 't' and are given in Table 37. The Sindhi cows gained significantly more weight during the commencement, middle and close of the experiment than the cross bred cows.

The body length of the experimental cows are tabulated as Table 17. The data of the two groups of animals were analysed using the analysis of variance technique. The results are presented in Tables 30 and 31. The two groups did not significantly increase the body length during the experimental period. The 't' values for the comparison of increase in body length at different stages of experiment, between the two groups of animals are included in Table 37. No significant difference was observed between these groups with respect to increase in body length.

The average heart girth increased from 147.33 cm to 150.41 cm in Sindhi cows and from 149.58 cm to 151.25 cm in Sindhi x Jersey cross bred cows. Table 28 presents the heart girth of the individual cows at the different stages of the experiment. In both the groups the increase in heart girth was found to be significant ($P < 0.01$). The values are presented in

Table 32 and 33 for the Sindhi and cross bred cows respectively. The 't' values of the statistical analysis are presented in Tables 35 and 36 for Sindhi cows and cross bred cows respectively. The comparison of the increase in heart girth from the pre-trial period to the different stages of the experiment, between the two groups of cows is done using Students 't' and the results are included in Table 37. No significant differences were obtained between the two groups of cows at different stages of the experiment.

The measurements of the height at withers of the experimental cows are presented in Table 16. The data from both the groups of animals were analysed separately using analysis of variance technique (Tables 29 and 30). It was found that there was no significant gain in height at withers in the two groups of cows at the different stages of the experiment.

The increase in heart girth observed in both groups of cows might be due to a better condition reached by the cows because of better feeding practices adopted from the pre-trial period onwards. The Sindhi cows which are comparatively lower milk producers might have utilised a portion of the feed for building up the

body tissues and hence a significant gain in body weight during the experimental period.

IV.4 Milk production

The details of milk production during the experimental period are tabulated in Table 7. The average daily milk productions (4 per cent fat corrected) were 4.007 kg and 6.287 kg for Sindhi and Sindhi x Jersey cross bred cows respectively. The fat corrected daily milk production ranged from 2.942 kg to 6.538 kg in Sindhi cows and from 5.459 kg to 6.689 kg in cross bred cows. The statistical analysis of the data on daily average fat corrected milk production (Table 23) indicated highly significant ($P < 0.01$) difference between the two groups.

The percentages of butter fat were 4.78 and 4.92 for Sindhi and cross bred cows respectively. A slightly higher butter fat percentage given by the cross bred cows were not found to be statistically significant (Table 24). The two groups of animals did not differ significantly in the percentage of total solids in milk (Table 25). The average percentage of total solids were 13.86 and 13.92 for the straight breds and cross breds respectively.

IV.5 Feed utilisation efficiency

The amounts of total digestible nutrients consumed by the experimental cows during the period under study are presented in Table 14. The gross efficiency of milk production by individual cows was calculated from the energy values of the milk produced and the total digestible nutrients consumed. The average gross efficiency of feed utilisation for milk production was found to be 18.66 per cent ranging from 14.71 to 26.52 in Sindhi cows. In the cross bred cows the average value of gross efficiency of feed utilisation was 24.65 with a range of 22.13 to 26.05. The difference in feed utilisation efficiency between the two groups of cows was found to be highly significant ($P < 0.01$).

The Sindhi x Jersey cross bred cows were found to be more efficient in feed utilisation than the Sindhi cows. The gross efficiency of feed utilisation is an important factor for economic maintenance of dairy cows. Brody (1945) calculated a theoretical efficiency of 35 per cent. It was reported by Wagon (1971) that under best feeding practices this theoretical maximum can be reached. It has also been stated that the efficiency of feed utilisation increases when

the ration contained more of less nutrient roughages with the milk yield maintained at a constant level. When the milk yield of the cows goes down more percentage of the total digestible nutrients was utilised for the maintenance of the body.

In the present study the average body weight of the Sindhi cows was 267.10 kg and it was 277.10 kg in the cross bred cows. Since the difference in body weight was not considerable the maintenance requirements also did not significantly differ between the two groups. But the cross bred cows on an average gave 50 per cent more milk than the Sindhi cows. The results obtained are in agreement with that of Wagon (1971) and Hazhizume et al. (1970). Burgess et al. (1968) reported that the efficiency of feed utilisation decreased with the reduction in milk yield. The superiority of the cross breds in feed conversion found in the present study is in agreement with the findings of Ledger et al. (1970).

