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ORIGINAL PAPER

Reproductive performance of crossbred dairy cows reared under traditional low input production system in the eastern Himalayas

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Abstract Reproductive performance of crossbred cows reared under traditional low input production system was assessed. A total number of 160 farmers were surveyed and traditional fodders were evaluated for proximate composition. Total protein, albumin and cholesterol concentrations in blood serum were analyzed. The age at first service, age at first calving, calving interval, calving to first service and calving to conception interval were calculated from records of 261 crossbred dairy cows. The crude protein, crude fiber, nitrogen free extract, ether extract and total ash content varied from 7.2 to 13.9, 18.2 to 34.4, 39.1 to 59.2, 2.1 to 4.1 and 7.2 to 17.9%, respectively. The total protein and albumin concentrations in blood serum were 7.6 ± 0.3 and 4.3 ± 0.3 g/dl, respectively. The cholesterol concentration was 221.1 ± 8.2mg/dl. The mean age at first service and age at first calving was 28.6 ± 1.0 and 40.7 ± 1.1months, respectively. The mean values for calving to first service and calving to conception intervals were 182 ± 14.5 and 224 ± 9.0days, respectively. The conception rate was significantly high among the cows that showed typical fern pattern of cervical mucus (56.6%). The conception rate based on 1st insemination was 44.4%. The incidence of repeat breeders and anestrus among the crossbred cows were 12.8 and 14.1%, respectively.

Keywords Crossbred cow · low input production system · management · reproduction

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Introduction

In the Eastern Himalayas, agriculture is highly complex production system, where livestock production is an integral and inseparable part. This region is a part of humid tropic and rich in natural resources. With rich forest resources and relatively low population pressure, dairying in this region is cheaper compared to other Himalayan agro climatic zones (Bujarbaruah and Bhatt 2006). Agriculture in the hilly areas is mainly of "shifting" or "slash and burn" *(Jhum cultivation)* type, in which the forest area is

cleaned, burnt and a variety of crops are cultivated in the slope of the hills. Once the productivity of the *Jhum* is reduced, the land is abandoned and new area is prepared for cultivation. This leads to deforestation, environmental degradation and ecological imbalance (Satapathy and Bujarbaruah 2006). To promote "settled cultivation" in place of "shifting cultivation", livestock rearing, especially dairying could play a very important role as manure of cattle is used to enrich the soil fertility.

Livestock production in the Eastern Himalayas is of subsistence type, in which animals are being managed in traditional way (Singh and Bhora 2005). To meet the food needs of the people within the resources available, the farmers of the region based on their traditional knowledge developed a dairy cattle production system that do not depend mainly on cereal grains. This alternative non-grain system has been practiced generation by generation and claimed to be sustainable for smallholder dairy production system. Like other developing countries, India is also practicing improvement of individual cow productivity through crossing the indigenous/local cattle with breeds like Holstein-Friesian and Jersey. However, the performance of the crossbred cattle varies with different agro ecological conditions. Information on the reproductive performance of crossbred cows reared under traditional smallholder dairy production system is limited (Shiferaw et al. 2003), especially under the mountain agro ecosystem.

The present study, therefore, was undertaken (i) to study the traditional low input dairy production system followed by the farmers and (ii) to assess the reproductive performance of crossbred dairy cattle in the mountain agro ecosystem of Eastern Himalayas in India.

Materials and methods

Location of study

The present study was conducted at Indian Council of Agricultural Research Complex for North Eastern Hill Region, Mizoram Centre, Mizoram, India over a period of three years (2003–2005). Mizoram is a hilly state of North Eastern India with elevation ranging from 30m to more than 1300m msl. In summer, temperature during daytime ranges from 21°C to 33°C, while during winter minimum temperature reaches up to 8°C. Rainfall varies from 1000mm to 4460mm per annum with an average of 2650mm. Relative humidity ranges from 58 to 89 per cent.

