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Study of the genetic and non-genetics factors affecting the net cost of milk production of dairy cattle in Madhepura District of Bihar, India

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Abstract
Animal husbandry & dairy play an important role in national economy and in socioeconomic development of the country. Animal husbandry output constitutes about 30 per cent of the country's agricultural output. The average gross cost of milk production in Desi, HFX and JX cows were obtained as Rs. 10.311, Rs. 8.535 and Rs. 9.312 respectively. Among various variable cost items, feed cost was found to be the major cost component which contributed 70.817%, 72.700% and 70.929% of their respective gross costs in Desi, HFX and JX cows respectively. The Operation Flood Programme, which is the world's largest integrated dairy development programme, has made considerable progress in achieving its outlined objectives. The second major cost component was observed to be the labour cost which contributed 12.607%, 14.645% and 16.108% of their respective gross costs in Desi, HFX and JX cows respectively. Nutritional benefits and social upliftment are the determinant of our agriculture growth. This success story of milk could have much larger dimensions with the higher population of indigenous cattle come under the umbrella of genetic improvement. Even when the growth in the sector in recent years has partially slowed down than what was seen during the previous two decades yet a growth rate of around four per cent in this sector provides ample testimony to capacity building and contribution of this commodity to the annual national growth.

Keywords: Genetic, non-genetic, net cost, milk production, dairy cattle

Introduction
India stands first, whereas USA stands second in the world in milk production. India constitutes in milk production, accounting for 17 per cent of world production. India is the largest milk producer country in the world producing about 155.5 million tonnes of milk per annum. Since the population of the country has already crossed the mark of 130 crores, there has become a big gap between availability and requirements of milk. Thus, intensive efforts are being made to increase milk production through scientific breeding, balanced feeding, health care and better management of milch animals. Animal husbandry & dairy play an important role in national economy and in socioeconomic development of the country. Animal husbandry output constitutes about 30 per cent of the country's agricultural output. The 19th livestock census has been conducted throughout the country with reference date of October 15, 2012. This census places the total livestock population at 512.05 million and poultry birds at 729.20 million. India ranks first in respect of buffalo, 2nd in cattle and goats, 3rd in sheep, 4th in ducks, 5th in chickens and 6th in camel population in the world. Livestock contributed 155.5 million tonnes of milk, 66.44 billion eggs, and 44.73 million kg of wool, 2.68 million tonnes of meat, and 9.45 million tonnes of fish during 2015-16. The great story of India's "White

Revolution" in livestock sector has several facts each presenting a success story which is unmatched in terms of its impact on rural economy. Nutritional benefits and social upliftment are the determinant of our agriculture growth. This success story of milk could have much larger dimensions with the higher population of indigenous cattle come under the umbrella of genetic improvement. Even when the growth in the sector in recent years has partially slowed down than what was seen during the previous two decades yet a growth rate of around four per cent in this sector provides ample testimony to capacity building and contribution of this commodity to the annual national growth.

Animal husbandry and dairy farming are vital sectors of rural economy. These provide a significant proportion of self-employment opportunities in these sectors. Landless milk producers and marginal and small farmers engage themselves in dairying for gainful employment or supplementing their income. The importance of dairying lies not only in production of milk but it brings about significant change in socio-economic structure of rural economy. The value of output from livestock sector at current prices was about Rs. 537535crore during 2014-15 which is about 25.63 per cent of the value of output from agricultural, fishing and forestry sector, at current price and 26.02 per cent at constant prices (200405). Livestock sector provides regular employment to 11 million in principal status and 9 million in subsidiary status. Women constitute 70 per cent of the labour force in livestock sector as against 35 per cent in crop farming.

Thus, animal husbandry, in general and dairying in particular remains as the only tool for alleviation of poverty in the state. Milk production in Bihar is mainly under the control of landless, small and marginal farmers constituting about 65% of the total production. A large number of Khatals have cropped up in and around district towns of the state where the dairy farmers are keeping Desi as well as crossbred cattle. These dairy units require best technological and managemental knowhow for which suitable strategies are to be formulated for maximizing milk production.The growing population of Madhepura town mainly because of unidirectional flow of population from rural to urban area has significantly increased the demand of milk and thus the town has become a very good market for milk and milk products. Resultantly a large number of dairy units (khatals) have cropped up and become operational in and around Madhepura.

