GENETIC STUDIES ON MILK PRODUCTION AND ON REPRODUCTIVE PERFORMANCE OF CROSS BRED CATTLE

AT

INDIAN VETERINARY RESEARCH INSTITUTE

MUKTESWAR.

By

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IZATNAGAR (U. P.)

Thesis

Submitted to the Agra University, Agra,

in partial fulfilment of the requirements for the Degree of

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ANIMAL GENETICS & BREEDING

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Dated 25 April, 1970.

Certified that the research work contained in this thesis entitled "Genetic Studies on Milk Production and on Reproductive Performance of Crossbred Cattle at Indian Veterinary Research Institute, Mukteswar" by Shri Madan Mohan Saxena is an original work carried out by him under my supervision and guidance.

O.B. Tandon

(O.B. TANDON)

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C O N T E N T S

INTRODUCTION

The northern hilly tract of India has a large area with substantial human population. Kumaun hills of Uttar Pradesh are a representative part of this tract. The cattle here are small, non-descript and low milk producers.

Kumauni cattle weigh only about 135 to 150 kg as adults, they have lactations of about 150 days followed by long dry periods. They are short with a compact body and possess a well developed hump in front of the withers (Mohyuddin, 1945 and Hosain, 1947). They yield on an average only about 1.5 kg of milk daily. Obviously milk production from these is an uneconomical proposition and the average per capita milk consumption in this tract, if anything, is much lower than in the rest of the country, which already is known to be inadequate.

The rainfall in this area is high and the winters are cold. The terrain is undulating and large scale fodder production is not possible as such milch breeds of large cattle from the plains cannot be economically maintained for increasing the milk supply there.

Afghan cattle are smaller, like Kumauni cattle but they have higher milk yields. They are well adapted also to hilly tracts of Afghanistan. They offered, therefore,

promise of being utilized in Kumaun area for solving the problem of milk shortage.

Importations of large number of Afghan cattle will not be economically possible for replacing the entire poor local hilly cattle. However, this ought not to be even necessary as in a number of studies in the tropics, crossing of local cattle with exotic milch breeds has repeatedly yielded fruitful results. Most of the production and reproduction traits in these studies have registered marked improvements in even half-breds. Some Afghan cattle were available at the Indian Veterinary Research Institute, Mukteswar. A number of Kumauni cows were also available there and these were crossed by the Afghan bulls producing Afghan-Hill half-breds which were bred subsequently to produce higher Afghan grades. Simultaneously purebred Afghan stock was also maintained.

The present study was undertaken, therefore, for assessing the relative performances of Kumauni, of Afghan and of various grades of Afghan on Kumauni hill cattle. This was intended to indicate the level of grading-up of hill cattle to Afghan breed which would yield the best result for this tract.

The traits included for the study were, birth weight, age at first calving, gestation period, service period, calving interval, lactation and dry periods, 301-day lactational milk yield and average milk yield per day of calving interval as well as butter fat percentage of this milk.

REVIEW OF LITERATURE

Crossing of Indian cattle with European milch breed has been tried not only in the Indian plains but also in other tropical countries of the world. In several hilly and heavy rainfall areas of India crossing of local cattle to Jersey had been taken up some years ago and is indicating the promising combinations from which better milch breeds could be evolved. The results from such studies have already been reviewed by many. It is, therefore, proposed to limit the present review only to that part which very closely relates to the aspects undertaken in this study.

Age at First Calving

In Jamaica, Howe (1946) observed that half-bred Jersey-Zebus calved earlier than half-breds of Holstein or of Guernsey. Fohrman *et al.* (1951) at Beltsville noted that Jersey-Red Sindhi crossbreds dropped their first calf between 23 to 26 months of age.

Tandon (1951) studying Friesian crosses with Red Sindhi and with Sahiwal reported that age at first calving of crossbreds decreased at a diminishing rate as Friesian inheritance increased in an individual over half. He also found that crossbreds of Red Sindhi and of

Sahiwal with Friesian did not have equal ages at first calving.

Age at first calving was less in half-breds and in 3/4th of Ayrshire breed according to Sen et al. (1953).

At Beltsville as also in Southern U.S.A. at Jeanerette and Tifton, McDowell et al. (1959) observed that as Red Sindhi inheritance increased in an animal, the age of sexual maturity was retarded. Armour et al. (1961) found that White Fulani females dropped their first calf at 50 months whereas their crossbreds with Jersey dropped their first calf at about 33 months of age.

In Madras when Jersey-Red Sindhi half-breds were backcrossed to Red Sindhi bulls, Dhandapani (1962) observed that age at first calving increased from 26.6 months to 38.8 months. Mathur (1963) reported that Jersey-Hilly crossbreds mature earlier than the hill cattle. Mahadevan and Hutchinson (1964) reported that the average age at first calving was 39.9 months for Zebus (with a coefficient of variation of 12%) whereas for crossbreds between Bos indicus and Bos taurus it was 37.4 months (with a coefficient of variation of 14%).

Naidu and Desai (1965) studying crosses of Friesian

on Sahiwal stated that age at first calving depended upon the proportion of Friesian inheritance in the crosses. Similarly Bhasin and Desai (1967) reported that age at first calving was 46.5 months for 1/4 Friesian-3/4 Harianas whereas for 1/2 Friesian-1/2 Sahiwals, it was only 39.8 months in Rajasthan area.

Asker et al. (1966) studied crosses of Friesian and Ayrshire with local cattle of Iraq. They reported that for pure Friesian, 3/4 Friesian, 1/2 Friesian and locals the average ages at first calving were 34.3, 38.5, 35.7 and 44.9 months, respectively whereas for Ayrshire and Ayrshire crosses it was 35.2 and 39.5 months, respectively.

Agarwala (1968) found that with Red Sindhi's increasing of inheritance from Jersey or from Brown Swiss over 1/2 did not cause a reduction in age at first calving.

Raj Kumar (1969) reported that average age at first calving for 23 Red Sindhi, was 1529 days whereas for 28 Jersey x Red Sindhi it was 952 days. Similarly for 15 Non-descripts it was 1486 days whereas for 31 Jersey-Desi it was 1206 days.

Gestation Period

Tandon (1949) studying 673 gestation lengths of Red Sindhi and Jersey Red Sindhi crosses reported average gestation period of 286 days with 91% observations being between 275 and 297 days. Breed and sex of calf and season of calving had significant effects. Half-bred calves were carried for 4.6 days less. Males required a gestation length 2 days longer than females. Repeatability was 13% and factors affecting short gestations were more potent than those determining longer gestation periods.

Rigor and Nelmida (1959) examined the average gestation periods of Red Sindhi and of Jersey crosses with this breed and reported them to be 271 and 270 days, respectively. McDowell *et al.* (1959) found a lengthening of gestation period in crosses of these two breeds as Red Sindhi inheritance increased. Narayankutty *et al.* (1962) found the average gestation period in Jersey and in Red Sindhi to be 276 and 281 days respectively. Non-descript hill cattle inseminated with Jersey semen had shorter gestation period than when they were inseminated with their own breed bulls according to Bawa and Gulati (1960).

Birth Weight

Doutressoulle (1938) reported that average birth weight of N'Dama calves was 15 kg whereas that of Tarentais-N'Dama half-breds was between 22 to 24 kg. Similarly a number of workers have reported higher birth weights of crossbreds than of the purebreds. Some of these are Poljakov (1935), Beotto (1936), Vasjakis (1937), Guzder (1952), McDowell et al. (1959) and Touchberry and Bereskin (1966).

On the other hand Taylor (1954) observed that average birth weight of purebred Red Sindhis was 22.9 ± 0.8 kg whereas that of half-bred Holstein-Red Sindhi was only 19.8 ± 0.8 kg. Roy and Goswami (1960) studied the variation in the birth weights of Zebu-Friesian crossbreds at the Military Farm, Mhow. They concluded that calves with more than 50% Friesian inheritance had an average birth weight of 28.24 ± 0.35 kg as against only 28.05 ± 0.37 kg for calves with less than 50% Friesian blood. Similarly Rigor and Robles (1951), Gercikov (1956), Horn et al. (1961) and Ulrych (1965) reported that the crossbreds had smaller birth weights than their purebred parents.

Naidu and Desai (1965, 1966) in their studies of Friesian-Sahiwal crossbreds reported that birth weight was

highest for those animals who had between 3/8 to 4/8 Friesian inheritance. Males were significantly heavier than females at all levels of Friesian inheritance.

Service Period

Howe (1946) compared half-breds of Friesian, Guernsey and Jersey and observed that Jersey half-breds had shorter service periods in Jamaica. Hariana, Sahiwal and Red Sindhi were crossed at Bangalore with Ayrshire. Sen et al. (1953) reported that crossbreds had shorter service periods than Zebu cattle.

In Venezuela Hernandez, Prado (1965) calculated the average service periods for Brown Swiss, Holstein-Friesian and for crossbreds and reported it to 209, 204 and 131 days respectively. Asker et al. (1966) studied in Iraq crosses of Friesian and Ayrshire with locals. They reported the average service periods for Friesian, 3/4 Friesian, 1/2 Friesian and locals to be 112, 224, 179 and 103 days respectively; whereas Ayrshire and Ayrshire crossbreds had these 140 and 175 days long. Abdel-Ghani and Fahmy (1966) reported the average service period of Friesians and of Friesian half-breds with local to be 173 and 160 days respectively.

Calving Interval

In Egypt, Khishin and El-Issawi (1954) studied various grades of Jersey. They reported that half-bred, 3/4, 7/8 and pure Jerseys averaged 363, 359, 383 and 384 days respectively.

Rigor and Nelmida (1959) calculated the averages for calving intervals of Red Sindhi and Jersey-Red Sindhi crossbreds. These were 510 ± 20 and 512 ± 11 days respectively. However, in Tourrialba, Dealba and Solares (1962) found that by crossing Zebus to exotic dairy cattle, calving interval in crossbreds decreased. Contrary to this Dhandapani (1962) reported that there was hardly any difference in average calving interval among crossbreds carrying varying amounts of Red Sindhi-Jersey inheritance.

In Kenya, Mahadevan et al. (1962) reported the average calving interval of Sahiwal grades as 388 days with 19% coefficient of variation whereas in adjoining Tanganyka, Mahadevan & Hutchison (1964) observed that Zebus and exotic-Zebu crossbreds differ significantly in average calving interval.

Mathur (1963) observed shorter calving intervals in crossbred cattle than in Hill cattle crossed with Jerseys.

Compere (1964) noticed that crossbreds between Sahiwal and Ankole have longer calving intervals than Ankoles. In Iraq, Asker et al. (1966) reported the average calving intervals of Friesian, 3/4 Friesian and 1/2 Friesian to be 418, 498 and 476 days respectively whereas Ayrshire and Ayrshire crossbreds had 465 and 440 days and that of native was 396 days. On the other hand in U.A.R. Friesians and their crossbreds averaged 462 and 441 days according to Abdel-Ghani and Fahmy (1966).

Studying 7 different types of Friesians crosses on three breeds viz. Hariana, Sahiwal and Red Sindhi, Bhasin and Desai (1967) from Rajasthan reported the range in average calving interval to be 344 days to 428 days. The highest value was for 3/4 Holstein 1/4 Hariana animals. Agarwala (1968) reported an improvement in breeding efficiency at Allahabad when Red Sindhi was crossed to Jersey or Brown Swiss.

Raj Kumar (1969) in Red Sindhi and Jersey grading observed that calving intervals were as follows :

29 Red Sindhi	...	433 days
31 Jersey x Red Sindhi	...	398 days
33 Non-descript (Desi)	...	741 days
21 Jersey x Desi F_1	...	544 days

Lactation Period

Jauffret and Autret (1948) had observed that Annamite cows had average lactation lengths of only 5 to 6 months and in crosses of Annamite with Red Sindhi, the lactation length decreased as Red Sindhi inheritance decreased whereas in Friesian Red Sindhi crossbreds it was of the order of 12 months.

Studying data from a number of Military farms where Friesian was crossed to Red Sindhi and Sahiwal, Tandon (1951) observed that lactation periods in crossbreds were longer than those in either of the two Indian breeds. Guzder (1952) reported average lactation periods of Brown Swiss-Red Sindhi and Brown Swiss-Hariana to be 352 and 333 days respectively. In Egypt, Khishin and El-Issawi (1954) found that the lactation length of Jersey and of Jersey crossbreds was longer than that of Friesians and of Friesian crosses.

Dealba and Solares (1962) noticed that in Tourrialba lactation period increased in crossbreds of Zebu with exotic breeds. Asker et al. (1966) reported the average lactation lengths for Friesian, 7/8 Friesian and 1/2 Friesian as 322, 293, and 319 days, respectively in Iraq whereas that for Ayrshire and Ayrshire crosses it was 314 and 282 days while

that for natives was only 219 days. Similarly Abdel-Ghani and Fahmy (1966) calculated the average lactation lengths for Friesian and for Friesian Native crossbreds to be 350 and 320 days respectively.

Raj Kumar (1969) reported that lactation period in 31 Red Sindhi were 269 days, in 43 Jersey x Red Sindhi it was 285 days and in 14 Non-descript (Desi) it was 271 days whereas in 46 Jersey x Desi F_1 it was 338 days.

Dry Period

Howe (1946) concluded that in Jamaica amongst the half-breds of Jersey, Guernsey and Holstein, half-breds of Jersey had shorter dry periods than the two others. Similarly, Tandon (1951) reported that Holstein crosses with Red Sindhi and with Sahiwal had shorter dry period than the concerned Indian breed. Ayrshire crossbreds with Red Sindhi had shorter dry period than the Red Sindhis themselves according to Sen *et al.* (1953).