Survey on traditional dairy production system

Survey was conducted in all the eight districts of Mizoram state. The rational of selecting this particular area was that the farmers in this area follow traditional dairy cattle production system. A village was selected randomly in each district and a total of 160 dairy farmers (20 farmers per village) were randomly selected. The selected dairy farmers were personally interviewed with a schedule about the managemental practices adopted by them in dairy cattle production along with personal observations. After completion of the field survey, data from the interview schedules were transferred to a master sheet to facilitate tabulation. The frequencies obtained regarding the managemental practices were converted into percentage.

Proximate analysis of fodder samples

The commonly used non-conventional fodders were collected from all the districts, local names of the plants/trees were recorded and their botanical names were identified as per the botanical survey of India. After sun drying, the samples were dried in a hot air oven (50°C for 24h) to find out the dry matter (DM). The samples were analyzed for proximate composition (crude protein, crude fiber, ether extract, total ash and nitrogen free extract) as per the standard procedure (AOAC, 1995).

Blood biochemical parameters

A total number of 180 crossbred dairy cattle were examined for total protein, albumin and cholesterol concentrations in blood serum. Blood samples were collected using 18G needle from jugular vein in clean, sterilized test tubes and allowed for clotting. The serum was separated and stored at -20°C for further analysis. Total protein concentration was estimated as per the standard procedure given by Lowry et al. (1951). Albumin and cholesterol concentrations were estimated using diagnostic kits (Qualigens diagnosis, Glaxo, Mumbai) following the procedure given by the manufacturers.

Reproductive performance assessment

A list of small dairy farms in different districts was collected from the Animal Husbandry and Veterinary Department. Reproductive records of 261 crossbred dairy cows were obtained from different dairy herds. Individual cow records were included in the study by interview or/and individual record sheet. The age at first service, age at first calving, calving interval, calving to first service and calving to conception interval were calculated.

Incidence of reproductive disorders

Crossbred dairy cows (n = 726) were subjected to Gynaecological examination to find out the incidence of reproductive disorders. The detailed history of the cows including the previous inseminations was obtained from the herdsman. Those cows with apparently normal genitalia, inseminated with quality semen, but failed to conceive after three inseminations were considered as repeat breeders. The cows with the history of prolonged absence of estrum were examined twice at 11days interval to assess the ovarian status and those with smooth ovaries on both examinations were confirmed as cases of anestrus. Besides this, morbid genitalia (n = 86) were also collected from the local slaughterhouse to assess the reproductive status of slaughtered cattle. The morbid genitalia were subjected to detailed study in the laboratory including tubal patency test.

Statistical analysis

Simple tabular technique of analysis using statistical tools such as means ratio, percentage was used in the study. One-way ANOVA was used to test the significance between the conception rates of cows showing different types of fern pattern. Means that were different at $p < 0.05$ were tested using Fisher's least significant difference test (Snedecor and Cochran 1989).

Results

Traditional dairy cattle production system

The dairy cattle in the study area were reared intensively due to lack of grazing land and undulating topography of the region. The cows were housed in a low cost shed made up of locally available wood, bamboo and thatch, with a slatted wooden floor. The average area per cow was 5.2 ± 0.2sq m. The average number of cows per family was 8.6 ± 0.4, of which Holstein Friesian crossbred cattle were common (85.4%).

The feeding system followed in this region was unique and different from the standard one. Cows reared here were mostly dependent on local vegetation and agro waste products. On an average, a cow was fed with 18.6 ± 1.5kg green fodder per day. Invariably, the green fodder was offered as such without chaffing. Majority of the dairy farmers (>90%) fed their cows with home-made concentrate feed, which comprised mainly of wheat bran and small amount of groundnut or mustard oil cake. On an average 3.5 ± 1.6kg of this mixture was offered to a dairy cow/day in two splits. The quantity of groundnut or mustard oil cake fed to lactating cattle ranged from 200–250g/day. Family members of the farmers were involved in feed processing and feeding of the cattle. Thirty five per cent of farmers fed their cows with wheat bran and green fodder only, while the rest 65 per cent fed their cows with wheat bran, groundnut or mustard oil cake and green fodder. Only 40 per cent of dairy farmers fed dry roughage to their cows. Interestingly, 52 per cent of dairy farmers fed their lactating cows with cooked rice (250–500g/day). Invariably, all the farmers fed common salt (100–150g/day) along with concentrate feed while feeding the cows. Another interesting practice was that all the farmers warmed the water before offering to cows.