From Table 15, it could be noted that the average gross efficiency of feed utilisation was 18.66 for the Sindhi cows and 24.65 for the cross bred cows. This indicates that the cross bred cows are 32.1 per cent more efficient converters of feed into milk.

From an unit amount of the locally available feeds and fodders the Sindhi x Jersey cross bred cows are capable of producing 32.1 per cent more milk than the Sindhi cows, when both were under the same microclimatic conditions prevailing in the State. This finding will be of great practical significance for the farmers of the State who wish to adopt scientific methods of rearing cross bred animals for milk production.

V. S U M M A R Y

V. SUMMARY

A comparison of the feed utilisation efficiency between the Sindhi and Sindhi x Jersey cross bred cows of the University Livestock Farm, Mannuthy was made. Six cows each, from Sindhi and Sindhi x Jersey cross breds, were paired on the basis of lactation number and stage of lactation. They were studied for a period of 76 days including a pre-trial period of 15 days. The animals were fed with a ration consisting of concentrate mixture and guinea grass to meet the protein requirements and paddy straw ad libitum. Following inferances were drawn.

1. The average dry matter consumption per 100 kg body weight in Sindhi cows was 3.30 kg and that of Sindhi x Jersey cross bred cows 3.61 kg. The average consumption of dry matter by the cross breds was more to the extent of 0.31 per cent of the body weight as compared to the Sindhis. In Sindhi cows the average dry matter consumption per 100 kg body weight from roughage alone was 2.04 kg and in cross bred cows it was 2.10 kg. The higher levels of dry matter intake might have been due to the incorporation of a higher proportion of concentrates in the ration, the cows being in lactation and the ad libitum feeding of paddy straw.

2. The digestibility coefficients of dry matter, crude protein and nitrogen free extract were higher for the cross breds even though the differences were not significant. But the Sindhi cows were slightly superior in digesting crude fibre and were equal to cross breds in digesting ether extracts.

3. The Sindhi cows gained weight and increased in heart girth significantly ($P < 0.01$) during the experimental period where as there was no significant weight gain in the Sindhi x Jersey cross bred cows. The increase in heart girth was significant ($P < 0.05$) in the case of cross bred cows also. The comparison of the body weight gains at different stages of the experiment between the groups revealed that the Sindhi cows were gaining weight significantly at all the stages. The height at withers and body length did not increase significantly in both the groups of cows.

4. Highly significant ($P < 0.01$) differences were obtained in the daily average four per cent fat corrected milk production between Sindhi and cross bred cows. The average fat and total solids percentages for the Sindhi and cross bred cows were 4.78 and 13.86 and 4.92 and 13.92 respectively. The differences between

the groups with respect to the percentages of fat and total solids were found to be non-significant.

5. The Sindhi x Jersey cross bred cows exhibited an average feed conversion efficiency of 24.65 against 18.62 in Sindhi cows. The difference was found to be highly significant ($P < 0.01$). These observations tend to show that the Sindhi x Jersey cross bred cows are 32.1 per cent more efficient in conversion of feed materials for milk production than Sindhi cows.

T A B L E S

Table 2. Body weights and dry matter consumption of the animals (in kg)

Sl. No.	Cow number	Average body weight	Dry matter consumption (61 days)				Dry matter consumption per day	Dry matter consumption per 100 kg body weight	
			Concentrate	Paddy straw	Guinea grass	Total		Total	From roughage
Sindhi cows									
1.	948	271.75	202.76	198.37	133.85	534.98	8.77	3.22	2.00
2.	950	247.12	202.76	195.33	133.51	531.60	8.71	3.52	2.18
3.	344	269.25	202.76	210.92	133.59	547.27	8.97	3.33	2.09
4.	836	280.62	177.41	184.47	132.48	494.36	8.10	2.88	1.84
5.	953	259.37	266.12	216.32	134.16	616.60	10.10	3.88	2.21
6.	964	274.50	159.14	189.94	133.83	482.91	7.92	3.19	1.93
Average		267.10					8.76	3.33	2.04
Sindhi x Jersey cows									
1.	995	268.87	266.12	216.92	136.20	619.24	10.15	3.77	2.14
2.	009	272.50	240.78	216.66	136.21	593.65	9.73	3.57	2.12
3.	866	282.00	253.45	224.06	136.11	613.62	10.06	3.56	2.09
4.	332	297.62	266.12	216.45	136.21	618.78	10.14	3.40	1.94
5.	023	222.50	253.45	199.09	136.39	587.93	9.63	4.32	2.46
6.	937	319.12	230.60	223.25	135.78	589.63	9.66	3.02	1.85
Average		277.10					9.89	3.61	2.10