Asker *et al.* (1966) reported the average dry period of Friesian, 3/4 Friesian and 1/4 Friesian as 103, 197 and 153 days respectively in Iraq. According to them Ayrshire and Ayrshire crosses averaged 150 and 164 days whereas natives had 182 days.

Naidu and Desai (1966) observed that dry periods decreased in Friesian Sahiwal crosses as Friesian inheritance increased from 4/32 to 11/32. It remained more or less equal than upto 19/32 and beyond that it increased.

Lactational Milk Production

Earliest report on the assessment of the advantage crossbreds possess over Indian cattle in milk yield was seen from Madras Presidency. In 1932, it was reported that half-breds of Red Sindhi or Sahiwals with Ayrshire were high yielders. However, the second and third generations deteriorated. Littlewood (1933) examined the records of the work since 1919 in Madras on Ongole breed. He observed that crossbreds with 1/8 to 1/4 exotic inheritance were the most suitable for tropical dairying. This was supported by the report from Imperial Institute of Agricultural Research (1934) where 1/4 Ayrshire 3/4 Sahiwals were found to have high milking quality.

In Jamaica, Lecky (1935) noticed that among Jersey crosses with Zebu, performance was best at 1/8 level of inheritance. Schneider (1938) examined the Guernsey crossbreds at Allahabad Agricultural Institute and reported that Guernsey half-breds produced 1650 kg more milk than their Red Sindhi dams. However, only 2 daughters were studied.

Howe (1946) analysed the records on Guernsey and Jersey half-breds in Tamaica and concluded that these half-breds yielded about 225 kg more milk than their purebred dams.

Jauffret and Autret (1948) concluded from their study of Red Sindhi Annamite crosses that the average daily milk yield was highest at the level of 3/4 Red Sindhi 1/4 Annamite.

Tandon (1951) from his study of Holstein Friesian crosses on Red Sindhi and Sahiwal in Military Dairy Farms in India concluded that milk production was highest in 5/8 Friesian 3/8 Red Sindhi. Sidky (1952) also examined results of Friesian crosses with Egyptian local Damiette cattle and concluded that milk yield increased as inheritance of Holstein inheritance increased upto 7/8 Holstein level. The same year Guzder reported that half-bred Brown Swiss-Red Sindhi as also the backcross of these to Red Sindhi were economical and efficient milk producers. The number of observations were rather limited. Stonaker et al. (1953) also observed that Jersey crossbreds with Red Sindhi had higher milk yield.

At National Dairy Research Institute, Bangalore, Hariana, Red Sindhi and Sahiwal were crossed with Ayrshire.

Sen *et al.* (1953) reported that half-breds with the three Indian breeds yielded 168, 102 and 78 per cent more milk respectively than their Zebu dams.

Khishin and El-Issawi (1954) reported that the average lactational yield of 1/2 Jersey, 3/4 Jersey, 7/8 Jersey and pure Jersey were 5223 kg, 5194 kg, 5894 kg and 5594 kg respectively. The last two groups had 27 and 153 lactational records averaged.

Armour *et al.* (1961) reported the work on crosses of Friesian bulls on White Fulani cows in Nigeria. They observed that in their first and second lactations the half-breds exceeded the White Fulani cows by 38% and 168% respectively. In Tourrialba, Costa Rica, Central America, Dealba and Solares (1962) reported the results from Jersey and Brown Swiss crossing on Zebu cattle. They found there that Jersey crossbreds with Zebu were superior in milk yield to purebred Jersey under tropical climate. F_2 of Brown Swiss Zebus was inferior to other crossbreds.

Marked improvement in milk production of crossbreds of Jersey over hill cattle was observed by Mathur (1963).

Work at Tanga experiment station was analysed by Mahadevan and Hutchison (1964). They found that crossbreds

were significantly superior to Zebus in milk yield. Singh and Desai (1964) studied the ratio between milk yield and body weight in crosses of Holstein from Military Dairy Farms. They concluded that this ratio increased with an increase in the proportion of Holstein inheritance upto 5/8 level. Friesian-Sahiwal crosses were examined by Naidu and Desai (1966). They reported that highest lactational milk yield was by cows having 16/32 to 23/32 Friesian inheritance. Peak yield increased upto 16/32 and remained more or less constant upto 19/32 in the north and 27/32 in the South thereafter decreased.

In U.A.R., Abdel-Ghani and Fahmy (1966) observed that lactational yields of crossbreds increases from first to fifth lactation and decreases thereafter upto 10th lactation. In Iraq Asker et al. (1966) reported the average 305-day milk yield to be 2574, 1839 and 2192 kg for Friesian, 3/4 Friesian and 1/2 Friesians respectively, whereas for Ayrshire and Ayrshire crossbreds it was 2371 and 1687 kg and for native cattle it was only 1027 kg.

At Birla Dairy Farm, Rajasthan Sahiwal, Red Sindhi and Hariana were crossed by Jersey. Bhasin and Desai (1967) analysed the data. They expressed the milk yields of various crossbreds keeping the yield of their parental Indian breed

equal to 100. They reported the following values :

1/2 Friesian-1/2 Sahiwal	...	182.2
1/2 Friesian-1/2 Red Sindhi	...	212.5
1/2 Friesian-1/2 Hariana	...	188.0
3/4 Friesian-1/4 Hariana	...	146.4
1/2 Friesian-1/4 Sahiwal-1/4 Hariana	...	221.1
1/2 Sahiwal-1/2 Hariana	...	108.7
1/2 Red Sindhi-1/2 Hariana	...	90.8

Amble and Jain (1967) substantiated Tandon's finding from Military Dairy Farm data and considered half to 5/8 exotic grades as best.

Agarwala (1968) on limited data from Allahabad Agricultural Institute observed that crossbreds having between 1/2 to 3/4 exotic inheritance yield less than those with 1/2 exotic inheritance. Half-breds of Jersey and Brown Swiss with Red Sindhi did not differ among themselves.

Raj Kumar (1969) reported milk production and other economic traits on Red Sindhi and Jersey grades. He reported that 31 Red Sindhi yielded 1159 kg, 43 Jersey x Red Sindhi gave 1640 kg and 14 Non-descript (Desi) yielded 443 kg of milk whereas 46 Jersey x Desi F_1 1378 kg.

Butterfat Percentage

Lecky (1935) reported that the crossbred progeny of Montgomery bull 'Sahiwal Pusa' in Jamaica had higher butterfat percentage than their dams whereas Pdjakov (1936) found that it was intermediate with a tendency towards lower parents in crossbreds Siberian cattle with East Friesian and Simmentals.

Fohrman et al. (1951) put forward the progress report of the Red Sindhi crossbreeding experiment at Beltsville, Md. They found a range of 5.42-6.77 in butterfat percentage in F_1 crossbreds.

Slight but non-significant increase of butterfat percentage in Jersey x Red Sindhi crossbreds over their purebred Red Sindhi was reported by Stonaker et al. (1953) while Gercikov (1954) found .9 more butterfat percentage in crossbreds than their Friesian x Kholmogor dams when crossed with Jersey bulls. According to Compere (1960) Swiss Brown x Native cattle crossbreds inherited the higher fat percentage of the native cattle.

Horn et al. (1961) studied the performance of Jersey x Hungarian Red Spotted and Jersey x Swiss Brown crosses. They obtained considerably higher butterfat percentage in

crossbreds than those of Hungarian Red Spotted and Swiss Brown.

In crossbreeding experiment of Sahiwal and Guernsey at Kenya, Veterinary Department (1961) reported the following percentage of butterfat in various grades :

1/2 Sahiwal	...	5.4%
3/4 Sahiwal	...	5.4%
7/8 Sahiwal	...	5.6%
15/16 Sahiwal	...	5.5%
Purebred Sahiwal	...	5.1%

In Democratic Republic of Vietnam the average butterfat percentage of Black Pied and Sindhi were 3.4% and 5.31% respectively whereas their hybrids had 4.35% butterfat according to Chang (1966).

MATERIAL AND METHODS

MATERIAL

For the present study, the reproductive and productive records were collected on Kumauni Hill and Afghan breed and on their crosses at various levels of Afghan inheritance, from the Indian Veterinary Research Institute, Mukteswar, District Nainital, Uttar Pradesh, India. These data covered a period of 32 years from 1938 to 1969.

Indian Veterinary Research Institute, Mukteswar is situated in the foot-hills of the Himalayas and lies about 155 kms away from Izatnagar and about 40 kms from Nainital. The altitude of the Dairy Farm is 7146 feet above sea level. The climate is cold with high rain fall. Ambient temperature ranges between -3.1^{o}C in winter to 29.9^{o}C in summer. The average annual rainfall is 52 inches.

A few Kumauni Hill cows and bulls were purchased during 1936-37 at Mukteswar, systematic programme of feeding, management and breeding started in 1938 and at that time the herd had 22 cows and heifers, 4 bull calves and 1 bull.

Even with optimum feeding, management and breeding, the Kumauni Hill cattle were found to be poor milk producers, having short lactations and long dry periods. Cross-breeding

with Afghan breed was therefore taken up since 1940 in order to increase the milk yield per animal. Two lots of Afghan were purchased, the first in 1940 consisting of 10 cows, 4 heifer calves and 4 bull calves. The second lot was purchased in 1948 and had 13 cows, 6 heifer calves, 2 bull calves and 2 stud bulls.

The first generation of Afghan-Hill crossbreds was born in June 1941 and the first one of these whose production record has been studied calved in May 1945. The second grade to Afghan i.e. 3/4 Afghan 1/4 Hill began to be born in October 1949, and the one with production record studied calved in November, 1953. The third grade to Afghan begin to be born in November 1953 and the first one with production record studied calved in July 1957. The total cow population thus available over the years consisted of 43 Kumauni Hill cows, 106 Afghan cows, 41 1/2 Afghan-1/2 Hill cows, 34 3/4 Afghan-1/4 Hill cows and 11 7/8 Afghan-1/8 Hill cows. With these were used 4 Hill bulls and 14 Afghan bulls in that period.

Only the first four lactational records per animal were taken into account. Among the observations on reproductive traits only those from normal breeding and calving had been utilized. Where abortions, dystokia and

other pathological conditions were detected, data on those cases were not included in this study. Animals whose exact date of calving were not known, were also excluded from the study. Milk production and related records were taken on cows with lactations of at least 100 days and all their calves were weaned.

The female stock in this herd is culled on the basis of senility, incurable contagious diseases, incurable breeding disorders and on account of poor yield.

Management and Feeding

Cows were housed in pucca-byres and were milked twice a day, at 6.00 A.M. and at 3.00 P.M. from November to March and at 5.30 A.M. and at 3.00 P.M. from April to October.

Dry stock was shifted to Rithani, which is about 4 kms from Mukteswar farm and at a lower altitude. The heat was detected mannually and followed by a natural service. The animals were let out for grazing in the jungle daily from 10.00 A.M. to 2.00 P.M. The jungle is around one kilometer from the Dairy.

For maintenance adult cows were given green fodder

at the rate of 15 kg per animal per day. From August to November, 540 gm of concentrate mixture was given per animal per day. In winter when green fodder was not available hay or silage was fed. Silage was allowed at the same rate as the green fodder. Contractor's hay, however, was allowed only from November to April at the rate of 5 kg per cow daily. This was supplemented by 540 gm of concentrate mixture per animal per day. During winter when animals could not go out for grazing because of snow, additional hay at the rate of 2½ kg per adult was given and this is called the grazing allowance.

For milk production the animals were given 1 kg of concentrate mixture for every 3 kg of milk yielded. Pregnant animals, after the seventh month of gestation, received 500 gm concentrate mixture additional to meet the requirement of pregnancy.

Concentrate mixture comprised of wheat bran, ground nut cake, maize, gram, barley along with 2% mineral mixture and 1% common salt. It was compounded from ingredients before November 1964. Nandi feed was utilized then upto November 1965. Feed from Hindustan Lever's was used upto July 1967. From June 1968 a mixture containing 53 parts wheat bran, 35 parts ground nut cake and 10 parts maize was being used.

All the ingredients for making up the concentrate mixture were not available always. As an example, since 20th September 1968 only maize and barley were available.

The following characters were included in this study :

(1) Age at first calving in months;
(2) Gestation period in days;
(3) Birth weights in kg of calves;
(4) Service period in days;
(5) Calving interval in days;
(6) Lactation period in days;
(7) Dry period in days;
(8) 301-day's milk yield in a lactation;
(9) Yield per day of calving interval and
(10) Butter fat percentage.

The following breeding groups were included for this purpose :

(1) Hill;
(2) 1/2 Afghan-1/2 Hill;
(3) 3/4 Afghan-1/4 Hill;
(4) 7/8 Afghan-1/8 Hill; and
(5) Afghan.

Statistical Methodology

Standard statistical methods were used for the analyses of the data (Snedecor, 1956).

The model utilized in this study was :

$$Y_{ijk} = g + b_i + L_k + (bL)_{ik} + e_{ijk}$$

Where

Y_{ijk} is the observation on the j^{th} cow in her k^{th} lactation, the cow belongs to the i^{th} breed;

g is the general value of the variable and is unaffected by the variations in breeds or lactations or individuals;

b_i is the effect of the i^{th} breed;

L_k is the effect of the k^{th} lactation;

$(bL)_{ik}$ is the interaction term between k^{th} lactation and i^{th} breed;

e_{ijk} is the error term for ij^{th} cow in her k^{th} lactation.

Based on this model the analysis of variance shown in Table 1 was arrived at.