Since the profitability is the main objective of any enterprise, there must be optimum level of milk production for maximizing the economic gain. The milk producing efficiency of cows is dependent upon various genetic and non-genetic factors. Although many studies have been conducted on milk production efficiency of cows in organized farms, yet the information on the cows maintained in unorganized dairy units (khatals) is scanty (Kalra 1995; Chandra and Agarwal, 2000; Shrivastava and Singh, 2000; Kumar, 2005 and Kumar 2006)[8, 5, 15, 13, 14].

Source of Data

The present research study was carried out on Desi and HFX and Jersey crossbred cows maintained in private dairy units located in a radius of about 15 kms in and around Madhepura (Bihar).

Rea of Experimentation

The whole area under study was divided into four distinct zones which are tabulated below:

Table 1: Zone-wise villages/Mohalla of area of experimentation.

Sl. No.	Zone No.	Major Area	Villages / Mohalla
1	I	Madhepura Block	College chowk, Bhirkhichowk, Karpuri chowk, Sahugarh, Tunyahi, Sukhashan, Budhma, Murho, Muchbakhra, Betona, Sadhwa, Ghodhala
2	II	Singheshwar Block	Rupauli, Dular, Singeon, Katiya, Bhawanipur, Jugwani, Rampatti, Satokhar, Larha, Itawa, Khar
3	III	Ghailarh Block	Ratanpura, Ramnagar, Srinagar, Basudeva, Itahari, Kamalpur, Bhaun, Tekthi, Lakhmanya, Mahua, Piprahi
4	IV	Shankarpur Block	Mauzma, Kalhua, Bairely, Shakarpura, Chaura, Kabyahi, Majha, Pasra

Primary survey

The primary survey was conducted in the private dairy units popularly known as 'Khatals' located in a radius of 15 kms in and around Madhepura. 'Khatals' consisting of at least 3 or more Desi or crossbred cows either alone or in combination were enumerated through a "door to door survey" method in this study. The animals were fed poor quality of roughages and there was deficiency of greens in the feed because the dairy khatals owners had the only aim of profit. This study did not include the dairy units which were managed with exceptional superiority and which also consisted of buffaloes.

Least squares analysis

Data were subjected to least squares analysis (Harvey, 1966) to study the effect of genetic and various non-genetic factors on milk production efficiency traits. The following mathematical model was used:

$$Y\ ijklmnop = \mu + Gi + HLj + HSk + HC1 + Lm + Sn + Zo + eijklmnop$$

Where

Y ijklmnop = The value of p^{th} individual under i^{th} genetic group, j^{th} herd location, k^{th} herd size, l^{th} herd constitution, m^{th} lactation order, n^{th} season of calving and o^{th} farming system.

1. = Overall general mean
Gi= the effect of ith genetic group (i = 1, 2, 3)
HLj= the effect of location of herd (j = 1, 2, 3, 4)
HSk= the effect of herd size k = 1, 2, 3)
HCl= the effect of herd constitution (l = 1, 2, 3, 4)
Lm= the effect of lactation order (m = 1, 2, 3, 4, 5)
Sn= the effect of season of calving (n = 1, 2, 3,)
Zo= the effect of farming system (o = 1, 2)

Eijklmnop = the random error which is distributed normally and independently with mean 0 and variance $\sigma^2 e$.

Duncan's Multiple Range (DMR) test as modified by Kramer, 1957 was used for pair-wise comparison of the least squares means at 5% level of probability.

Result & Discussion

Net Cost

Average

The average net cost per kg of milk production for Desi, HFX and JX cows were obtained as Rs. 10.051±0.032, 8.428±0.055 and 9.221±0.052 respectively. Kumar (2005) [13] and Kumar (2006) [14] reported the average net cost per kg of milk

production in Desi cows to be Rs. 10.28 and Rs. 10.14 respectively under farmers' managemental condition in different districts of Bihar which are very close to the findings of the present study. Both the authors observed average net cost per kg of milk production for HFX to be