Table 1. Age and details of lactation of experimental cows

Sl. No.	Cow No.	Date of birth	Lactation number	Date of last calving
Sindhi cows				
1	948	1-9-1967	2	10-5-1974
2	950	5-8-1967	2	17-12-1973
3	344	14-12-1966	3	20-3-1974
4	836	18-6-1965	5	28-2-1974
5	953	6-10-1967	3	27-8-1974
6	964	24-2-1968	2	8-12-1973
Sindhi x Jersey cows				
1	995	5-8-1967	2	3-5-1974
2	009	3-9-1969	2	27-12-1973
3	866	3-8-1967	3	13-4-1974
4	332	1-8-1966	5	29-1-1974
5	023	28-10-1969	3	16-7-1974
6	937	17-7-1968	2	25-11-1973

Table 3. Proximate principles of paddy straw, guinea grass and L and P feed

(Per cent on dry matter basis)

	Paddy straw	Guinea grass	L and P feed
Dry matter	94.25	25.00	90.60
Crude protein	0.70	4.80	16.30
Ether extract	0.50	3.10	5.70
Crude fibre	34.60	35.70	9.90
Nitrogen free extract	50.20	46.20	53.20
Total ash	13.40	10.20	15.10
Acid soluble ash	3.10	0.60	3.80

Table 4. Total and average daily intake of proximate principles during the experimental period (in kg)

Sl. No.	Cow number	Dry matter		Crude protein		Crude fibre		Ether extracts		Nitrogen free extracts	
		Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Sindhi cows											
1.	948	534.98	8.77	40.85	0.669	136.48	2.237	15.35	0.252	270.21	4.429
2.	950	531.60	8.71	40.82	0.669	135.31	2.218	15.32	0.251	268.52	4.402
3.	344	547.27	8.97	40.93	0.671	140.74	2.307	15.41	0.253	276.39	4.531
4.	836	494.36	8.10	36.56	0.599	128.67	2.109	13.81	0.226	249.15	4.084
5.	953	616.60	10.10	51.32	0.841	149.07	2.443	19.06	0.312	312.95	5.130
6.	964	482.91	7.92	33.68	0.552	129.24	2.118	12.83	0.210	242.85	3.981
Sindhi x Jersey cows											
1.	995	619.24	10.15	51.42	0.843	180.01	2.459	19.10	0.313	313.92	5.146
2.	009	593.65	9.73	47.29	0.775	147.42	2.416	17.66	0.289	300.65	4.928
3.	866	613.62	10.06	49.40	0.810	181.20	2.478	18.42	0.302	311.04	5.099
4.	332	618.78	10.14	51.42	0.843	149.85	2.456	19.10	0.313	313.95	5.146
5.	023	587.93	9.63	49.77	0.816	142.30	2.332	18.27	0.299	297.90	4.883
6.	937	589.63	9.66	45.65	0.748	148.54	2.435	17.10	0.280	298.38	4.891

Table 5. Proximate principles of the dung voided by individual animals (Average of 3 analyses)

Sl. No.	Cow number	Dry matter (per cent)	Per cent on dry matter basis				
			Crude protein	Crude fibre	Ether extract	Total ash	Nitrogen free extract
Sindhi cows							
1.	948	23.73	2.96	29.53	2.24	23.14	42.13
2.	950	24.08	3.15	30.55	2.05	23.72	40.53
3.	344	23.03	2.92	31.11	1.77	22.55	41.65
4.	836	26.61	2.82	29.99	1.56	22.69	42.94
5.	953	27.04	2.96	28.64	1.99	22.95	43.46
6.	964	22.80	2.41	31.23	2.24	24.71	39.41
	Average	24.55	2.87	30.17	1.97	23.29	41.68
Sindhi x Jersey cows							
1.	995	23.17	2.56	31.13	1.96	22.78	41.57
2.	009	22.00	2.45	29.71	2.31	22.33	43.20
3.	866	24.71	2.98	31.28	1.86	22.16	41.72
4.	332	24.02	2.72	31.08	2.71	22.95	40.54
5.	023	21.83	2.44	30.32	2.66	22.66	41.92
6	937	22.21	2.55	31.23	2.14	23.18	40.90
	Average	22.99	2.62	30.79	2.27	22.68	41.64

Table 6. Total and average daily output of proximate principles in dung (in kg)