Table 1

Variation due to	d.f.	S.Sq.	M.Sq.	E.M.Sq.
Breed	(b-1)	$\sum_i \frac{Y^2_{i...}}{n_{i..}} - \frac{Y^2_{....}}{n_{...}}$	MS_B	$\sigma^2_e + K'_1 \sigma^2_{bL} + K_3 \sigma^2_b$
Lactation	(L-1)	$\sum_k \frac{Y^2_{..k}}{n_{..k}} - \frac{Y^2_{....}}{n_{...}}$	MS_L	$\sigma^2_e + K'_1 \sigma^2_{bL} + K_2 \sigma^2_L$
Breed x Lactation	(b-1)(L-1)	$\sum_{ik} \frac{Y^2_{i.k}}{n_{i.k}} - \sum_i \frac{Y^2_{i..}}{n_{i..}} - \sum_k \frac{Y^2_{..k}}{n_{..k}} - \frac{Y^2_{....}}{n_{...}}$	MS_{BL}	$\sigma^2_e + K_1 \sigma^2_{bL}$
Experimental error	n...-bL	$\sum_{ijk} Y^2_{ijk} - \sum_{ik} \frac{Y^2_{i.k}}{n_{i.k}}$	MS_E	σ^2_e
Total	n...-1	$\sum_{ijk} Y^2_{ijk} - \frac{Y^2_{....}}{n_{...}}$		

The estimates of σ^2_b, σ^2_L, σ^2_{bL} and σ^2_e were obtained by substituting the values of Ks in the E.M.Sq. and equating these to percentage.

RESULTS

AGE AT FIRST CALVING

Table 2 presents the averages and variability in age at first calving for the various breeding groups. Average age at first calving for Hill cows was 44.3 months and that for Afghan cows was 42.9 months. Afghan cows were slightly earlier maturing than Hill cows. The half-bred was closer to Afghan type.

Table 2

Average Age at First Calving in Months of Hill, Afghan and Grades of Afghan at Mukteswar

Breeding group	No. of observations	Average	Standard error	C.V. %
Hill	23	44.3	1.8	19
1/2A 1/2 H	39	42.1	0.9	13
3/4A 1/4 H	34	44.3	1.0	13
7/8A 1/8 H	11	40.7	1.8	15
Afghan	79	42.9	0.8	15

The analysis of variance for this trait is presented in Table 3.

Table 3

Analysis of Variance of Age at First Calving in Months of Hill, Afghan and Grades of Afghan at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Breeding groups	4	187.78	46.94	1.08 NS
Within groups	181	7845.90	43.34	
Total	185	8033.68		

NS - Not significant

Breeding groups did not statistically differ in this trait. Only 0.2% of the variation in this trait was attributable to differences among breeding groups.

GESTATION PERIOD

In Table 4 are presented the average gestation periods for the first four lactations of the five breeding groups based on 621 observations. The values have been subdivided according to the sex of the calf as this factor is reported to affect gestation length and are presented in Table 5.

Table 4

Average Gestation Lengths in Days of Hill, Afghan and Grades of Afghan at Mukteswar for the First Four Lactations

Breeding group	First lactation		Second lactation		Third lactation		Fourth lactation		Overall	
	No.	Average	No.	Average	No.	Average	No.	Average	No.	Average
Hill	20	279.9±1.2	34	278.9±0.8	33	279.1±0.9	27	278.6±1.9	114	279.1±0.5
1/2A 1/2H	32	278.7±0.8	31	281.0±1.0	25	279.2±0.9	21	282.3±1.0	109	280.2±0.5
3/4A 1/4H	31	281.5±0.9	25	281.3±1.2	18	281.5±1.0	13	283.7±0.7	87	281.8±0.4
7/8A 1/4H	10	282.6±1.6	9	279.6±1.6	9	280.7±1.6	8	281.8±0.7	36	281.2±0.7
Afghan	76	280.8±0.5	82	282.2±0.6	63	279.7±0.5	54	279.3±0.7	275	280.0±0.3

Table 5

Average Gestation Lengths in Days of Hill, Afghan and Grades of Afghan at Mukteswar in Their First Four Lactations

Breeding groups	First lactation		Second lactation		Third lactation		Fourth lactation		Overall	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Hill	282.6 ±2.2	277.7 ±1.1	279.0 ±1.2	278.8 ±1.2	281.5 ±1.3	277.0 ±1.0	279.2 ±1.2	277.8 ±2.3	280.2 ±0.7 (62)	277.8 ±0.7 (52)
1/2A 1/2H	278.3 ±1.2	279.0 ±1.2	282.6 ±1.3	278.4 ±1.7	279.4 ±1.1	278.8 ±1.8	282.9 ±1.3	280.4 ±2.5	280.9 ±0.7 (66)	279.0 ±0.8 (43)
3/4A 1/4H	282.4 ±1.6	280.4 ±0.9	282.6 ±1.1	280.3 ±1.6	284.4 ±2.7	279.6 ±1.0	284.4 ±1.2	282.0 ±0.7	283.2 ±0.8 (43)	280.3 ±0.6 (44)
7/8A 1/8H	283.2 ±4.1	282.2 ±1.5	279.2 ±2.3	280.0 ±2.2	284.8 ±1.6	277.4 ±1.5	283.3 ±1.2	280.8 ±0.9	282.2 ±1.3 (17)	280.3 ±1.2 (19)
Afghan	281.6 ±0.8	280.0 ±0.7	280.6 ±0.8	279.6 ±0.9	279.4 ±0.8	280.0 ±0.9	279.8 ±0.8	278.6 ±1.3	280.3 ±0.4 (150)	279.6 ±0.4 (125)

In Afghan cows there was hardly any difference in gestation length irrespective of whether the calf being born was male or female. In all other groups the male calves were carried 2 to 3 days longer than the female calf.

The average lengths for the male and female bearing gestations have been presented for the breeding groups in Fig. 1. The grades tended to have longer gestation periods than either of the two pure breeds which were crossed to produce them. The gestation length increased with increasing Afghan inheritance upto 3/4 level and declined thereafter.

In Table 6 is presented the analysis of variance of this trait. Sex differences were highly significant statistically. Even breeding groups differed significantly in this trait.

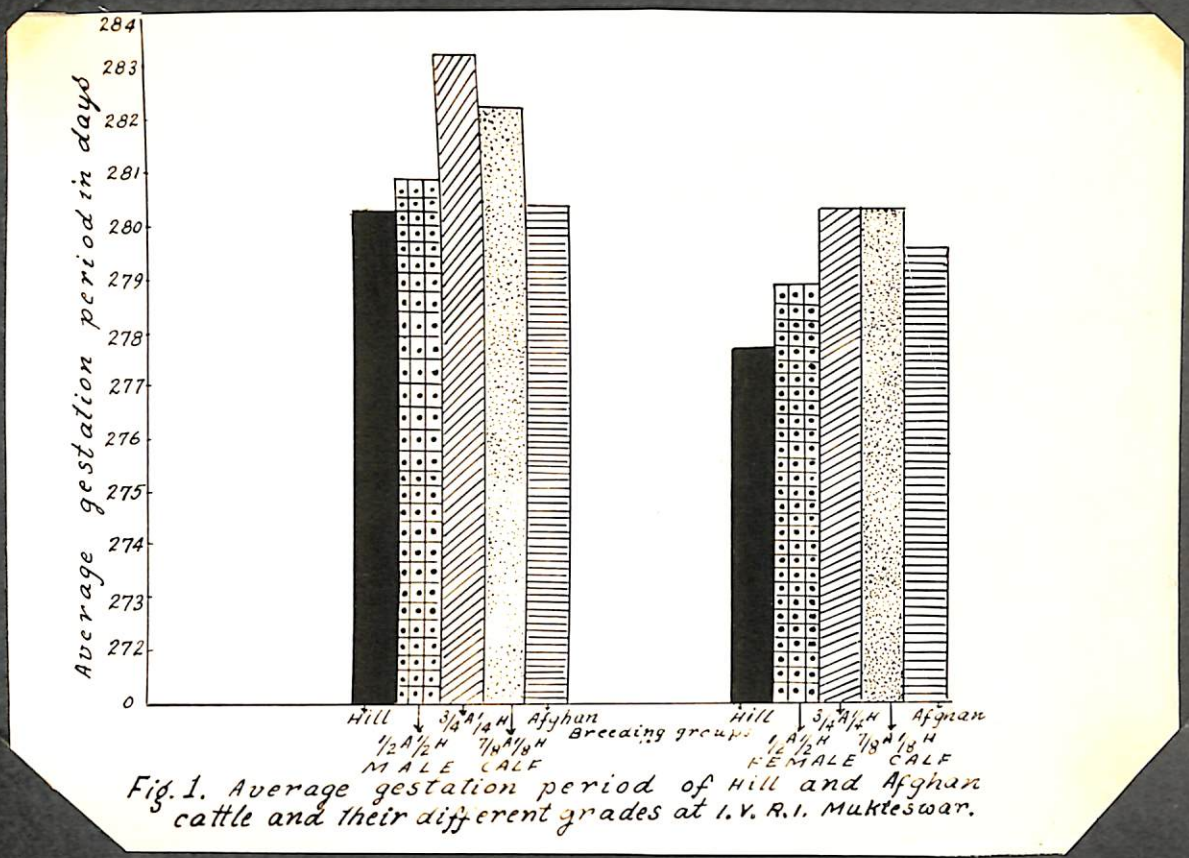


Fig. 1. Average gestation period of Hill and Afghan cattle and their different grades at I.V.R.I. Mukteswar.

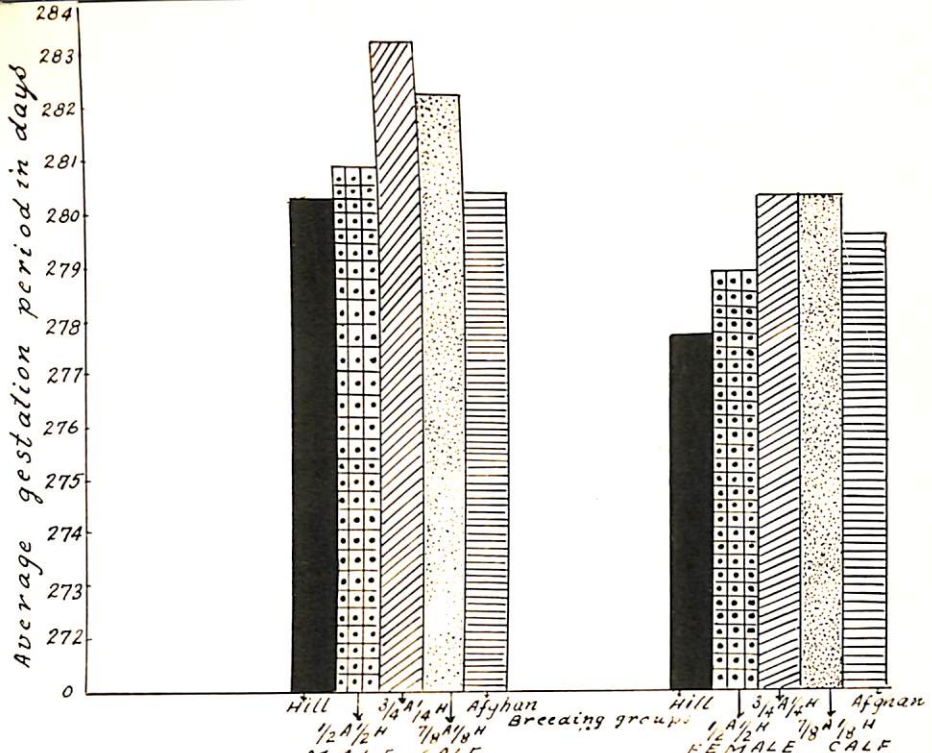


Fig. 1. Average gestation period of Hill and Afghan cattle and their different grades at I.V.R.I. Mukteswar.

Table 6

Analysis of Variance of Gestation Length in Days of Hill, Afghan and Grades at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeding groups	4	393.4	98.35	4.206**
Among lactations	3	47.7	15.90	0.680 NS
Between sex	1	385.5	385.50	16.480**
Breed x lactation	12	373.0	31.08	1.320 NS
Breed x sex	4	138.2	34.55	1.480 NS
Lactation x sex	3	20.7	6.90	0.295 NS
Breed x lactation x sex	12	859.8	71.65	3.065*
Error	581	13588.6	23.38	

* Significant at 5 per cent level
** Significant at 1 per cent level
NS - Not significant

BIRTH WEIGHT OF CALVES

Table 7 presents the average birth weight of 463 male and 385 female calves of these five breeding groups whereas the analysis of variance of this trait is presented in Table 8.

Table 7

Average Birth Weight in kg of Calves of Hill, Afghan and Their Grades at Mukteswar

Breeding group	Male			Female		
	No.	Average	C.V. %	No.	Average	C.V. %
Hill	16	11.8±0.4	13	18	10.7±0.4	16
1/2A 1/2H	86	11.1±0.2	13	65	10.7±0.2	12
3/4A 1/4H	90	11.0±0.2	15	69	11.0±0.2	13
7/8A 1/8H	54	11.9±0.3	19	53	11.9±0.3	21
Afghan	217	12.4±0.2	18	180	11.6±0.2	17

Table 8

Analysis of Variance of Birth Weight in kg of Calves of Hill, Afghan and Grades at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeding group	4	207.46	51.86	0.539 NS
Between sex	1	42.50	42.50	0.442 NS
Breed x sex	4	30.87	7.72	0.080 NS
Error	838	80502.26	96.06	

NS - Not significant

Both Hill and Afghan cows produced male calves of about 12 kg at birth. However, all the grades among them except 7/8A 1/8H had smaller calves. Among female calves however birth weight gradually increased as Afghan inheritance increased. None of these differences were, however, statistically significant.