Effect of genetic factor

Least squares analysis of variance (table –01) revealed significant (P<0.01) effect of genetic groups on Net cost per kg of milk production in this study. An appraisal of leastsquares means (Table-02) revealed that HF crossbred cows were most economical with respect to net cost per kg of milk production. The HF crossbred cows had the lowest net cost per kg of milk production followed by Jersey crossbreds and Desi cows. The HF crossbred cows had significantly (P<0.05) Rs. 1.623 and Re. 0.793 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.05) Re. 0.83 lower net cost per kg of milk production than Desi cows. Kumar (2005)[13] and Kumar (2006)[14] also reported the lowest net cost per kg of milk production to be in HFX cows followed by JX and Desi cows which are in close agreement with the findings of the present study. Besides, Priya Raj (2002) [18] also reported the net cost/kg of milk production of HFX to be significantly (P<0.05) lower than JX cows under farmers' managemental condition which are in conformity with the findings of the present study. No doubt, the net cost/kg of milk production of HF crossbred cows was observed to be lower than the net cost/kg of milk production of Jersey crossbred cows. However, it requires to be mentioned here that during the questionnaires the dairy farmers revealed that Jersey crossbred cows had more milk fat percentage and better reproductive performance than HF crossbred cows.

Table 2: Least squares means of Net cost of per kg milk production under various genetic and non-genetic factors.

Genetic and Non-genetic factors	Net cost/Kg of milk production (Rs)
Mean ± SE	
Genetic factors	
Desi	10.051^{a}±.032
HF crossbred	8.428^{b}±.055
Jersey crossbred	9.221^{c}±.052
Non-genetic factors	
Location of Herd (zones)	
I	9.310±.040
II	9.231±.052
III	9.199±.048
IV	9.194±.064
Herd size	
3 - 4	9.321^{a}±.033
5 - 7	9.296^{a}±.050
8 & above	9.083^{b}±.064
Herd constitution	
One group alone	9.209±.059
D+HFX	9.242±.055
D+JX	9.235±.056
D+HFX+JX	9.248±.045
Season of calving	
Winter	9.187±0.042
Summer	9.214±0.041
Rainy	9.298±0.048
Lactation order	
1st	9.271^{a}±0.050
2nd	9.215^{ac}±0.051
3rd	9.023^{b}±0.043
4th	9.103^{b}c±0.052
5th& above	9.555^{d}±0.067
Farming system	
Dairying alone	9.491^{a}±0.043
Agriculture + Dairying	8.976^{b}±0.035

Trait-wise and column-wise means bearing different superscripts differ significantly (P<0.05).

Effect of non-genetic factors

Location of herd

Least squares analysis of variance (table-01) presented non-significant effect of location of herd on net cost/kg of milk production. Singh (1994) [25] and Priya Raj (2002) [18] observed that the location of herd did not play significant role on average net cost/kg of milk production in Desi and crossbred cows under farmers' managemental condition in Bihar which are in conformity with the findings of the present study. It may be pointed out here that all the four zones taken under study were located in and around 15 kms of Madhepura and therefore there might not have been significant differences in feeds and fodder and hired labours in all the zones under study. However, Kumar[1] (2004) [11], Kumar (2005) [13] and Kumar (2006) [14] observed significant (P<0.05) effect of location of herd on average net cost/kg of milk production.

Herd Size

Table-01, presented significant (P<0.01) effect of herd size on net cost/kg of milk production. The average net cost/kg of milk production of herd size 8 & above was observed to be significantly (P<0.05) lower by Re. 0.238 and 0.213 than the herd sizes of 3-4 and 5-7 respectively. However, the mean net

cost/kg of milk production of 3-4 and 5-7 did not differ significantly. Significant effects of herd size on average net cost/kg milk production have also have been reported by Singh (1994) [25], Priya Raj (2002) [18], Kumar[1] (2004) [11], Kumar (2005) [13] and Kumar (2006) [14] under farmers' managemental condition. Priya Raj (2002) [18], Kumar[1] (2004) [11], Kumar (2005) [13] and Kumar (2006) [14] also reported that the cows maintained in the herd size of 7&above had significantly (P<0.05) lower net cost per kg of milk production than the cows maintained in lower herd sizes. The findings of above authors are in close agreement with findings obtained in the present study.