Sl. No.	Cow number	Dry matter		Crude protein		Crude fibre		Ether extracts		Nitrogen free extracts	
		Total	Average	Total	Average	Total	Average	Total	Average	Total	Average
Sindhi cows											
1.	948	321.93	5.28	9.529	0.156	95.068	1.558	7.211	0.118	135.63	2.223
2.	950	289.94	4.73	9.133	0.150	88.580	1.452	5.943	0.097	117.52	1.926
3.	344	304.73	4.99	8.898	0.146	94.800	1.554	5.394	0.088	126.92	2.080
4.	836	234.87	3.86	6.623	0.109	70.440	1.155	3.664	0.060	100.85	1.163
5.	953	344.67	5.65	10.202	0.167	98.720	1.618	6.859	0.112	149.79	2.456
6.	964	290.43	4.76	6.999	0.115	90.700	1.486	6.506	0.106	114.46	1.876
Sindhi x Jersey cows											
1.	995	329.86	5.41	8.444	0.138	102.680	1.683	6.465	0.106	137.12	2.248
2.	009	280.41	4.59	6.870	0.113	83.310	1.365	6.477	0.106	121.14	1.986
3.	866	331.43	5.43	9.876	0.162	103.670	1.699	6.164	0.101	138.27	2.267
4.	332	321.61	5.27	8.747	0.143	99.960	1.638	8.716	0.143	130.38	2.137
5.	023	315.69	5.17	7.703	0.126	95.920	1.569	8.397	0.138	132.34	2.169
6.	937	327.78	5.37	8.358	0.137	102.360	1.678	7.014	0.115	134.06	2.198

Table 7. Milk production particulars for the experimental period

Sl. No.	Cow number	Total milk (kg)	Average butter fat (%)	Average total solids (%)	Total 4% F.C.M. (kg)	Daily average 4% F.C.M. (kg)	Total butter fat (kg)	Total solids (kg)
	Sindhi cows							
1.	948	210.43	5.00	13.99	241.54	3.959	10.503	29.823
2.	950	199.45	4.61	13.75	218.34	3.579	9.236	27.466
3.	344	220.41	4.91	14.23	251.11	4.116	9.248	31.403
4.	836	184.52	4.68	13.63	203.35	3.333	8.636	25.157
5.	953	354.49	4.83	13.97	398.83	6.538	17.134	41.426
6.	964*	106.78	4.68	13.59	117.67	2.942	4.997	14.512
	Average	212.69	4.78	13.86	238.47	4.007		
	Sindhi x Jersey cows							
1.	995	361.66	4.74	13.65	402.59	6.599	17.194	49.219
2.	009	324.55	5.41	14.49	392.61	6.436	17.549	46.963
3.	866	353.58	4.57	13.38	381.23	6.249	16.182	47.333
4.	332	348.23	5.14	14.28	408.03	6.689	17.911	49.743
5.	023	348.10	4.70	13.55	383.89	6.293	16.110	47.118
6.	937*	191.41	4.94	14.15	218.39	5.459	9.455	27.417
	Average		4.92	13.92		6.287		

* Milked for 40 days only

Table 8. Digestibility coefficient of dry matter

Sl. No.	Cow number	Total intake (kg)	Total out go (kg)	Total digested (kg)	Digestibility coefficient
	Sindhi cows				
1.	948	534.98	321.93	213.05	39.82
2.	950	531.60	289.95	241.65	45.45
3.	344	547.27	304.73	242.54	44.31
4.	836	494.36	234.87	259.49	52.49
5.	953	616.60	344.68	271.92	44.09
6.	964	482.91	290.43	192.42	39.85
	Average				44.33
	Sindhi x Jersey cows				
1.	995	619.24	329.86	289.38	46.73
2.	009	593.65	280.41	313.24	52.76
3.	866	613.62	331.41	282.19	45.98
4.	332	618.78	321.61	297.17	48.02
5.	023	587.93	315.69	272.24	46.30
6.	937	589.63	327.78	261.85	44.40
	Average				47.36

Table 9. Digestibility coefficient of crude protein

Sl. No.	Cow number	Total intake (kg)	Total out go (kg)	Total digested (kg)	Digestibility coefficient
Sindhi cows					
1.	948	40.85	9.525	31.321	76.67
2.	950	40.82	9.133	31.687	77.62
3.	344	40.93	8.898	32.032	78.26
4.	836	36.56	6.623	29.937	81.88
5.	953	51.32	10.202	41.118	80.12
6.	964	33.68	6.999	26.681	79.21
	Average				78.96
Sindhi x Jersey cows					
1.	995	51.42	8.444	42.976	83.57
2.	009	47.29	6.870	40.420	85.47
3.	866	49.40	9.876	39.524	80.00
4.	332	51.42	8.747	42.673	82.98
5.	023	49.77	7.703	42.062	84.52
6.	937	45.65	8.358	37.292	81.69
	Average				83.04