Proximate composition of fodder samples

The proximate composition of commonly used green fodders (pasture herbages, grasses and tree leaves) is given in Table 1. The crude protein content of local grasses ranged from 7.2 to 11.8 per cent (on DM basis) and crude fiber content from 21.9 to 32.8 per cent. *Erianthus longisetosus* was very popular among cattle farmers and most commonly used in dairy cow feeding. The CP content of the tree leaves and shrubs varied from 7.2 to 13.9% on DM basis. The CF, NFE, EE and TA content varied from 18.2 to 34.4, 39.1 to 59.2, 2.1 to 4.1 and 7.2 to 17.9%, respectively.

Biochemical parameters

The blood serum samples of dairy cows were analyzed for total protein, albumin and cholesterol

Table 1 Proximate composition of green fodders (DM basis)

Name	CP (%)	CF (%)	NFE (%)	EE (%)	Total Ash (%)
Grass fodders					
Erianthus Spp.	8.5	32.1	44.9	2.8	11.7
Setaria Spp.	11.8	25.3	42.8	2.2	17.9
Imperata Spp.	7.2	32.8	48.2	3.1	8.7
Thysanolaena Spp.	8.3	29.9	46.7	2.9	12.2
Panicum Spp.	7.8	32.4	44.3	1.7	13.8
Brachiaria Spp.	9.8	21.9	46.8	2.7	18.7
Tree and shrub fodders					
Autocarpus heterophullus	11.9	20.2	51.4	3.0	13.6
Autocarpus chaplasa	10.8	22.5	56.3	2.4	8.1
Bassia latifolia	8.9	20.1	59.8	4.1	7.2
Bauhinia variegata	13.9	32.8	44.3	2.1	6.8
Bauhinia vahili	13.2	15.8	59.2	3.1	8.5
Ficus benghalensis	9.7	19.8	51.8	3.1	15.6
Ficus elastica	12.9	34.4	39.1	4.1	9.6
Ficus fistulosa	10.8	22.5	56.3	2.4	8.1
Mangifera sylvatica	9.8	22.9	54.8	3.3	9.2
Musa sylvatica	12.6	18.2	48.6	2.7	17.9
Callicarpa Spp.	9.2	28.8	48.6	2.8	10.6
Sauranja Spp.	11.2	31.5	47.1	2.4	7.9
Eurya Spp.	8.9	32.4	44.9	3.1	10.7
Litsea Spp.	7.2	31.8	49.8	2.6	8.6
Alstonia Spp.	10.3	27.6	52.7	2.4	7.1

concentrations. Results of biochemical analysis revealed that the total protein and albumin concentrations were 7.6 ± 0.3 and 4.3 ± 0.3 g/dl, respectively. The cholesterol concentration was 221.1 ± 8.2mg/dl.

Reproductive performance and incidence of disorders

The mean (±SE) age at first service was 28.6 ± 1.0months with an overall age at first calving of 40.7 ± 1.1months. The calving interval ranged from 16 to 21months with an average of 538 ± 25.26days. The mean (±SE) values for calving to first service and calving to conception interval was 182 ± 14.5 and 224 ± 9.0days, respectively (Table 2). The incidence of repeat breeding, anestrus, retained fetal membrane, uterine infection and cystic ovary among the crossbred dairy cows is given in Table 2.