SERVICE PERIOD

Average service period in days for 517 observations according to breeding groups and to the lactational sequence of the cows is presented in Table 9. These have also been represented graphically in Fig. 2.

The average service period of Afghan cows was longer than that of Hill cows. The half-bred was slightly higher than midway. 7/8A 1/8H with relatively small number of observations showed average service period much smaller than either of the two parental breeds. The range of average service period was, thus between 126 days for Hill to 142 days for Afghan. The 3/4A 1/4H was usually high and 7/8A-1/8H rather low.

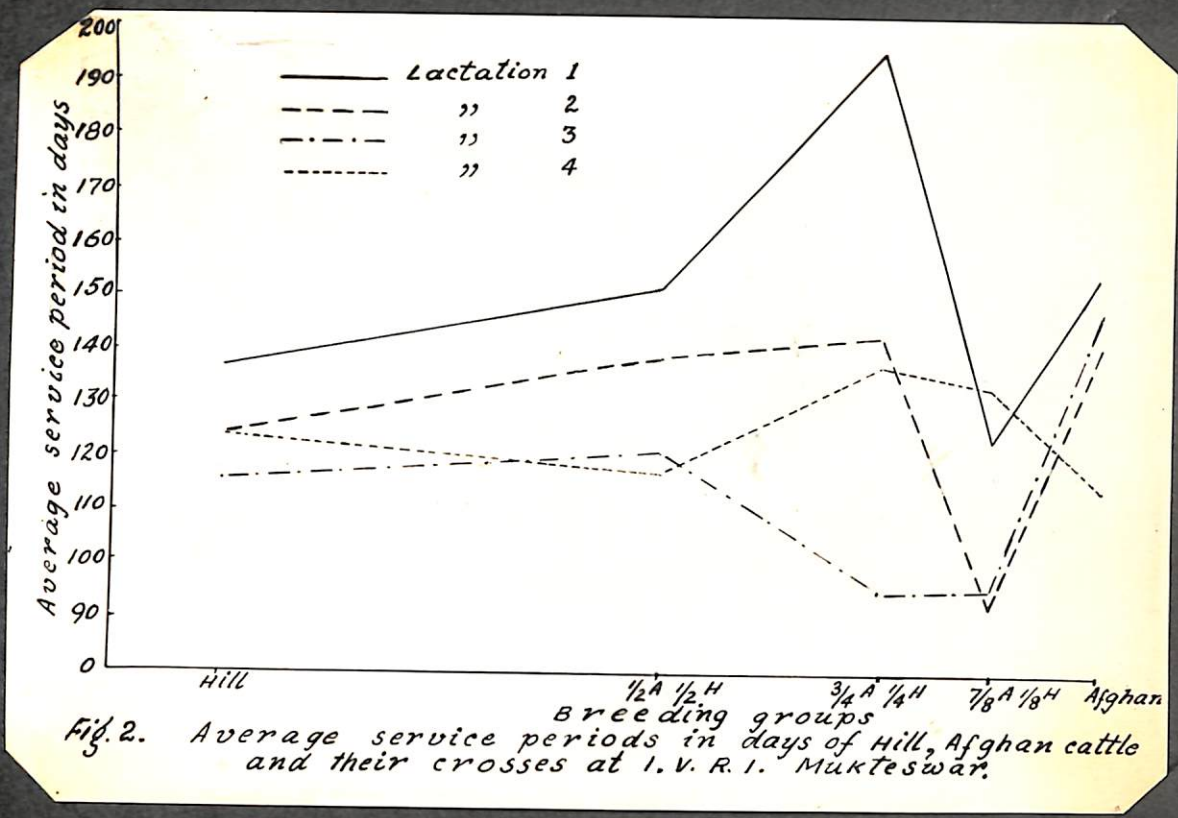
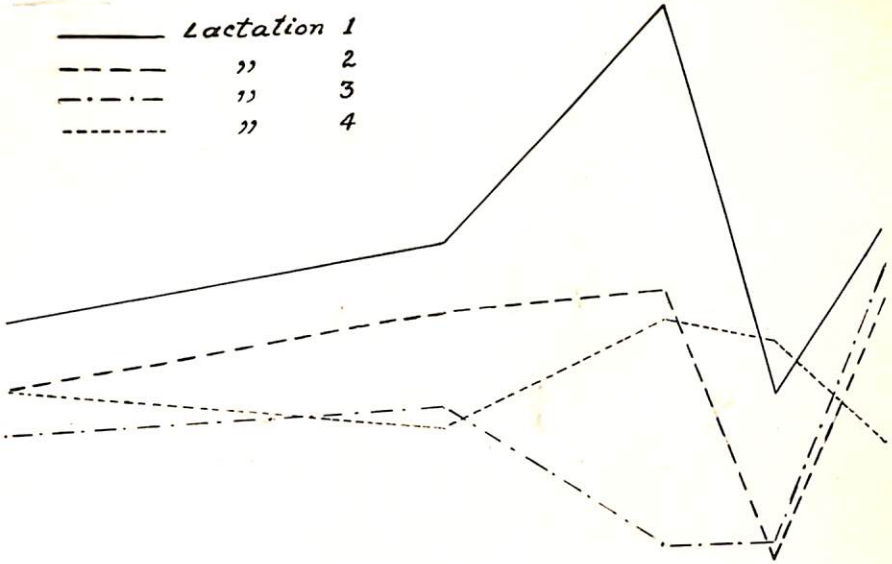


Fig. 2. Average service periods in days of Hill, Afghan cattle and their crosses at I. V. R. I. Mukteswar.


Lactation 1
" 2
" 3
" 4

The analysis of variance for this trait has been presented in Table 10. Differences in service periods among lactations were highly significant statistically. Upto the third lactation the service period declined. Differences among breeding groups were negligibly small. Since interaction between breeding groups and lactational sequence was statistically non-significant, the corresponding sum of squares was pooled with error sum of squares and a joint mean square worked out. Using this, it was observed that, breeding groups accounted for only 1.3% of the total variability in service periods, lactational sequence was associated with 3% of the total variability, leaving 96% of the variability in this trait to factors other than these two.

Table 10

Analysis of Variance of Service Period in Days for Hill, Afghan and Grades at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeding group	4	57016.2	14254.05	2.247 NS
Among lactation	3	94482.3	31494.10	4.900**
Breed x lactation	12	74966.5	6247.20	0.980 NS
Error	497	3162753.7	6343.56	

** Significant at 1 per cent level
NS - Not significant

CALVING INTERVAL

A total of 578 observations was available on the calving intervals of Hill, Afghans and of its various grades. Since there was a highly significant difference among service periods in different lactations, Table 11 presents the average calving intervals in days for the first four lactations of the five breeding groups.

These values have also been represented diagramatically in Fig. 3. In all breeding groups, except the Afghan, calving interval decreased as the cows advanced in age at least upto the third lactation. Calving interval was only 396 days in Hill cows whereas in Afghan cows and grades of Afghan it was of the order of 418 days i.e. about 22 days longer. Only 7/8A 1/8H did not fit into this pattern but that may be because of small number of observations on it.

Analysis of variance of this trait has been presented in Table 12.

Differences among breeding groups were statistically not significant but those among lactations were highly significant. Breeding groups accounted for only 0.6% of total variability in calving intervals whereas lactational sequences were associated with 2.1% of total variability, the remaining 97.3% being unaccounted for due to other uncontrolled factors. Heritability of this trait seems to be very low.

Table 11

Average Calving Intervals in Days of Hill, Afghan and Grades of Afghan at Mukteswar in Their First Four Lactations

Breeding groups	First lactation			Second lactation			Third lactation			Fourth lactation			Overall		
	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %
Hill	38	402±13	20	34	390±13	19	28	396±12	16	21	392±17	20	121	396±7	18
1/2A 1/2H	33	443±16	20	26	414±17	21	26	392±14	18	20	403±22	24	105	416±9	21
3/4A 1/4H	27	467±21	22	22	404±15	17	16	382±15	16	13	390±23	21	78	419±10	21
7/8A 1/8H	11	402±21	17	10	368±18	15	7	359±16	11	6	469±50	25	46	395±14	20
Afghan	72	429±11	22	66	418±11	20	56	424±13	23	46	395±10	17	240	418±6	21

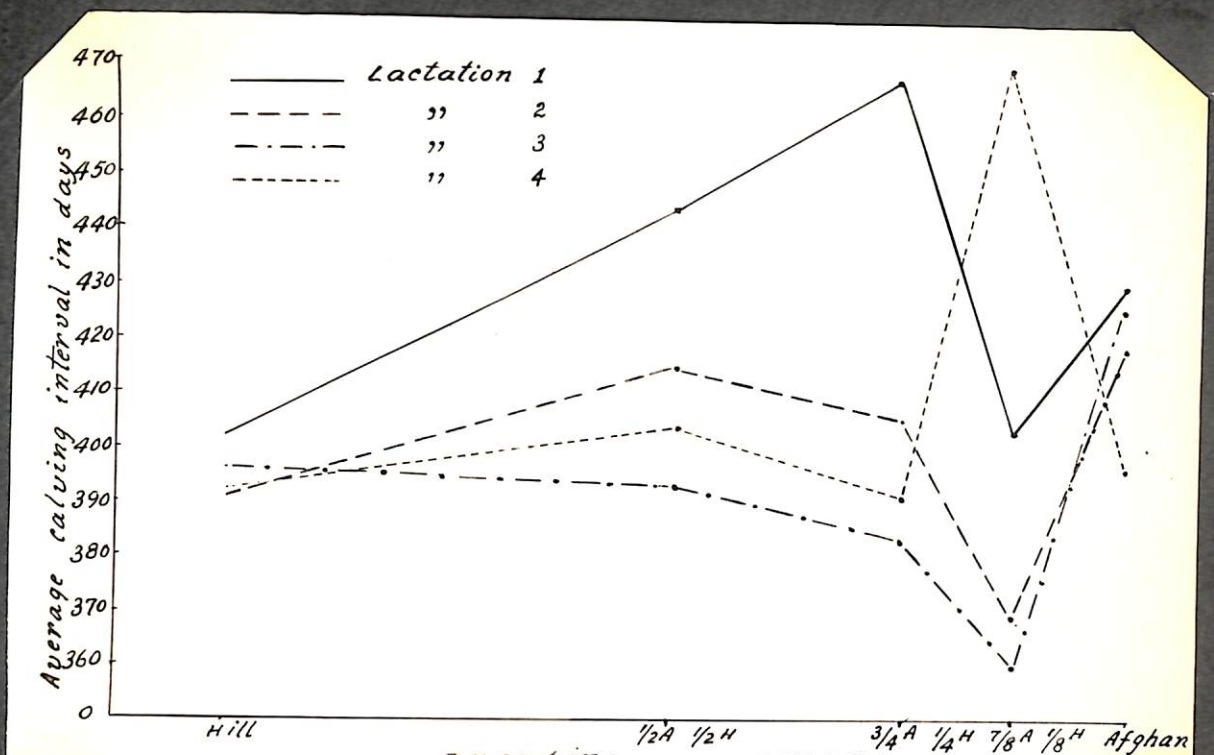


Fig. 3. Average calving intervals in days of Hill, Afghan cattle and their crosses at I.V.R.I. Mukteswar.

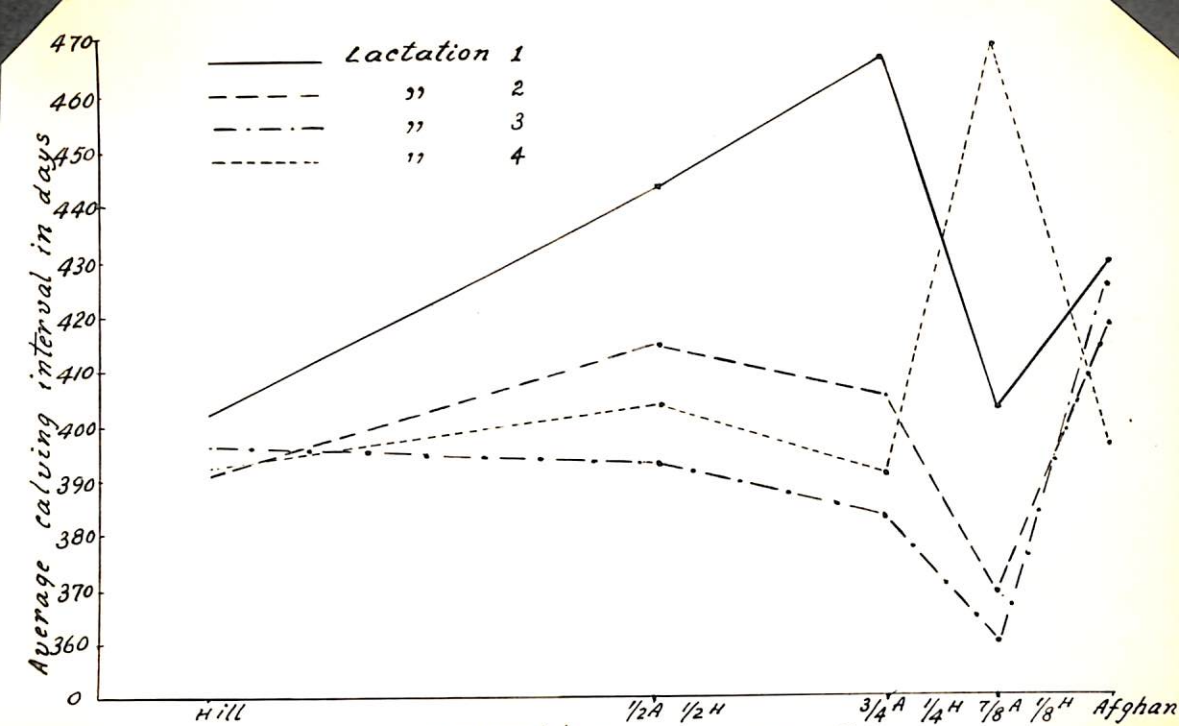


Fig. 3. Average calving intervals in days of Hill, Afghan cattle and their crosses at I.V.R.I. Mukteswar.

