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Estimation of Economic Values for Fertility, Stillbirth and Milk Production Traits in Iranian Holstein Dairy Cows

Research Article

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ABSTRACT

The objective of present study was to derive the economic values for number of inseminations to conception, calving interval, milk yield and stillbirth, using economic data of 10 Iranian Holstein herds. The economic values were derived by using the profit function methods and differentiating a profit equation with respect to the traits of interest. The cow fertility costs herd amortization or replacement cost and cow feed cost were included in the profit function. The average of feed cost per cow per day was 8.65 USD. The total feed cost comprised 61 percent of milk production, 23 percent of maintenance, 12 percent of pregnancy and 4 percent of growth. In calculation of cow feed cost, the estimated cost for each Mcal and per g protein of feed were 0.0006 and 0.165 USD, respectively. The replacement cost of each heifer per cow herd was 1719 USD. The average cost of each insemination was 30 USD. The estimated economic values for the number of insemination, calving interval, milk yield and one percent unit of stillbirth, were -82, -2.08, 0.193 and -1.27 USD per cow/per year, respectively. The results of the current study suggested that improving the number of inseminations, calving interval, milk yield and stillbirth will have a positive effect on the profitability of Iranian Holstein cows.

KEY WORDS calving interval, cow feed cost, cow fertility cost, fertility, number of insemination, selection index.

INTRODUCTION

According to Fewson (1993), the breeding objective is defined as "developing vital animals. Which ensure that the profit will be as high as possible under future commercial conditions of production. On the other hand, the aim of breeding programs in the dairy cattle industry is to produce cows that maximize profitability for the farmer (Kearney, 2007). The profitability of dairy herds depends on the productive life-time which depends on a number of traits including level of production and functional traits. The functional traits are animal characteristics that increase the efficiency via reduction of production costs (Forabosco, 2005). Fertility is one of the most important functional traits, so that improvement of this trait will increase the net returns via reduction of calving interval, involuntary culling rate, replacement cost and also by increasing milk production (Bagnato and Oltenacu, 1994). Moreover, the level of milk production is the major source of income in dairy farm. However selection on milk production alone could increase the production cost, through negative genetic correlations that exist between milk production and functional traits (Young, 1970). In the past decades and in many breeding goals, the most emphasis had focused on milk production except in Scandinavian and North American countries. However, in the beginning of 2000, the most of developing countries have shifted their emphasis from milk production to functional traits because of quota-based milk marketing systems, price constraints, Labor costs and deterioration of the functional traits. The average of relative emphasis for production and reproduction traits in selection indices in 2003 was 59.5 and 12.6%, respectively. In comparison among countries, Danish S-Index focused the most emphasis (37%) on health and reproduction performance (Miglior *et al*. 2005).

The first and the most important steps to define a breeding program is definition of breeding objectives. The economic values and the genetic parameters are two components that should be estimated in defining breeding objective and to develop selection indices (Dekkers, 2003). In other words, the economic values are the key point in defining the breeding objectives and a criterion for evaluating the livestock improvement programs (Groen *et al*. 1997). Moreover, estimation of economic value for the important traits was required to establish an economic total merit index.

In animal breeding, the economic value of the trait was defined as the value of a unit change in the mean of the trait while keeping constant the other traits in the aggregate genotype (Berry *et al*. 2005). Therefore, the breeding objectives have to define in economic terms and the important production and functional traits should be included in the breeding goal, based on their economic importance. Knowing the economic value for key traits in the breeding goal enables the establishment of an economic total merit index (TMI). The TMI then permits the assessment of these traits on sustainable breeding programs that will benefit future farm productivity. The objective of the present study was to derive the economic values for number of insemination, calving interval, milk yield and stillbirth in Iranian Holstein cows.

MATERIALS AND METHODS

Estimation of economic values for fertility traits

Economic data

The economic information from 10 large Iranian herds was used to estimate economic values. The economic data including production cost of each kg milk, the price of each kg milk, the price of a 3 months of age calves (male and female), the cost of raising a 3 months of age calve, the price of heifer, the cost of raising a heifer, the average of salvage value, the average cost of each doses of semen, the cost of hormonal treatment for reproduction purpose, the average veterinary fee per insemination and the average cost of genetic counselor (Table 1).