Conception rate

Cervical mucus of 68.5% cows revealed typical fern pattern, while 23.7% had atypical fern pattern of cervical mucus (Fig. 1) at the time of insemination. Only 7.8% cows showed no fern pattern of cervical mucus. The conception rate was significantly higher among the cows that showed typical fern pattern of cervical mucus (56.6%) compared to those that showed atypical fern pattern (23.7%). No conception

Table 2 Reproductive performance of crossbred dairy cows

Reproductive traits (n=261)	
Age at first service (months)	28.6±1.0
Age at first calving (months)	40.7±1.1
Calving interval (days)	538±25.3
Calving to first service interval (days)	182±14.5
Calving to conception interval (days)	224±9.0
Incidence of reproductive disorders (n=726)	
Repeat breeders (%)	12.8
Anestrus (%)	14.1
Uterine infection (%)	9. 8
Cystic ovary (%)	0.1
RFM (%)	6.2
Incidence of disorders in morbid genitalia (n=86)	
Fallopian tube block (%)	4.7
Uterine infection (%)	5.8
Ovario-bursal adhesion (%)	4.6
Kinked cervix (%)	3.5

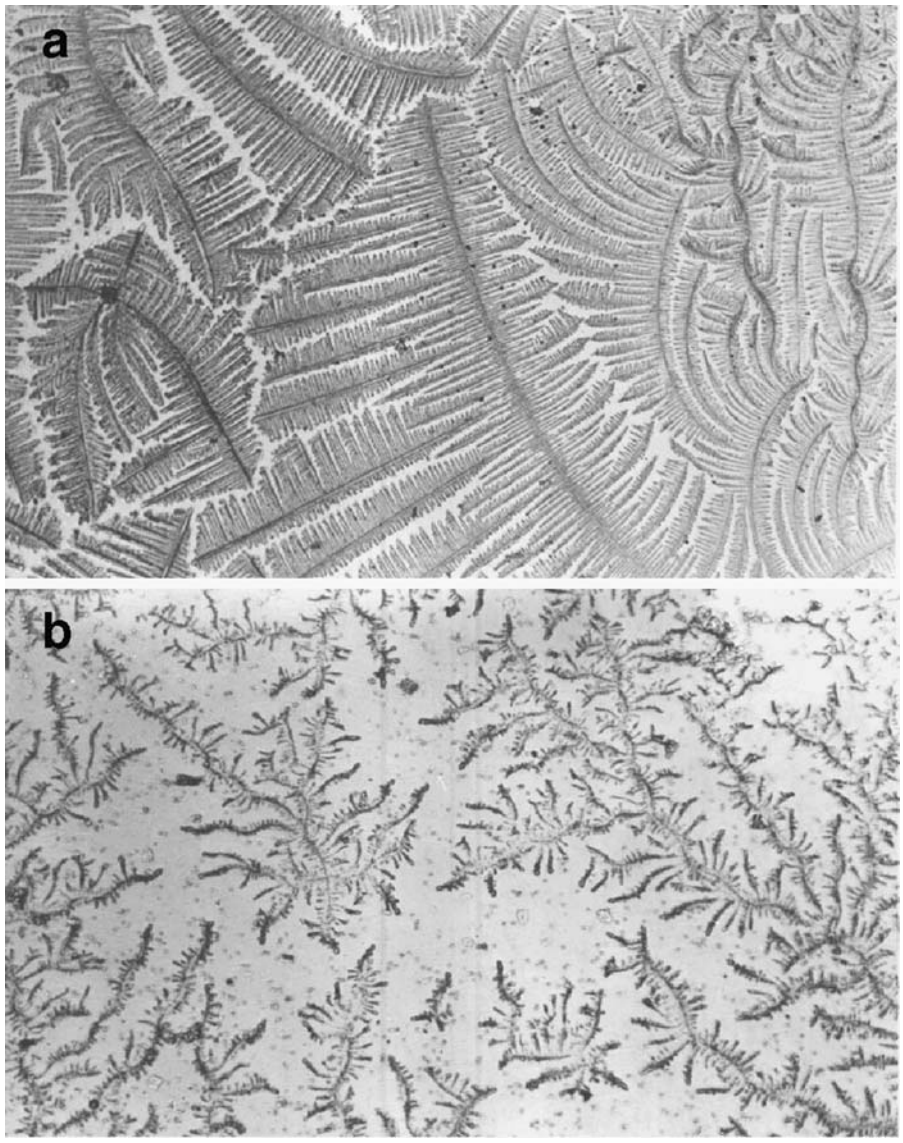

Fig. 1 Typical (**a**) and atypical (**b**) fern pattern of cervical mucus of crossbred dairy cows