Herd constitution

Least squares analysis of variance (table-01) reflected non-significant effect of herd constitution on net cost/kg of milk production in this study. The average net cost/kg of milk production ranged from Rs. 9.209 in the group when considered alone to Rs. 9.248 in the group consisting of Desi, HFX and JX cows, Kumar (2006) observed non-significant effect of herd constitution on net cost/kg of milk production in Desi, HFX and JX cows under farmers' managemental condition which is in conformity with the findings of the present study. However, Kumar[1] (2004) [11] and Kumar (2005) [13] observed significant (P<0.01) effect on net cost/kg of milk production in Desi and crossbred cows.

Season of calving

As evident from least squares analysis of variance (table-01), season of calving did not play any significant role on net cost/kg of milk production. The average net cost/kg of milk production ranged from Rs. 9.187 in winter calvers to Rs. 9.298 in rainy calvers. Priya Raj (2002) [18] and Kumar (2005) [13] observed non-significant influence of season of calving on net cost/kg of milk production in private dairy units under farmers' managemental condition which are in conformity with the findings of the present study. However, contrary to thefindings of this investigation, Singh (1994) [25], Kumar[1] (2004) [11] and Kumar (2006) [14] observed significant (P<0.05) effect of season of calving on average net cost/kg of milk production.

Lactation order

Least squares analysis of variance (table-01) presented significant (P<0.01) effect of lactation order on average net cost/kg of milk production. The net cost/kg of milk production decreased by Re. 0.056 in 2nd lactation from 1st. However, the average net cost/kg of milk production of 1st and 2nd lactations did not differ significantly. The average net cost/kg of milk production decreased significantly (P<0.05) by Re. 0.192 in 3rd lactation from 2nd. The average net cost/kg of milk production increased non-significantly by Re. 0.08 in 4th lactation from 3rd. The average net cost/kg of milk production of 5th& above lactations increased significantly (P<0.05) by Re. 0.452 than 4th lactation. The lactation order presented very clear trend that there was gradual decline in average net cost/kg of milk production upto 3rd lactation after which it tended to increase gradually. It is worth mentioning here that LMY (kg), peak yield (kg), MY/day LL (kg) and MY/day CI increased upto 3rd lactations and there after declined gradually suggesting optimum economy upto 3rd – 4th sequences of lactation after which it tended to increase.

The trend obtained in the present study is similar to the trend obtained by the above mentioned authors. However, Kumar (2006) [14], contrary to the findings of the present study, could not find significant effect of lactation order on net cost/kg of milk production.

Farming system

The system of farming played significant (P<0.01) role on netcost/kg of milk production. The average net cost/kg of milk production of cows maintained in the dairy units integrated with agriculture was found to be significantly (P<0.01) lower by Re. 0.515 than the units maintaining dairying alone. Kumar (2004) also observed lower net cost/kg of milk production in dairy units integrated with agriculture farming which is in conformity with the findings of the present study. It requires to be pointed out here that the LMY (kg), peak yield (kg), MY/day LL (kg) and MY/day CI (kg) were significantly (P<0.05) higher in the dairy units integrated with agriculture than those units maintaining dairying alone which might have resulted into lower net cost/kg of milk production of the units integrated with agriculture. However, Kumar (2005) [13] and Kumar (2006) [14], contrary to the findings of thepresent study, did not find significant effect of farming system on net cost/kg of milk production.

Economics of milk production

Cost components

The various cost components included feed cost, labour cost, depreciation cost, veterinary and A.I. cost, interest on fixed capital and miscellaneous cost. The variable cost components were calculated relative to their gross cost. The average gross cost of milk production in Desi, HFX and JX cows were obtained as Rs. 10.311, Rs. 8.535 and Rs. 9.312 respectively. Among various variable cost items, feed cost was found to be the major cost component which contributed 70.817%, 72.700% and 70.929% of their respective gross costs in Desi, HFX and JX cows respectively. The second major cost component was observed to be the labour cost which contributed 12.607%, 14.645% and 16.108% of their respective gross costs in Desi, HFX and JX cows respectively. The interest on fixed capital ranked 3rd which contributed 4.655%, 4.979% and 4.832% of their respective gross costs respectively. The depreciations on fixed assets like depreciations on housing equipments, machinery and animals were taken together as one item namely "Depreciation" which were observed to be 4.364, 4.686 and 4.317 percentages of their respective gross costs respectively. The veterinary and A.I. cost shared 2.996%, 1.757% and 1.610% of their respective gross cost of milk production in Desi, HFX and JX cows respectively. The respective values for miscellaneous cost were observed to be 4.073%, 1.230%, 2.203% of their respective gross cost in Desi, HFX and JX cows respectively. The dung was the only source of income other than milk to the dairy farmers, which contributed 2.512%, 1.253% and 0.977 of their respective gross costs in Desi, HFX and JX cows respectively.