Table 10. Digestibility coefficient of crude fibre

Sl. No.	Cow number	Total intake (kg)	Total out go (kg)	Total digested (kg)	Digestibility coefficient
	Sindhi cows				
1.	948	136.48	95.068	41.412	30.34
2.	950	135.31	88.579	46.731	34.53
3.	344	140.74	94.801	45.939	32.64
4.	836	128.67	70.438	58.232	45.25
5.	953	149.07	98.715	50.355	33.77
6.	964	129.24	90.701	38.539	29.81
	Average				34.39
	Sindhi x Jersey cows				
1.	995	150.01	102.685	47.325	31.54
2.	009	147.42	83.310	64.110	43.48
3.	866	151.20	103.672	47.520	31.43
4.	332	149.85	99.956	49.894	33.29
5.	023	142.30	95.719	46.580	32.73
6.	937	148.54	102.365	46.175	31.08
	Average				33.92

Table 11. Digestibility coefficient of nitrogen free extract

Sl. No.	Cow number	Total intake (kg)	Total out go (kg)	Total digested (kg)	Digestibility coefficient
Sindhi cows					
1.	948	270.21	135.633	134.577	49.80
2.	950	268.52	117.516	151.004	56.23
3.	344	276.39	126.920	149.470	54.07
4.	836	249.15	100.854	148.296	59.52
5.	953	312.95	149.797	163.153	52.13
6.	964	242.85	114.458	128.392	52.86
	Average				54.10
Sindhi x Jersey cows					
1.	995	313.92	137.123	176.797	56.31
2.	009	300.65	121.138	179.512	59.70
3.	866	311.04	138.273	172.767	55.54
4.	332	313.95	130.38	183.57	58.47
5.	023	297.90	132.339	165.561	55.57
6.	937	298.38	134.062	164.318	55.07
	Average				56.78

Table 12. Digestibility coefficient of ether extract

Sl. No.	Cow number	Total intake (kg)	Total out go (kg)	Total digested (kg)	Digestibility coefficient
	Sindhi cows				
1.	948	15.35	7.211	8.139	53.02
2.	950	15.32	5.943	9.377	61.20
3.	344	15.41	5.393	10.017	65.00
4.	836	13.81	3.664	10.146	73.46
5.	953	19.06	6.859	12.201	64.01
6.	964	12.83	6.505	6.325	49.29
	Average				60.99
	Sindhi x Jersey cows				
1.	995	19.10	6.465	12.635	66.15
2.	009	17.66	6.477	11.183	63.32
3.	866	18.42	6.164	12.256	66.53
4.	332	19.10	8.715	10.385	54.37
5.	023	18.27	8.397	9.873	54.03
6.	937	17.10	7.014	10.086	58.98

Table 13. Summarised data on the digestibility coefficients of nutrients in feeds

Sl. No.	Cow number	Dry matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract
	Sindhi cows					
1.	948	39.82	76.67	30.34	53.02	49.80
2.	950	45.45	77.62	34.53	61.20	56.23
3.	344	44.31	78.26	32.64	65.00	54.07
4.	836	52.49	81.88	45.25	73.46	59.52
5.	953	44.09	80.12	33.77	64.01	52.13
6.	964	39.85	79.21	29.81	49.29	52.86
	Average	44.33	78.96	34.39	60.99	54.10
	Sindhi x Jersey cows					
1.	995	46.73	83.57	31.54	66.15	56.31
2.	009	52.76	85.47	43.48	63.32	59.70
3.	866	45.98	80.00	31.43	66.53	55.54
4.	332	48.02	82.98	33.29	54.37	58.47
5.	023	46.30	84.52	32.73	54.03	55.57
6.	937	44.40	81.69	31.08	58.98	55.07
	Average	47.36	83.04	33.92	60.56	56.78

Table 14. Consumption of total digestible nutrients during the experimental period (in kg)