was observed among the cows that showed no fern pattern of cervical mucus at the time of insemination (Fig. 2). The conception rate based on 1st insemination was 44.4%.

Discussion

The present study documented the traditional low input dairy cattle production system followed by the farmers of Eastern Himalayas. Hill agriculture is, by and large, subsistence-oriented; in which livestock play a crucial role. Sustainability of hill agriculture without livestock is virtually impossible in Eastern Himalayas (Singh and Bhora 2005). Among the livestock, dairying is closely interwoven with the socio-economic fabric of rural hill people of India, and is practiced by millions of smallholders as a part of mixed farming systems. Traditionally, dairy animals have performed multiple functions of producing milk for household consumption, males as a source of drought power in agricultural operations, and dung as manure and fuel. Milk is a cash crop for small holders, converting low value agriculture byproducts and crop residues and using family labour into a value added market commodity (Taneja and Birthal 2005). However, scientific dairying is constrained by shortage of feed and the profitability of the practice of

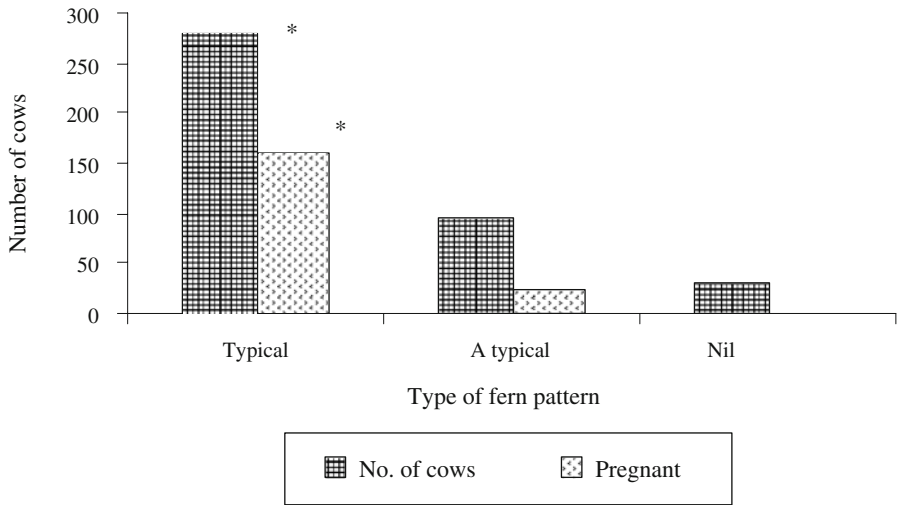

Fig. 2 Conception among cows with different fern pattern of cervical mucus at the time of insemination

feeding farm crops to dairy cows in an unsystematic manner is low. This poses a serious constraint to the farmers, because milk often provides the only source of cash income. The farmers themselves evolved, based on the traditional knowledge, feeding system for their cows with locally available materials. Dairy cow production system in hilly areas is distinguishable from that of standard one (Singh and Bhora 2005).