Table 12

Analysis of Variance of Calving Interval in Days for Hill, Afghan and Grades of Afghan at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeding group	4	56399.7	14099.92	1.894 NS
Among lactations	3	90083.4	30027.80	4.034**
Breed x lactation	12	25282.2	6070.55	0.815 NS
Error	558	4153230.8	7443.07	

** Significant at 1 per cent level
NS - Not significant

LACTATION PERIOD

Milk production depends upon the duration over which a cow is able to prolong her lactation within certain limits. This duration tends to vary with the age of a cow in certain breeds. Consequently average lactation periods in days for the five breeding groups were calculated for each of the first four lactations. These results of the total of 534 lactation period are presented in Table 13. The same values have been diagramatically presented in Fig. 4.

Table 13

Average Lactation Period in Days of Hill, Afghan and Grades at Mukteswar in Their First Four Lactations

Breeding group	First lactation			Second lactation			Third lactation			Fourth lactation			Overall		
	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %
Hill	19	221±18	36	24	224±17	37	19	201±14	31	13	227±25	39	75	218±9	35
1/2A 1/2H	29	265±15	31	27	241±16	33	19	266±20	32	19	277±15	23	94	261±8	31
3/4A 1/4H	26	260±21	41	21	247±19	35	17	252±16	25	13	265±26	35	77	256±10	35
7/8A 1/8H	10	268±33	39	11	214±20	31	8	264±20	21	6	316±44	33	35	258±15	34
Afghan	76	289±8	25	72	286±10	31	58	277±11	29	47	281±8	20	253	284±5	27

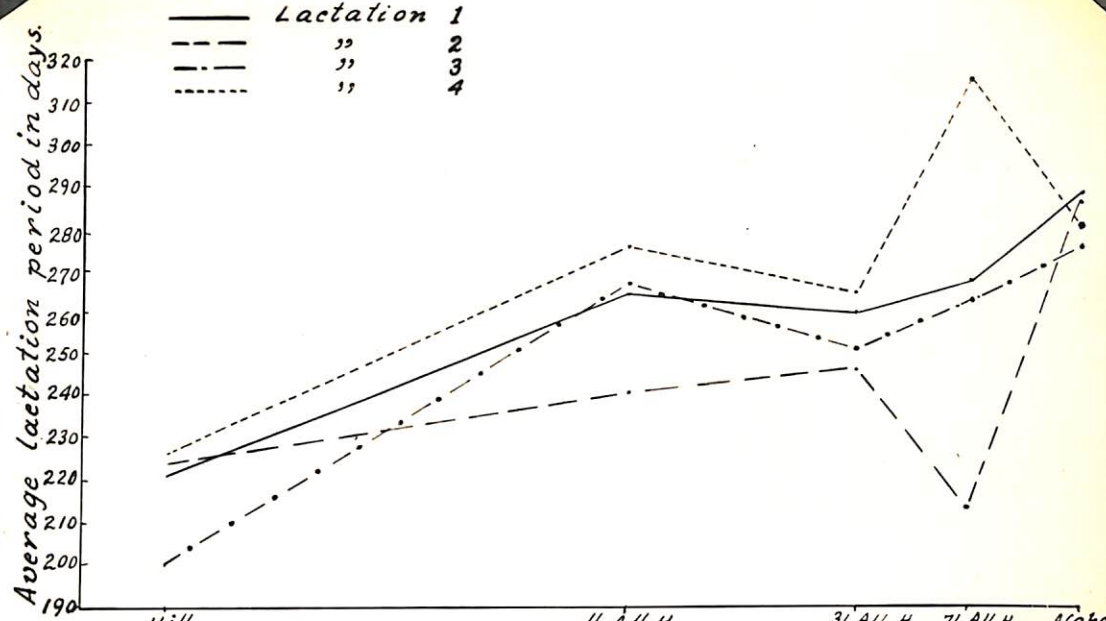


Fig. 4. Average lactation period in days of Hill, Afghan cattle and their crosses at I. V. R. I. Mukteswar.

Hill cows had an average lactation length of only 218 days whereas Afghans had it of 284 days. Half-breds as well as other grades were about mid-way between these two breeds. Fourth lactation was slightly longer than others in all breeding groups but no clear cut trend of lactational sequence on each breeding groups was indicated.

Analysis of variance of this trait is presented in Table 14. Differences among breeding groups were statistically highly significant but not those among lactational sequences. Even the interaction was non-significant statistically.

Table 14

Analysis of Variance of Lactation Period in Days for Hill, Afghan and Grades at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeding groups	4	266235.3	66558.82	10.288**
Among lactations	3	23103.3	7701.10	1.190 NS
Breed x lactation	12	54009.2	4500.76	0.695 NS
Error	514	3325204.6	6469.26	

** Significant at 1 per cent level
NS - Not significant

Breeding groups accounted for 9% of total variability whereas lactational sequences only 1.4%. Nearly 90% of the variation could not be accounted for by these two factors.

DRY PERIOD

A total of 484 observations was available on this trait. Since differences among lactations in the calving interval were observed to be statistically highly significant and as dry period is one of the two components of the calving interval, it was felt that these may differ from lactation to lactation within same animal. Hence the averages for the five breeding groups for this trait for the first four lactations of the cows are presented in Table 15. These values have also been shown diagramatically in Fig. 5.

Dry period was longest for Hill cows, being on an average, of the order of 181 days. Afghan cows remained dry on an average only for 137 days, half-breds and three fourth were closer to Afghan than to Hill cows. No noticeable change occurred as inheritance increased over 1/2 Afghan level. In nearly all breeding groups dry period decreased upto the third lactation as cows advanced in their lactational sequence.

Table 15

Average Dry Periods in Days for Hill, Afghan and Grade Cattle at Mukteswar Following Their First Four Lactations

Breeding group	First lactation			Second lactation			Third lactation			Fourth lactation			Overall		
	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %
Hill	19	187±26	59	21	173±21	55	17	176±17	41	13	190±34	62	70	181±12	54
1/2A 1/2H	25	193±23	60	23	146±20	65	18	127±14	46	17	125±14	46	83	152±10	61
3/4A 1/4H	25	205±22	53	19	141±19	58	14	120±20	61	10	109±9	26	68	156±11	60
7/8A 1/8H	10	142±21	47	10	144±23	51	7	55±3	12	5	101±11	24	32	118±12	55
Afghan	70	151±12	68	63	137±12	71	55	139±14	74	43	113±12	66	231	137±6	70

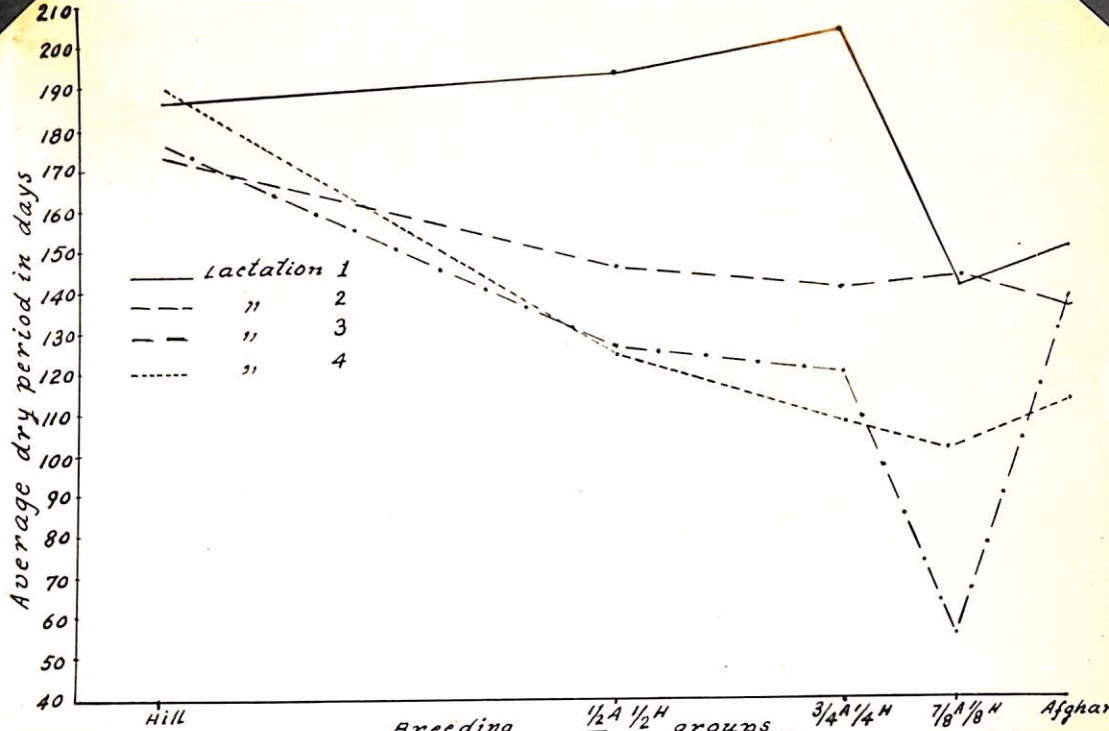


Fig. 5. Average dry period in days of Hill, Afghan cattle and their crosses at I.V.R.I. Mukteswar.

Analysis of variance of this trait has been presented in Table 16. Differences among breeding groups as also among lactational sequences were statistically significant whereas the interaction among them was non-significant. Breeding groups as well as lactational sequence were about equally important in controlling the variability in this trait. Their actual contribution in this study was 3.2% and 3.5% respectively. Thus over 93% of the variation still remained unaccounted for.

Table 16

Analysis of Variance of Dry Period in Days for Hill, Afghan and its Crosses at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeds	4	136534.0	34133.50	3.922**
Among lactations	3	142007.8	47335.93	5.430**
Breed x lactation	12	111583.8	9298.65	1.068 NS
Error	464	4038007.4	8702.60	

** Significant at 1 per cent level
NS - Not significant

LACTATIONAL MILK PRODUCTION

The crossbreeding between Afghan and Hill cattle was undertaken with a view to increasing the milk production per cow. Among all breeds, it is well known, that the lactational yield increases upto a certain age and may remain at the same level for some time or may begin to decline thereafter. With this objective in view the lactational yield of these breeding groups were studied separately for the first four lactations. The results on 534 lactations are presented in Table 17 and these have also been presented diagramatically in Fig. 6.

Lactations had been taken as standard at 301 days. Lactations shorter than 100 days were not included in this study and those more than this but less than 301 days were taken to be as though they were of 301 days with zero yields in period when milk secretion ceased. In other words no correction for length of lactation was made in this study. Since data were not large, such correction factors could not be evolved from this study. Similarly no correction was made for the age of the cow other than through her lactational sequence.

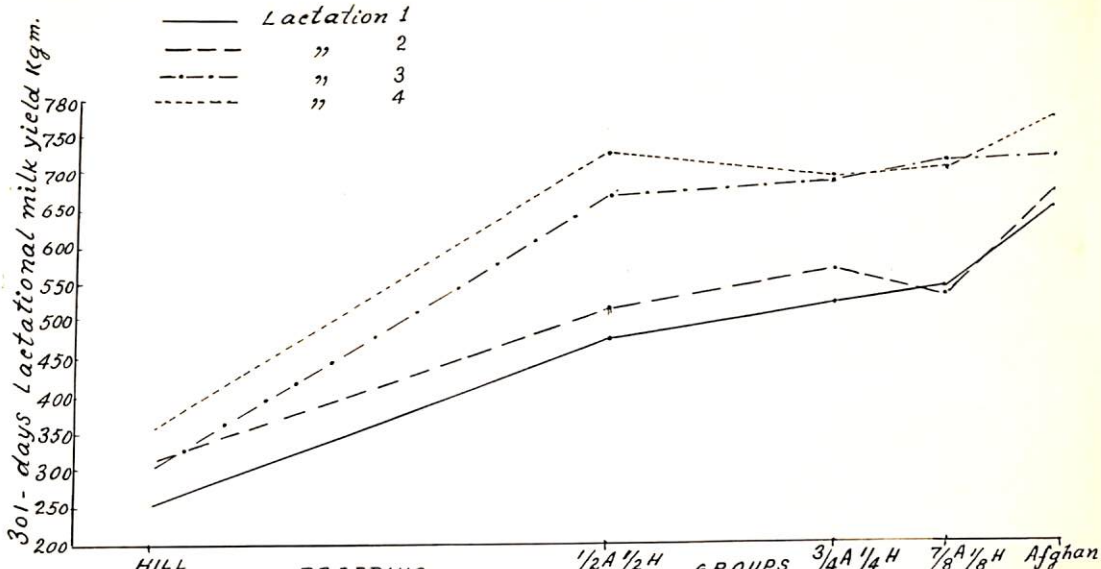


Fig. 6. Average 301 days lactational milk yield in Kgm by Hill, Afghan crosees at I.V.R.I Muktesuar.