Badal and Dhaka (1998), Priya Raj (2002) [18], Kumar[1] (2004) [11], Kumar (2005) [13] and Kumar (2006) [14] reported a similar trend of cost component to the trend obtained in the present investigation. However, Kalra *et al*. (1995) [8] reported lower percentage of cost contribution in feed cost than obtained in the present study. Besides, Chandra and Agarwal (2000) [5] observed higher labour cost than observed in this study.

Variable managemental practices in different dairy units, variable feeds and fodder used in different ecological conditions, variations in degree of demand from place to placeinfluencing price of milk, variable sample size and different degree of sampling, different ecological regions, period of study, genetic group of cows inflation rate etc.

might be responsible for variations in the estimate of contribution of different cost items to the gross cost per kg of milk production.

Conclusion

The present investigation was conducted on 104 randomly selected private dairy units consisting of 229 Desi, 85 HFX and 103 JX cows utilizing the procedures of "stratified random sampling with proportional allocation" (Snedecor and Cochran, 1967) in and around Madhepura (Bihar). The main aim of this investigation was to study the effects of genetic and various non-genetic factors on net cost of milk production efficiency traits. Apart from these, various constraints perceived by the dairy farmers were also studied to suggest a suitable package of dairy practices for economic milk production. The average net cost per kg of milk production for Desi, HFX and JX cows were observed to be Rs. 10.051±0.032, Rs. 8.428±0.055 and Rs. 9.221±0.052 respectively. The HF crossbred cows had the lowest net cost / kg of milk production followed by Jersey crossbred and Desi cows. The HF crossbred cows had significantly (P<0.05) Rs. 1.623 and Rs. 0.793 lower net cost per kg of milk production than Desi and JX cows respectively. Besides, JX cows had also significantly (P<0.05) Re. 0.83 lower net cost per kg of milk production than Desi cows. Location of herd, herd constitution and season of calving had no significant effect on net cost / kg of milk production. The cows maintained in the herd size of 8 & above had significantly (P<0.05) Re. 0.238 and Re. 0.213 lower net cost / kg of milk production than the herd sizes of 3-4 and 5-7 respectively. The average net cost / kg of milk production was observed to be the lowest (Rs. 9.023) in 3rd lactation after which it tended to increase. However, the net cost per kg of milk production of 3rd and 4th sequences of lactations did not differ significantly. The average net cost / kg of milk production of cows maintained in the dairy units integrated with agriculture was observed to be significantly (P<0.01) lower by Re. 0.515 than the units maintaining dairying alone. The farmers of the dairy units located in and around Madhepura (Bihar) perceived eleven constraints of which high cost of crossbred cows ranked 1st followed by high cost of feed, fodders and feed supplements, non-availability of good dairy animals in the locality, high incidence of repeat breeding, poor results of A.I., high cost of veterinary medicines, lack of proper housing, non-availability of green fodder throughout the year, un-economical crossbred male calves, lack of finance / credit facilities and non-remunerative price of milk which need to be given due consideration on priority basis.

Recommendation

On the basis of findings of the present study, it was observed that both HFX and JX cows are well adapted in the agro climatic region of Madhepura (Bihar). However, HF crossbred cows should be preferred to Jersey crossbred cows for lactation milk yield, lactation length, peak yield, DAPY, MY / day LL, MY / day CI and net cost per kg of milk production suggesting more use of HF than Jersey for crossbreeding in and around Madhepura (Bihar). Besides, the herd size of 8 & above cow's upto 4th sequence of lactation would be optimum for relatively economic milk production in this area. It was determined that some factors such as the time spent in dairy cattle farm, farmers' dairy farming experience, farmers' educational level, farmers' feed procurement, livestock diseases and maize silage production in the farms had significant effects on milk production costs. In conclusion, these factors were explained to have important impacts on decreasing farmers' milk production costs.

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