Livestock feeding practices, like many other features, is different and unique in this region. Common property resources viz forest and grasslands (community land) serve as the largest base for fodder extraction in the region. Singh et al. (2001) also reported similar findings in Indian central Himalayas. Farmers of this region feed several nonconventional feeds and fodders to dairy cows, but there is paucity of information on their chemical composition. From the results of the present study, it appears that, there are surprising numbers of potential and viable sources of protein that might be used more economically than the cereal based system to suit the local dairy cattle production system. Nutrient content of few tree fodders in the mountain agro ecosystem has already been reported (Singh 1999). Present study analyzed the proximate composition of leaves of 15 tree fodders and shrubs used as fodder for dairy cows. Results of the proximate analysis revealed that *Bauhinia variegata* and *Bauhinia vahili* may be used as a good source of protein as the CP content was higher. Increased milk production and better palatability of these leaves has been reported by Das et al. (2006). Higher NFE content in the tree fodders and shrubs may be due to more starch content indicating good quality carbohydrate. Though the cows were not fed adequately with concentrate protein source, blood biochemical analysis revealed normal total protein, albumin and high cholesterol levels. This indicates that the cattle derived good amount of nutrients from the green fodders fed to them.

In this system of production, majority of the hill dairy cows were of local/native type in earlier days. Due to the introduction of artificial insemination and crossbreeding programme, at present, crossbred bovine population dominates the native population; however, the reproductive performance of such cattle is frequently compromised due to low input production system. Calving interval of over 500 days has been quoted under the smallholder dairy production system (Shiferaw et al. 2003). The findings of the present study also suggest that the economic reproductive traits of the crossbred cows like age at first calving and calving interval were towards higher side than those reported earlier (Bhadauria and Katpatal 2003). Maximum return from dairy operation depends on cows with high milk output and production of milk depends heavily on reproduction (Kiwuwa *et al.* 1983). Late age at sexual maturity and first calving and longer calving interval are major areas of reproductive loss in dairy cattle (Alberro 1983). These factors are influenced by the system of rearing (Das et al. 1999; Obese et al. 1999). Under traditional system, the heifers received little attention, which may be a cause for late age at first service and delayed first calving.

Among the different reproductive disorders, anestrus and repeat breeders were the major problems in

crossbred cows. The high proportion of anestrus cows presumably was due to inadequate nutrition as no farmer fed the cows with balanced feed and minerals, which are very much essential for normal cyclicity (Yadav et al. 2006). Similarly, the negligence in estrus detection, improperly timed insemination and other managemental practices might be responsible for the high incidence of repeat breeders. When compared to local and purebred cattle, the incidence of repeat breeders was higher in crossbred dairy cattle (Singh et al. 1981; Kaikini et al. 1983).

The conception rate at first service was 44.4%, which is with in the range of reported earlier in plain areas of India (Kumaresan and Ansari 2000). Several factors have been reported to influence the conception rate including the accuracy of heat detection and timing of insemination. In most of the dairy farms, no time was exclusively allotted for detection of estrus and even if an animal was detected to be in estrus, the farmer took the cow to the insemination center depending upon his wish and whenever he was free from agricultural work. This resulted in improperly timed insemination and failure to conceive. This is clearly visible in the fern pattern analysis of cervical mucus of the cows before insemination. Nearly 8% of the cows claimed to be in estrus by the farmers were not actually in estrus, thus showing no fern pattern in their cervical mucus. The relationship between cervical mucus fern pattern and conception rate has been reported (Kumaresan et al. 2001). The conception rate was significantly ($P<0.05$) higher among the cows that showed typical fern pattern of cervical mucus at the time of insemination compared to those showed atypical pattern. Cervical mucus shows clinical changes in its physical and chemical properties, which are influenced by gonadal hormones. Low progesterone level (<1 ng/ml), essential for conception, favours typical fern pattern of cervical mucus. When the progesterone level is increased, the fern pattern also changes from typical to atypical and then to nil pattern (Kumaresan et al. 2001) thus reducing the chance of conception.

From this study, it may be inferred that there is enough scope to improve the reproductive performance of crossbred dairy cows under the traditional low input production system. There are surprising numbers of potential and viable sources of protein that might be used more economically than the cereal based system to suit the local dairy cattle production system. Hence, with the existing resources, based on their nutritive value, a farmer friendly feeding regime has to be evolved to improve the performance of crossbred dairy cows.

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