Sl. No.	Cow number	Digestible protein	Digestible crude fibre	Digestible nitrogen free extract	Digestible ether extract x 2.25	Total Digestible nutrients
	Sindhi cows					
1.	948	31.321	41.412	134.577	18.313	225.623
2.	950	31.687	46.731	151.004	21.098	250.520
3.	344	32.032	45.939	149.470	22.538	249.979
4.	836	29.937	58.232	148.296	22.828	259.293
5.	953	41.118	50.355	163.153	27.452	282.078
6.	964*	18.480	25.250	86.813	10.902	142.910
	Sindhi x Jersey cows					
1.	995	42.976	47.325	176.797	28.428	295.526
2.	009	40.420	64.110	179.512	25.162	309.204
3.	866	39.524	47.520	172.767	27.576	287.387
4.	332	42.673	49.894	183.570	23.366	299.503
5.	023	42.062	46.580	165.561	22.133	276.336
6.	937*	26.210	30.642	111.188	17.060	185.100

* For forty days only.

Table 15. The gross efficiency of milk production

Sl. No.	Cow number	TDN consumption (kg)	Energy value of TDN (TDN x 3999) (MCal)	Total 4% FCM produced (kg)	Energy value of FCM (FCM x 750) (MCal)	Gross efficiency $\frac{\text{FCM x 750}}{\text{TDN x 3999}} \times 100$ (%)
	Sindhi cows					
1.	948	225.62	902.27	241.54	181.16	20.08
2.	950	250.52	1001.83	218.34	163.76	16.35
3.	344	249.98	999.67	251.11	188.33	18.84
4.	836	259.29	1036.91	203.35	152.51	14.71
5.	953	282.08	1128.03	398.83	299.12	26.52
6.	964	142.91	571.50	117.67	88.25	15.44
	Average					18.66
	Sindhi x Jersey cows					
1.	995	295.53	1181.81	402.59	301.94	25.50
2.	009	309.20	1236.51	392.61	294.46	23.81
3.	866	287.39	1149.26	381.23	285.92	24.87
4.	332	299.50	1197.71	408.03	306.02	25.55
5.	023	276.34	1105.07	383.89	287.92	26.05
6.	937	185.10	740.21	218.39	163.80	22.13
	Average					24.65

Table 16. Body weight of the experimental cows at different stages of experiment (in kg)

Sl. No.	Cow number	Pre-trial period (18-10-74)	Commencement (1-11-74)	Middle (2-12-74)	Close (31-12-74)	Mean
	Sindhi cows					
1.	948	270.0	271.0	272.5	273.5	271.75
2.	950	246.0	247.5	247.0	248.0	247.12
3.	344	268.0	270.5	269.0	269.5	269.25
4.	836	279.0	280.5	281.0	282.0	280.62
5.	953	258.0	260.0	259.5	260.0	259.37
6.	964	273.0	275.0	276.0	274.0	274.50
	Average	265.66	267.42	267.52	267.83	
	Sindhi x Jersey cows					
1.	995	269.0	268.5	269.5	268.5	268.87
2.	009	272.5	272.0	272.0	273.0	272.50
3.	866	282.0	282.0	281.5	282.5	282.00
4.	332	297.5	297.5	296.5	299.0	297.62
5.	023	223.0	223.5	222.0	221.5	222.50
6.	937	319.0	318.5	319.0	320.0	319.12
	Average	277.16	277.08	276.75	277.42	

Table 17. Body length of the experimental animals at different stages of experiment (in cm)

Sl. No.	Cow number	Pre-trial period	commencement (18-10-74)	Middle (1-11-74)	Close (31-12-74)	Mean
	Sindhi cows					
1.	948	102.5	103.0	103.0	103.0	102.87
2.	950	101.0	101.0	101.0	101.5	101.12
3.	344	103.0	103.0	103.0	102.5	102.87
4.	836	113.5	113.5	113.5	113.5	113.50
5.	953	104.0	104.0	104.5	104.0	104.12
6.	964	98.0	98.0	98.0	98.0	98.00
	Average	103.66	103.75	103.83	103.75	
	Sindhi x Jersey cows					
1.	995	108.0	108.0	108.0	108.0	108.00
2.	009	112.0	113.0	113.5	113.0	112.87
3.	866	109.0	109.0	110.5	110.5	109.75
4.	332	120.5	120.5	120.0	120.0	120.25
5.	023	112.0	112.0	112.0	112.5	112.12
6.	937	112.0	112.0	113.5	114.5	113.00
	Average	112.25	112.42	112.91	113.08	

Table 18. Heart girth of the experimental cows at different stages of experiment (in cm)