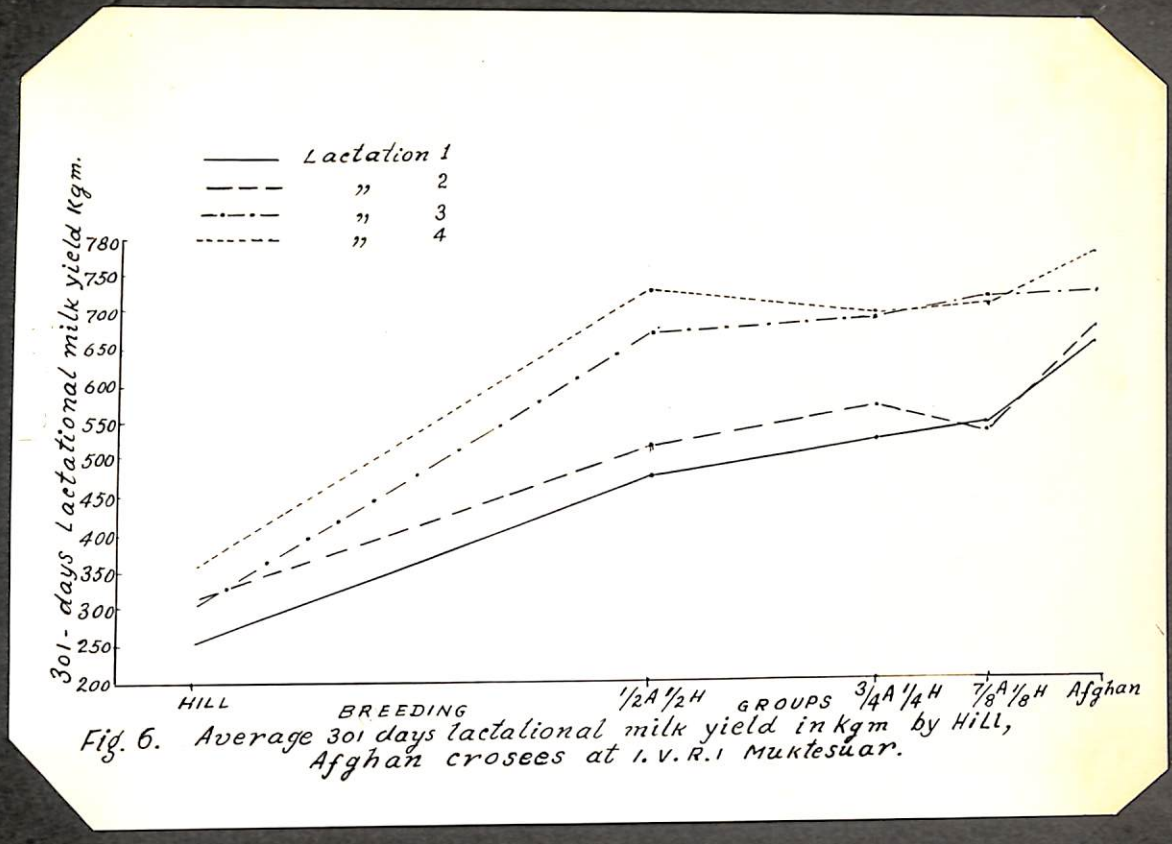


Fig. 6. Average 301 days lactational milk yield in kgm by Hill, Afghan crosees at I.V.R.I Mukteswar.

Hill cows on an average, over 75 lactational records, yielded 304 kg of milk. Afghan cows in the same environment and under same management yielded 704 kg i.e. 230% of that yielded by Hill cows or a 2.3 folds increase. The half-breds yielded more than the average yield of the two purebreds. There was slight increase in milk yield per lactation as Afghan inheritance increased over 1/2 upto 3/4. Additional Afghan inheritance did not exhibit any improvement in milk production. This suggests that in even hilly areas of India where climate is temperate, the halfbreds, or grades upto 3/4th Afghan exhibit maximum milk production per lactation.

All breeding groups showed an increase in their yield as lactational sequence advanced upto the fourth. Hill cows reached their peak in the second lactation. Half-breds showed the maximum increase from their first lactation to the fourth, the average yields being 482 kg and 734 kg respectively. 3/4 Afghan also exhibited an increase but most of it took place from the second to the third lactation. With small numbers for 7/8A-1/8H, clear cut and dependable trend can not be observed.

Over the first four lactations, on the basis of the total average lactational yields, Hill cows would have

yielded 1233 kg of milk whereas 1/2A-1/2H would have yielded during similar four lactations 2403 kg of milk i.e. nearly a 100% increase over that of Hill cows. The 3/4A-1/4H and 7/8A-1/8H would have correspondingly yielded 2499 kg and 2477 kg of milk whereas pure Afghan's yield would have been 2851 kg of milk.

Analysis of variance of this trait has been presented in Table 18. Interaction between breeding groups and lactational sequences was statistically not significant but differences among breeding groups as well as among lactational sequences were statistically highly significant. Breeding groups were associated with 30% and lactational sequence with 5% of the total variability in this trait. Thus more than one third of the total variability in this trait is accountable by only these two factors.

Table 18

Analysis of Variance of 301 Day Lactational Milk Yield in kg of Hill, Afghan and Their Crosses at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeds	4	9333711.9	2333427.9	43.90**
Among lactations	3	1713983.6	571327.8	10.70**
Breed x lactation	12	467825.3	38985.4	0.73 NS
Error	514	27288327.1	53090.1	

** Significant at 1 per cent level
NS - Not significant

(Service period + gestation period) or (lactational period + dry period) each equal to the calving interval. A more useful measure of a cow's producing ability would be her average daily yield over her calving interval. This will be indirectly affected by the differences in all those four periods (as calving interval incorporates all these four periods).

Accordingly these values were calculated and have been diagramatically represented in Fig. 7.

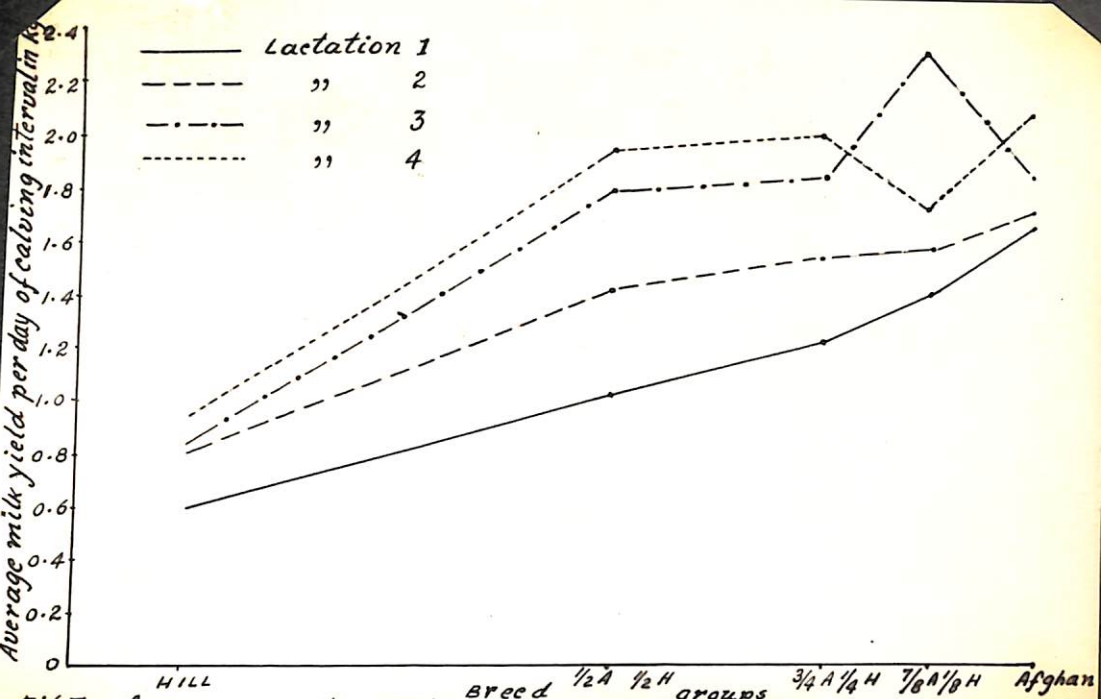


Fig. 7. Average milk yield in kgm per day of calving interval in Hill, Afghan cattle and their crosses at I.V.R.I. Mukteswar

The increase is very marked from Hill to 1/2A-1/2H level. Thereafter the increase is very slight. Whereas the Hill cows yield, on an average, 0.8 kg of milk per day of their first four calving intervals and Afghan cows yield 1.8 kg, the half-breds between these two breeds yield 1.6 kg. As Afghan inheritance increased this yield also gradually increased.

Half-bred cows showed an increase of 80% in their average yield per day of calving interval, from the first to the fourth lactation, while Afghan cows had only a 20% increase. These findings have been further substantiated by analysis of variance of this trait which has been presented in Table 19. Breeding groups, lactational sequences as well as interaction between these two were all statistically significant.

Table 19

Analysis of Variance of Average Milk Yield Per Day of Calving Interval of Hill, Afghan and Their Crosses at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeds	4	30.64	7.66	19.26**
Among lactation	3	18.09	6.03	15.16**
Breed x lactation	12	33.08	2.75	6.914**
Error	462	183.75	0.398	

** Significant at 1 per cent level

BUTTER FAT PERCENTAGE

A total of 463 observations was available on this trait. With an increase in lactational milk yield, with subsequent lactations, and as a negative correlation coefficient has been generally reported between butter fat percentage and milk yield, it was considered useful to examine this trait also separately for the first four lactations. The findings have been summarised in Table 20 and presented also graphically in Fig. 8.

Table 20

Average Butter Fat Percentage in Milk of Hill Cows, Afghan Cows and of Crosses Between These Breeds at Mukteswar

Breeding group	First lactation			Second lactation			Third lactation			Fourth lactation			Overall		
	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %	No.	Average	C.V. %
Hill	19	5.73±0.20	14	18	5.68±0.20	14	16	5.70±0.18	13	13	5.65±0.27	16	66	5.69±0.10	14
1/2A 1/2H	24	5.27±0.21	19	20	4.77±0.18	16	19	5.00±0.23	20	18	5.08±0.20	16	81	5.04±0.10	18
3/4A 1/4H	18	4.73±0.28	25	14	4.37±0.26	22	15	4.74±0.18	14	11	4.19±0.22	17	58	4.54±0.12	6
7/8A 1/8H	9	4.30±0.27	18	10	4.16±0.31	23	6	4.71±0.24	14	4	4.87±0.80	34	29	4.42±0.18	19
Afghan	70	4.29±0.08	14	66	4.26±0.07	13	51	4.21±0.11	18	42	4.43±0.10	15	229	4.33±0.04	14

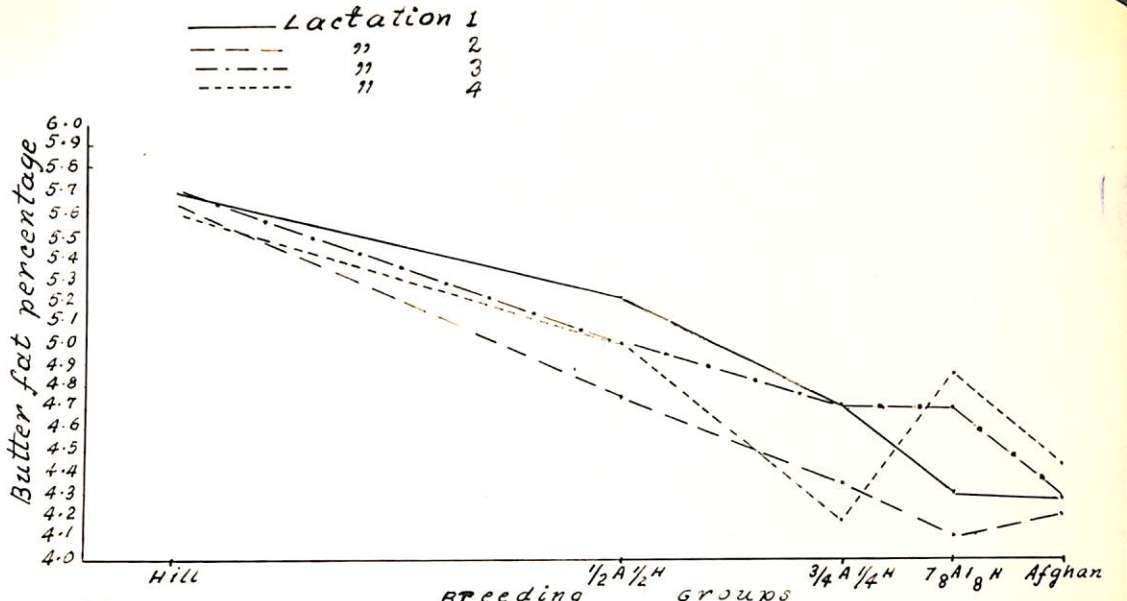


Fig. 8. Average butter fat percentage in months of Hill cows and Afghan cows and their crosses between these two breeds at I.V.R.I. Mukteswar.

Hill cows have a butter fat percentage of 5.69 with very small variation from lactation to lactation. Afghan cows yield milk with only 4.33% butter fat. Half-breds were nearly mid-way between these two breeds. Almost linearly, the butter fat percentage, decreased as Afghan inheritance increased. Lactational differences did not follow any definite trend in the breeding groups.