Sl. No.	Cow number	Pre-trial period (18-10-74)	Commencement (1-11-74)	Middle (2-12-74)	Close (31-12-74)	Mean
	Sindhi cows					
1.	948	148.5	149.0	156.0	155.00	152.12
2.	950	141.0	142.0	143.5	143.5	142.50
3.	344	151.0	151.0	153.5	153.5	152.25
4.	836	152.5	152.0	153.5	153.5	152.87
5.	953	143.5	142.5	143.5	143.5	143.25
6.	964	147.5	148.0	153.5	153.5	150.62
	Average	147.33	147.41	150.58	150.41	
	Sindhi x Jersey cows					
1.	995	153.5	153.5	154.0	153.5	153.62
2.	009	152.5	152.5	153.5	154.0	153.12
3.	866	147.0	147.0	147.0	148.0	147.25
4.	332	150.0	151.0	151.5	152.5	151.25
5.	023	142.0	142.5	143.5	143.0	142.75
6.	937	152.5	153.5	156.0	156.5	154.62
	Average	149.58	150.00	150.91	151.25	

Table 19. Height at withers of the experimental cows at different stages of experiment (in cm)

Sl. No.	Cow number	Pre-trial period (18-10-74)	Commencement (1-11-74)	Middle (2-12-74)	Close (31-12-74)	Mean
	Sindhi cows					
1.	948	200.5	200.0	200.5	201.0	200.50
2.	950	207.0	207.0	207.5	207.5	207.25
3.	344	211.0	211.0	211.0	211.0	211.00
4.	836	211.0	211.5	211.5	211.0	211.25
5.	953	207.0	207.0	207.0	207.5	207.12
6.	964	203.0	203.0	203.5	203.5	203.25
	Average	206.58	206.50	207.16	207.00	
	Sindhi x Jersey cows					
1.	995	207.0	207.0	207.0	207.0	207.00
2.	009	208.0	208.0	208.0	208.5	208.12
3.	866	205.5	205.5	205.5	206.0	205.62
4.	332	209.5	209.5	210.0	209.5	209.62
5.	023	204.5	204.5	204.5	205.0	204.62
6.	937	209.5	210.0	210.0	210.0	209.87
	Average	207.33	207.34	207.50	207.66	

Table 20. Nutritive values of common feeds (in kg)

Name	Digestible nutrients per 100 kg dry matter			Digestible nutrients per 100 kg raw material	
	Crude protein	Carbo-hydrates	Ether extract	Digestible crude protein	Total digestible nutrients
Napier grass	3.85	48.54	1.33	0.91	13.80
Guinea grass	4.44	39.23	0.72	1.11	12.80
Para grass	7.91	-	-	1.51	11.40
Rice straw	0.00	48.86	0.30	0.00	44.60
Coconut cake (Expellar)	22.81	22.12	8.20	20.53	75.40
Cotton seed cake (undecorticated)	19.42	39.56	8.97	17.48	71.60
Ground nut cake	46.39	14.59	7.97	41.75	71.00
Til cake	42.60	23.36	9.32	38.34	78.20
Rice bran	9.09	31.69	15.70	8.18	68.00
Wheat bran	11.80	58.00	2.28	10.62	67.50
Tapioca	1.46	81.19	0.28	1.31	75.00

(Adopted from Sen and Ray, 1964).

Table 21. Percentage total dry matter consumption

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Due to stage of lactation	5	1.292	0.258	4.031
Due to groups	1	0.099	0.099	1.540
Error	5	0.322	0.064	
Total	11	1.713		

Table 22. Percentage roughage dry matter consumption

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Due to stage of lactation	5	0.28	0.05	5.00*
Due to groups	1	0.01	0.01	1.00
Error	5	0.05	0.01	
Total	11	0.34		

* Significant at 5% level

Table 23. Four per cent fat corrected milk production

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Due to stage of lactation	5	5.108	1.021	1.269
Due to groups	1	14.648	14.648	18.218**
Error	5	4.021	0.804	
Total	11	23.777		

Table 24. Average fat percentage

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Due to stage of lactation	5	0.101	0.020	0.198
Due to groups	1	0.052	0.052	0.514
Error	5	0.507	0.101	
Total	11	0.660		

** Significant at 1% level

Table 25. Percentage total solids in milk

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Due to stage of lactation	5	0.178	0.035	0.155
Due to groups	1	0.010	0.010	0.044
Error	5	1.134	0.226	
Total	11	1.322		

Table 26. Body weight-Sindhi cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between weighings	3	17.120	5.700	10.96**
Between animals	5	2890.430	578.080	
Error	15	7.940	0.520	
Total	23	2915.490		

Table 27. Body weight-Sindhi x Jersey cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between weighings	3	1.417	0.472	0.810
Between animals	5	21128.667		
Error	15	8.750	0.583	
Total	23	21138.834		

** Significant at 1% level

Table 28. Height at withers - Sindhi cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	0.531	0.177	2.950
Between animals	5	360.052		
Error	15	0.910	0.060	
Total	23	361.493		

Table 29. Height at withers - Sindhi x Jersey cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	0.365	0.121	3.184
Between animals	5	90.302		
Error	15	0.580	0.038	
Total	23	91.247		

Table 30. Body length - Sindhi cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	0.080	0.026	0.590
Between animals	5	546.750		
Error	15	0.670	0.044	
Total	23	547.500		

Table 31. Body length - Sindhi x Jersey cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	2.840	0.946	2.570
Between animals	5	352.960		
Error	15	5.530	0.368	
Total	23	361.330		

Table 32. Heart girth - Sindhi cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	58.701	19.567	8.669**
Between animals	5	453.097		
Error	15	33.862	2.257	
Total	23	545.660		

Table 33. Heart girth - Sindhi x Jersey cows

Analysis of variance

Source	D.F.	S.S.	M.S.S.	F
Between measurements	3	10.868	3.622	7.303**
Between animals	5	419.347		
Error	15	7.445	0.496	
Total	23	437.660		

** Significant at 1% level

Table 34. 't' values for comparing the body weight of Sindhi cows at different stages of the experiment

	Commencement	Middle	Close
Pre-trial	4.23**	4.512**	5.216**
Middle	--	--	0.801
Close	0.985	--	--

Table 35. 't' values for comparing the heart girth of Sindhi cows at different stages of the experiment

	Commencement	Middle	Close
Pre-trial	0.092	3.748**	3.552**
Middle	3.656**	--	--
Close	3.460**	0.092	--

** Significant at 1% level

Table 36. 't' values for comparing the heart girth of Sindhi x Jersey cows at different stages of the experiment

	Commencement	Middle	Close
Pre-trial	1.034	3.275**	4.113**
Middle	2.241*	--	--
Close	3.078**	0.837	--

Table 37. 't' values for comparison of increasing body weight and measurements at different stages of the experiment between Sindhi and Sindhi x Jersey cows

	Commencement	Middle	Close
Body weight	3.036**	3.712**	4.009**
Wither height	0.195	0.889	0.195
Heart girth	0.355	2.006	1.473
Body length	1.941	1.189	1.796

** Significant at 1% level

* ,, at 5% level

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ABSTRACT OF "A COMPARATIVE STUDY ON THE FEED UTILISATION OF THE LOCAL AND CROSS BRED COWS"

A comparison of the feed utilisation efficiency between Sindhi and Sindhi x Jersey cross bred lactating cows of the University livestock farm was made. Six cows each from the two groups were paired on the basis of the lactation number and stage of lactation. The animals were stall fed for 76 days including a pre-trial period of 15 days. The ration consisted of a concentrate feed and guinea grass to meet the protein requirement and paddy straw *ad libitum*.

The following observations were recorded for individual cows:

i) daily intake of different food ingredients;
ii) daily milk yield;
iii) daily out put of dung;
iv) body weight and body measurements during the pre-trial period, commencement, middle and close of the experiment;
v) percentages of butter fat and total solids of individual composite samples tested once in a week; and
vi) calculation of gross efficiency of feed utilisation.

The following inferences could be drawn:

1. The total dry matter consumption by the Sindhi and the cross bred cows were 3.30 kg and 3.61 kg per 100 kg body weight respectively and the dry matter consumption from roughage alone was 2.04 kg and 2.10 kg respectively.

2. The digestibility coefficients of dry matter, crude protein and nitrogen free extract were higher for the cross breds and in straight breds it was higher for crude fibre. For ether extract the digestibility coefficient was the same in both the groups.

3. The straight bred cows gained weight and increased in heart girth significantly ($P < 0.01$) during the experimental period, but no significant weight gain was recorded in cross breds. The increase in heart girth was significant ($P < 0.05$) among cross breds. The height at withers and body length did not increase significantly in the two groups.

4. The average daily 4% fat corrected milk yields were significantly higher ($P < 0.01$) in the cross breds. No significant difference was noticed between the two groups in the percentages of fat and total solids in milk.

5. The average gross efficiency of feed utilisation for milk production was 24.65 in cross breds and it was 18.62 in straight breds indicating that the cross breds were superior to the straight bred in the utilisation of feeds for milk production.

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