The analysis of variance for this trait has been presented in Table 21. Differences among lactational sequences or due to interaction between breeding group and lactational sequence were statistically not significant. The differences among the breeding groups were highly significant and they accounted for nearly 31% on the total variability, whereas lactational sequences could control about 14% variability thus 55% of the variability in this trait still remained unaccounted for.

Table 21

Analysis of Variance of Butter Fat Percentage in Milk of Hill Cows, Afghan Cows and Crosses Between These Breeds at Mukteswar

Source	d.f.	S.Sq.	M.Sq.	F
Among breeds	4	116.02	29.0100	44.52**
Among lactations	3	2.51	0.8360	1.283 NS
Breed x lactation	12	6.72	0.5600	0.859 NS
Error	443	288.65	0.6515	

** Significant at 1 per cent level
NS - Not significant

DISCUSSION

AGE AT FIRST CALVING

Kumauni Hill breed is not an established breed of India, it is considered to belong to non-descript category. These Hill cows are late maturing and poor producers of milk. Very little information is available on these cattle.

Tandon (1951) studying the Friesian crosses with Red Sindhi and with Sahiwals reported that age at first calving decreased at a diminishing rate with increasing Friesian blood and found that early maturity of Friesians was dominant over late maturity of the Red Sindhi and Sahiwal breeds. Similarly with Ayrshire, Sen et al. (1953) observed a lower age at first calving in half-breds and in 3/4 Ayrshire than the indigenous stock crossed with Ayrshire. Raj Kumar (1969) also reported an earlier age at first calving in Jersey-Red Sindhi crosses than in Red Sindhis and thus confirmed the findings of Tandon (1951).

McDowell et al. (1959) reported the lengthening of age at first calving with the increasing amount of Sindhi inheritance in crossbreds with varying amounts of Red Sindhi and Jersey breeding. Similarly Dhandapani (1962) observed an increase of age at first calving from 26.6 to 38.8 months when crossbreds were using imported Jersey cows with Red Sindhi

bulls as also when crossbreds were bred back at Madras Race Club.

In the present investigation age at first calving of Kumauni Hill cattle averaged 44.3 ± 1.8 months with a coefficient of variation of 19%. This is similar to what has been reported for other tropical breeds by many workers in India as well as outside. The average age at first calving of Afghan cattle was found to be 42.9 ± 0.8 months. Half-breds averaged 42.1 ± 13 months resembling Afghan breed in this trait. This indicates that there is complete dominance of genes for early maturity from Afghan over those for late maturity in Hill breed. This is in agreement with the findings of Tandon (1951), Mathur (1963) and Raj Kumar (1969).

Second grades i.e. 3/4 Afghan-1/4 Hill first calved at 44.3 ± 1.0 months (coefficient of variation 13%) resembling Hill breed even though Afghan inheritance was more than half. This indicates that environment and management may markedly affect this trait.

Average age at first calving in 7/8 Afghan-1/8 Hill was only 40.7 ± 1.8 months (with coefficient of variation 15%) which is less than even in the Afghan cattle. As the number of observations in this group was very small not much importance

need be attached to this finding.

Armour et al. (1961) studying the performance of White Fulani and Friesian cattle in Nigeria reported that the age at first calving averaged 33 months for the cross-breds and 50 months for the White Fulani. Mahadevan and Hutchison (1964) in Tanganyika concluded that average age at first calving was 39.9 months in Zebus (with a coefficient of variation of 12%) as against 37.4 months (with coefficient of variation of 14%) for crosses.

Naidu and Desai had found that age at first calving was affected significantly by the amount of Friesian blood in the South while Bhasin and Desai (1967) reported the range of age at first calving from 39.8 months in 1/2 Friesian-1/2 Sahiwal to 46.5 months in 1/4 Friesian-3/4 Hariana. Seven types of crossbreds between Friesian and three indigenous breeds were studied.

Asker et al. (1966) reported the average ages at first calving of Friesian, 1/2 Friesian, 3/4 Friesian and native cattle as 34.3, 35.7, 38.5 and 44.9 months while that of Ayrshire and Ayrshire crossbred averaged 35.2 and 39.5 months respectively.

Statistically no significant difference was found

between breeding groups and only 0.2% of the variation in this trait was associated with breed differences.

This trait, it seems can be further reduced by better managerial practices.

GESTATION PERIOD

The gestation period of Kumauni Hill cattle over both sexes of the calves averaged 279.1 days. The gestation period for Indian breeds in the plains is generally higher. Tandon (1949) reported that the average gestation period in Red Sindhis was as 286 days whereas Rigor and Nelmida (1959) found that the gestation period of Red Sindhi at Tarlac Breeding Centre averaged 270.8 ± 0.9 days. While Bawa and Gulati (1960) reported the gestation period of Non-descript indigenous hill cattle when that were inseminated with Jersey semen averaged 276 ± 0.6 days. This is much shorter than what is generally accepted for Indian breeds. Gestation period in Afghan cattle averaged 280 days. This was only 0.9 days longer than that of the Hill cattle. Half-breds had longer gestation periods than Hill cattle and even longer than Afghan cattle. Contrary to this Tandon (1949) reported that half-bred Jersey-Red Sindhi calves were carried for 9.6 days less. Rigor and Nelmida (1959) reported that the gestation period of Jersey-Red Sindhi crossbred cows was 1.2

days shorter than that of the Red Sindhis. The gestation period of 3/4 Afghan-1/4 Hill and of 7/8 Afghan-1/8 Hill averaged 281.8 and 281.2 days, respectively.

McDowell et al. (1959) reported the lengthening of gestation periods with the increasing amount of Sindhi inheritance. Narayankutty and Vemigopalan (1962) concluded that the gestation period of Sindhi crossbred calves was on an average 5.2 days longer than for Jersey crossbred.

In this study the differences between sexes were highly significant in all other groups except in the Afghans. The male calves were carried 2 to 3 days longer during gestation than were the females. This is in agreement with the findings of Tandon (1949) who reported that males required a gestation length 2 to 3 days longer than did the females.

Bawa and Gulati (1960), however, found no significant difference in the mean gestation period for male and female calves in the non-descript indigenous Hill cattle when these were inseminated with Jersey semen.

The gestation periods of cattle in the temperate zone is shorter than that of the cattle in the tropical zone. Tandon (1949) found 286 days as the gestation period of Red Sindhi at Allahabad. For the same breed it was 270.8

days at Tarlac Breeding Centre. The temperate climate of the Hill might result in shorter gestation periods. This was found in Kumauni Hill cattle as well as in Afghan cattle. Longer gestation periods of crossbreds merit further study to ascertain the genetic and physiological mechanism involved.

BIRTH WEIGHT

Guzder (1952) reported that the birth weights of Brown Swiss-Red Sindhi crossbreds averaged 21.4 kg whereas those of Red Sindhi averaged only 18.2 kg.

Naidu and Desai (1965, 1966) also found that the average birth weight of the crossbred calves was highest when they had between 12/32 and 19/32 Friesian inheritance. Males were found to be heavier at birth than the females. Taylor (1954) however observed that the average birth weight of 1/2 Holstein-1/2 Red Sindhi calves was only 19.8 ± 0.8 kg whereas that of Red Sindhi's was 22.9 ± 0.8 kg.

Roy and Goswami (1960) studied the birth weights of Zebu-Friesian crossbreds at Mhow. They concluded that the average birth weight of calves with less than 50% Friesian inheritance was 28.1 ± 0.4 kg as against 28.3 ± 0.4 kg for calves with more than 50% Friesian inheritance.

In the present study the average birth weights of calves

of Kumauni Hill breed was only 11.0 kg and that of Afghan breed was 12.0 kg. On an average half-breds were found only 0.3 kg less at birth than Hill cattle whereas 3/4 Afghan grades were 0.2 kg heavier and 7/8 Afghan 0.7 kg heavier than in the Hill breed.

Statistically no significant difference was found from breed to breed as well as among the two sexes.

Both breeds crossed have about equal birth weights as such the crossbreds were also intermediate between the two, halfbreds being slightly smaller, possibly due to sampling error and other grades tending to come closer to Afghan as Afghan inheritance increased.

SERVICE PERIOD

On the basis of first four lactational records in the present study, the service periods averaged 126 days with a coefficient of variation of 60% for Kumauni Hill cattle and in Afghan cattle it averaged 142 days with a coefficient of variation of 59%. Half-breds were slightly higher than the midway between the two purebreds than average service period equalled 135 days. The 3/4 breds exceeded Afghan breed by 10 days. On the other hand, the 7/8 Afghans had much shorter service periods. This is in agreement with the

findings of Asker et al. (1966) in Iraq who reported that the service periods of Friesian, 1/2 Friesian, 3/4 Friesian, and local cattle averaged as 112, 179, 224 and 103 days respectively and that of Ayrshire and Ayrshire crosses was 140 and 175 days respectively. Contrary to this Sen et al. (1953) reported that the service period of Ayrshire cross-breds was shorter than those of Harianas, Sahiwals, and Red Sindhis at Bangalore. Similarly Howe (1946) in Jamaica and Abdel Ghani and Fahmy (1966) reported shorter service periods of half-breds.

In the first and second service periods, half-breds were closer to Afghans while in the third and fourth these were below the midpoint of the two breeds crossed. However, on an average breeding group differences were statistically non-significant. Though the differences among lactations were highly significant in service period, the average service period in the different lactations did not follow any clear cut trend.

CALVING INTERVAL

Calving interval in Kumauni Hill cattle averaged over their first four lactations, was 396 days, with a coefficient of variation of 18% and in Afghan cattle it was 418 days with a coefficient of variation of 21%. Half-breds had an average

calving interval of 416 days with a coefficient of variation of 21%, whereas in 3/4 Afghan and 7/8 Afghan the calving intervals averaged 419 and 395 days, with coefficients of variation of 21 and 20%, respectively.

The calving intervals in half-breds and in 3/4 Afghan were closer to Afghan cattle showing dominance of longer calving intervals of Afghan over shorter calving intervals of Hill cattle. In 7/8 Afghans, this did not hold true which may be attributable to small number of observations in this group. Similar results were also observed by Rigor and Nelmida (1959) who reported slight increase in calving intervals from 510 days of Red Sindhi to 512 days of Jersey at Tarlack Breeding Centre. Similarly Mahadevan and Hutchison (1964) in Tanganyika observed that the calving intervals averaged 382 days, with a coefficient of variation of 23% in Zebus and 432 days with a coefficient of variation of 31% in crosses between Bos taurus and Bos indicus. Compere (1964) also observed longer calving intervals in Sahiwal-Ankole crossbreds (averaging 457 days) than in Ankole half-sisters (averaging 409 days). Similarly Asker et al. (1966) found the average calving interval of Friesian Native, 1/2 Friesian and 3/4 Friesian as 418, 396, 476; and 498 days respectively whereas it was 465 and 440 days in Ayrshire and Ayrshire crossbreds.

Dhandapani (1962) failed to observe a difference in calving intervals of Red Sindhi and Jersey cattle over their five generations.

Contrary to these, Khisin and El-Issawi (1954) reported average calving interval of Jerseys as 384 days, 363 days for 1/2 Jerseys, 359 days for 3/4 Jerseys and 383 days 7/8 Jerseys. Similarly Abdel-Ghani and Fahmy (1966) observed average calving intervals in Friesian as 462 days and in crossbreds with local cattle in U.A.R. as 441 days.

Raj Kumar (1969) also reported smaller calving intervals of crossbreds than in Red Sindhis crossed to Jersey and also in non-descript Desi cattle crossed by Jerseys.

The average calving intervals in the first lactation of half-breds and 3/4 breds were longer than that in the parental breeds. This possibly is not due to genetic reasons but may be attributed to environmental conditions to which these groups were exposed. Only small number of observations were available for 7/8 Afghan as such no conclusion can be drawn on them.

Analysis of variance revealed no significant differences among breeding groups though the differences among lactations were significant. The calving interval consistently decreased

from the first to the third in all breeding groups. The number of observations in the fourth were rather small. There appears much scope for reducing calving interval by improving managemental conditions.

LACTATION PERIOD

The lactation periods of Hill cattle averaged only 218 days with a coefficient of variation of 35%. In Afghans it was 284 days with a coefficient of variation of 27%. Half-breds averaged 261 days with a coefficient of variation of 31%. The lactation period of Hill cattle was 66 days less than in Afghan cattle. Half-breds had lactations longer than would be expected for mid-parent. This is in agreement with the findings of Jauffret and Autret (1948) who reported that the lactation periods of French-Sindhi crossbreds averaged 12 months and these decreased progressively with decreasing Sindhi inheritance in Annamite crosses with Sindhi. Annamite cows had lactations of 5 or 6 months.

Tandon (1951), also reported longer lactation periods in Holstein crossbreds than in Red Sindhis and in Sahiwals, dams of those crossbreds. Mathur (1963) reported longer lactation periods in Jersey-Non-descript crossbreds than in non-descript Hill cattle. Similarly, Asker et al. (1966) reported that the average lactation periods of Friesian, 1/2 Friesian, 3/4 Friesian and natives were 322, 319, 293

and 219 days, respectively. Raj Kumar (1969) reported that the average lactation periods of Jersey-Red Sindhi crossbreds were 285 days while in Red Sindhi it was only 269 days. It was 271 days in Non-descripts, and 338 days in Jersey-Desi crosses.

The increase in lactation length beyond half-breds was not commensurate with the increase in Afghan inheritance. From lactation to lactation the magnitude of lactation length for various breeding groups did not maintain the same relationship. This may at least in part be due to managemental differences to which various groups were exposed.

There was highly significant difference among breeds but lactations did not differ significantly.

In this trait breeding groups accounted for 9% of the total variability whereas lactational sequences for only 1.4%. Since 90% of the variation was unaccounted for there is much scope for improvement due possibly to management.

DRY PERIOD

Tandon (1951) reported that Holstein crosses with Red Sindhi and with Sahiwal had shorter dry periods than the concerned Indian breeds. Similarly Sen et al. (1953) observed shorter dry periods in Ayrshire crossbreds than in Red Sindhis.

Asker et al. (1966) reported the average dry period of Friesian, 3/4 Friesian, 1/2 Friesian and Native in Iraq as 103, 197, 153 and 182 days respectively. Ayrshire and Ayrshire crosses to native averaged 150 and 164 days, respectively.

Naidu and Desai (1966) observed that dry periods decreased in Friesian-Sahiwal crosses as Friesian inheritance increased from Friesian inheritance increased from 4/32 to 11/32. It remained more or less equal upto 19/32 and beyond that it increased.

In the present study the dry periods of Hill, Afghan and crossbreds averaged 181 days, 152 days and 137 days, respectively with coefficient of variation of 54%, 61% and 70%. In 3/4A-1/4H and in 7/8A-1/8H dry periods averaged 156 days and 118 days respectively with 60% and 55% coefficients of variation. In half-breds it was less than the average of the two purebreds. This is in agreement with the findings of Tandon (1951), Sen et al. (1953) and Asker et al. (1966).

No definite change occurred in dry periods with increasing the Afghan inheritance beyond half. This relationship among breeding groups varied from lactation to lactation.

Analysis of variances revealed that there was significant differences among breeding groups and also among lactations. The dry period decreased with the increase of Afghan inheritance and also as the age advancing. In this trait breeding groups and lactational sequences were about equally important in controlling the variability, the contribution being 3.2 and 3.5% respectively.

There is considerable scope for improving dry periods due to improvement in managemental practices.

LACTATIONAL MILK YIELD

Kumauni Hill cattle are very poor milk producers. Afghan breed was therefore introduced as that is of the same size. The present investigation was undertaken to find out the improvement that could be brought about by crossbreeding between these two.

The average 301-day milk yields of Hill, Afghan and their half-breds were 304 kg, 704 kg and 582 kg with coefficients of variation of 50%, 15% and 41% respectively. Half-breds were above the level of mid-parent. 3/4A-1/4H and 7/8A-1/8H showed further improvement in milk yield but not in proportion to increase in the Afghan inheritance. Littlewood (1939) in Madras had observed that the crossbreds

with 1/8 to 1/4 exotic inheritance were the most suitable for tropical dairying. Tandon (1951) however concluded that milk yield was highest in 5/8th Friesian-3/8th Red Sindhi. Stonaker et al. (1953) also observed that Jersey crossbreds with Red Sindhi had higher milk yield.

Sen et al. (1953) reported that half-breds of Ayrshire with the three Indian breeds yielded 168, 102 and 78% respectively more milk than their Zebu dams. Mathur (1963) also observed increased milk yield in Jersey crossbreds with Non-descript Hilly cattle in India. Mahadevan and Hutchison (1964) found that crossbreds were significantly superior to Zebus in milk yield. Amble and Jain (1967) substantiated Tandon's finding from Military Dairy Farm and considered half to 5/8th exotic grades as the best. Raj Kumar (1969) reported 50 to 300% increase in milk yield of Jersey crossbreds over their Red Sindhi and Desi dams.

In the first lactation the 301 day milk yield was maximum in Afghan and minimum in Hill cattle. The half-breds yielded more than the average of the two pure breeds. 3/4th Afghan had 41 kg more milk than in half-breds whereas 7/8A had 26 kg more milk than three-quarter breds. Milk yield did not increase proportionately with the increase of Afghan inheritance upto third lactation yield increased. The yield

of Hill cows was higher in the third lactation. The milk yield was maximum in the fourth lactation for half-breds, 3/4-breds and Afghans. Productive peak is reached one lactation later in Afghan and its grades than in Hill cows.

Highly significant differences were found among breeding groups as well as among lactations. The breeding groups were found to be associated with 30% of the variability and lactations with only 5% of variability. Thus more than one-third of the total variability was accounted for by these two factors. Among all the traits studied the variability in milk yield is controlled to the maximum by these two factors.

Yield per day of calving interval in Hill cattle averaged 0.79 kg with a coefficient of variation of 53%, and in Afghan cattle 1.83 kg with a coefficient of variation of 37%. The half-breds averaged 1.54 kg with a coefficient of variation of 43%. This is more than the average of the two purebreds. It was only 1.58 kg in 3/4 kg but on smaller numbers in 7/8A it was 1.73 kg. The increase beyond half-breds was not substantial.

Analysis of variance revealed highly significant differences among breeds, among lactations and due to

interaction between these two. With advancing age the yield per day of calving interval increased upto the fourth lactation.

This character combines information on production as well as on reproductive traits. Thus it measures the relative placement of various breeding groups on the net merit.

BUTTER FAT PERCENTAGE

The average butter fat percentage in Hill cattle for the first four lactational records was 5.96 with a coefficient of variation of 14% and in Afghans it was 4.33 with a coefficient of variation of 14%. The butter fat percentage in the half-breds averaged 5.04 with a coefficient of variation of 18%. The butter fat percentage in half-breds was just mid-way between the two purebreds. The butter fat percentage of the 3/4 Afghans averaged 4.54%. This was again mid-way between the half-breds and the Afghans. Similarly the butter fat percentage of 7/8A was mid-way between 3/4A and Afghan breed. There was thus a completely linear relationship between butter fat percentage in milk and proportion of Afghan inheritance.

Howe (1946) observed that the butter fat percentage of

half-bred Jerseys was 5.89% which was 1% more than that of purebreds. Half-bred Guernseys had a butter fat percentage of 5.27% which was just under 1% higher than the 7/8 Holstein crosses with local cattle in Jamaica.

On the other hand, Stonaker et al. (1953) observed that the crosses showed slight but non-significant increase over the purebred Red Sindhi which were crossed with Jerseys.

Gercikov (1954) observed an increase of 0.9% i.e. from 3.4 to 4.3 in butter fat percentage in Kholmogor cows crossed with Friesian.

Horn et al. (1961) also reported considerably higher butter fat percentage in crossbreds than in Hungarian Red Spotteds or in Swiss Brown.

The analysis of variance showed a highly significant difference among breeding groups and no significant differences among lactations. Variability due to breeding group was 31% and that due to lactations was 14%.

These findings are in agreement with the findings of many workers to the effect that the butter fat percentage is a large part of inheritance due to additive nature of genes.

SUMMARY

This study was carried on Hill and on Afghan cattle and on their crossbred females maintained over a period of 32 years at Indian Veterinary Research Institute, Mukteswar, Nainital, U.P.

Normal reproductive and productive performance records of first four lactations were included in the present study which comprised of 43 Kumauni Hill cows, 106 Afghan cows, 41 1/2 Afghan-1/2 Hill cows, 34 3/4 Afghan-1/4 Hill cows and 11 7/8 Afghan-1/8 Hill cows with these were used 4 Hill bulls and 14 Afghan bulls in that period.

The following reproductive and productive traits of the five breeding groups were studied :

(1) Age at first calving in months;
(2) Gestation period in days;
(3) Birth weights in kg;
(4) Service period in days;
(5) Calving interval in days;
(6) Lactation period in days;
(7) Dry period in days;
(8) 301-day lactational yield in kg;
(9) Yield per day of calving interval in kg; and
(10) Butter fat percentage.

The analysis was carried to find out the differences among breeding groups and among the four lactations.

AGE AT FIRST CALVING

Average age at first calving in the five different groups was 44.3 ± 1.8 months for Hill cows, 42.9 ± 0.8 months for Afghan cows, 42.1 ± 0.9 months in 1/2 Afghan-1/2 Hill and 44.3 ± 1.0 months in 3/4 Afghan-1/4 Hill. 7/8 Afghan-1/8 Hill had an average age at first calving of 40.7 ± 1.8 months on small numbers.

No statistical difference was observed among breeding groups. Only 0.2% of the variation was attributable to differences among breeding groups.

GESTATION PERIOD

Average gestation periods ranged between 279.1 ± 0.5 days in Hill cows to 281.8 ± 0.4 days in 3/4A-1/4H. Afghan cows had a gestation period of only 280.0 ± 0.3 days. Whereas it was 280.2 ± 0.5 days in 1/2A-1/2H and 281.2 ± 0.7 days in 7/8A-1/8H.

No difference due to sex was found in Afghan breed. In others the male calves were carried 2 to 3 days longer than the female calves. Grades tended to have longer

gestation periods than either of the two pure breeds.

Differences among breeding groups and between sex of the calves were statistically significant.

BIRTH WEIGHT

Average birth weights of males and females in Hill breed were 11.8 ± 0.4 kg and 10.7 ± 0.4 kg, respectively. Afghans had the average birth weights as 12.4 ± 0.2 kg and 11.6 ± 0.2 kg in males and females, respectively. The grades except 7/8 had lighter calves. None of these differences were, however, statistically significant.

SERVICE PERIOD

Average service periods for the first four lactations of Hill and Afghan cows were 126 ± 7 days and 142 ± 6 days. In 1/2 A-1/2 H, 3/4 A-1/4 H and 7/8 A-1/8 H it was 135 ± 8 days, 154 ± 3 days and 110 ± 12 days, respectively.

Differences in service periods among lactations were highly significant. Upto third lactations the service periods declined. Differences among breeding groups were negligibly small.

Breeding groups accounted for only 1.3% of the total variability while lactational sequences were associated with 3.0% of the total variability.

CALVING INTERVAL

Average calving intervals for Hill and Afghan cows over the first four lactations were 396 ± 7 days and 418 ± 6 days. Half-breds averaged 416 ± 9 days and 3/4 A-1/4 H averaged 419 ± 10 days. For 7/8 Afghan-1/8 Hill cows it was 395 ± 14 days. In all breeding groups except the Afghan, calving interval decreased as the cows advanced in age, at least upto the third lactation.

Differences in breeding groups were statistically not significant but those among lactations were highly significant. Breeding groups accounted for only 0.6% of total variability whereas lactational sequences were associated with 2.1% of the total variability.

LACTATION PERIOD

Average lactation period for the first four lactations in Hill cows was only 218 ± 9 days and in Afghan cows it was 284 ± 5 days. In 1/2 Afghan-1/2 Hill the lactation period was 261 ± 8 days and in 3/4 Afghan-1/4 Hill it was 256 ± 10 days and in 7/8 Afghan-1/8 Hill it was 258 ± 15 days. Fourth lactation was slightly longer than others in all breeding groups.

Differences among breeding groups were statistically

highly significant but not those among lactation sequences.

Breeding groups accounted for 9% of total variability whereas lactational sequence only 1.4%. Nearly 90% of the variation could not be accounted for by these two factors.

DRY PERIOD

Average dry periods for the first four lactations in Hill, Afghan, 1/2 Afghan-1/2 Hill, 3/4 Afghan-1/4 Hill and 7/8 Afghan-1/8 Hill were 181 ± 12 days, 137 ± 6 days, 152 ± 10 days, 156 ± 11 days and 118 ± 12 days, respectively.

In all the breeding groups dry period decreased upto the third lactation.

Differences among breeding groups as also among lactational sequences were statistically significant.

LACTATIONAL MILK PRODUCTION

Average 301 day lactational milk yield of Hill cows was only 304 ± 18 kg while that of Afghans was 704 ± 15 kg. 1/2 Afghan-1/2 Hill on an average yielded 582 ± 25 kg and 3/4 Afghan-1/4 Hill it was 607 ± 30 kg. In 7/8 Afghan-1/8 Hill it was 606 ± 35 kg. All the breeding groups showed an increase in their yield as lactational sequence advanced upto the fourth. Hill cows reached their peak in the second lactation. Half-breds showed the maximum increase from their first

lactation to the fourth. In Afghan cows most of the increase was between second and third lactation.

Differences among breeding groups as well as among lactational sequences were statistically highly significant. Breeding groups were associated with 30% and lactational sequence with 5% of the total variability in this trait.

AVERAGE YIELD PER DAY OF CALVING INTERVAL

The increase was very marked from Hill to 1/2 A-1/2 H level. Thereafter the increase was only slight. Hill cows yielded on an average 0.8 kg of milk per day of her first four calving intervals. Afghan cows yielded 1.8 kg and half-breds 1.6 kg. As Afghan inheritance increased this trait gradually increased.

Breeding groups, lactational sequences as well as interaction between these two were statistically significant.

BUTTER FAT PERCENTAGE

Average butter fat percentage for first four lactations for Hill and Afghan cows was 5.69 ± 1.0 and 4.33 ± 0.04 whereas it was 5.04 ± 0.10 in 1/2 A-1/2 H and 4.54 ± 0.12 for 3/4 A-1/4 H. In 7/8 A-1/8 H the butter fat percentage was 4.42 ± 0.18. Almost linearly the butter fat percentage decreased as Afghan inheritance increased. Lactational

differences did not follow any definite trend in the breeding groups.

Breeding groups accounted for nearly 31% of total variability whereas lactational sequence could control about 14% variability thus 55% variability in this trait still remain unaccounted for.

Crossbreeding of Hill cattle with Afghan breed was found to nearly double the milk production over non-descript Hill cows at Mukteswar. Except for service periods and calving intervals the crossbreds were more desirable than Hill cows. These two traits were larger in crossbreds than in the Hill cows. Butter fat percentage was lower in crossbreds than in Hill.

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