Table 1 Economic and performance parameters used to estimate economic value

Parameter	Value 2008
M (kg)	9200
P (USD)	0.51
CMP (USD)	0.36
CP (USD)	555
CRC (USD)	405
CI (day)	415
INS	3
CM (%)	0.035
SB (%)	0.05
SP (USD)	20
EHTC (USD)	11
CIN (USD)	10
L	3
SL	1000
LFH	3.33
CRH (USD)	2777
FXC (USD)	500
COM (%)	3

M: milk production for the average calving interval; P: average price of milk per kg including bonus; CMP: average cost of milk production per kg including lactation feed cost and other variable costs related to milk production; CP: average price of 3 month female and male calf; CRC: average cost of rearing 3 months female or male calf; CI: average calving interval; INS: number of insemination per conception; CM: mortality of calves from birth to selling; SB: average stillbirth; SP: cost of doses of semen; EHTC: cost of per hormonal treatment; CIN: veterinary fee per insemination; L: average herd life in number of lactation; SL: salvage value; LFH: Labor of the farmer per hour ($); CRH: cost of replacement heifer; FXC: fixed costs per cow per year and COM: average cow mortality.

Profit equation

The profit function was constructed as follows:

$$P = R - C$$

$$R = [((M_{AVCI}+(a\times CI))\times P) + ((1-CM)\times(1-SB-NH)) \times CP] \times 365 / CI$$

$$C = FXC + CFERC + HA + FCP + [(((1-CM)\times(1-SB-NH))\times CRC) + ((M_{AVCI}+(a\times CI))\times CMP) + (CI\times FCMA)] \times 365 / CI$$

Where:

R: average revenue per cow per year.

C: average cost per cow per year.

M_{AVCI}: milk production for the average calving interval. CI: average calving interval.

a: regression coefficient for the linear regression (kg milk/day CI).

P: average price of milk per kg including bonus.

CM: mortality of calves from birth to selling.

SB: average stillbirth.

NH: portion of female calves determined for replacement (as proportion of all born calves, including stillbirth).

CP: average price of 3 month female and male calf.
FXC: fixed costs per cow per year.
CFERC: cow fertility costs.
HA: herd amortization or replacement cost.
FCP: cow feed cost for pregnancy.
CRC: average cost of rearing 3 months female or male calf.
CMP: average cost of milk production per kg including lactation feed cost and other variable costs related to milk production.
FCMA: feed costs for maintenance.

It should be noted that in order to estimate the economic value for calving interval, milk production and feed cost were expressed as a function of calving interval. Feed cost for pregnancy was independent of calving interval and were assumed that the cow was mature and, therefore, feed costs for growth were not included. Feed cost for lactation was added to other variable costs for milk production and related to the calving interval. Cow feed cost for maintenance was calculated per cow per day and then multiplied by calving interval.

Cow fertility cost (CFERC)
Cow fertility costs were obtained from the costs of insemination and hormonal treatments.

Average insemination cost (AIC)
To calculate AIC, veterinary fees per insemination, cost of each dose of semen and cost of genetic counselor were included.

$$AIC= INS \times (SP+CIN) + GC$$

Where:
INS: number of insemination per conception.
SP: average cost of doses of semen.
CIN: veterinary fee per insemination.
GC: cost of genetic counselor.

In these herds that were used in the current study and before of each insemination, a cow genetic counselor determines which cow should be inseminated with which of the available sperm. Therefore the cost of genetic counselor was added to the average of insemination cost.

Cost of hormonal treatment for fertility problems (THC)
This cost is only for the cows that need more than one insemination per conception and was calculated as follows:

$$THC= (INS-1) \times (EHTC)$$

Where:
EHTC: cost of one hormonal treatment including veterinary cost and treatment for removing corpus luteum, synchronization and other related costs.
Total cow fertility cost was then obtained by summing of THC and AIC:

$$CFERC= AIC + THC$$

Herd amortization or replacement cost (HA)
To calculate HA, the following equation was used:

$$HA= 1 / (LH\times(CI/365)) \times [(1/(1-HM)\times THC) - ((1-CM)\times SV)]$$

Where:
LH: average number of lactations.
CI: average calving interval.
THC: total cost of rearing a heifer.
HM: average heifer mortality.
COM: average cow mortality.
SV: average salvage value.

Derivation of economic values
The economic value of trait X was estimated by partially deriving the profit function with respect to the trait X. As we know, by each day increase in calving interval, the revenue and the cost of milk will be changed, but milk production and calving interval were included in the aggregate genotype. Therefore, in order to estimate economic value for calving interval to use in index we should assume that milk production will be constant. Therefore, we use M instead of (MAVCI+(a×CI)) in the profit function and for economic evaluation of calving interval the profit function with (MAVCI+(a×CI)) were used.

RESULTS AND DISCUSSION

Cow feed cost
The cost of each Mcal and each g/protein plus cow feed cost for each cow with 650 kg body weight and 28 kg daily milk production are presented in Table 2. The cost of each Mcal and g/protein was 0.0006 and 0.152 USD, respectively. From the total cow feed cost, 61 percent was the cost of milk production, 23 percent was the cost of maintenance, 12 percent was the cost of pregnancy and 4 percent was the cost of growth.

Replacement or herd amortization cost
The cost of replacement of one heifer instead of calling cow was 3094.5 USD.

The result showed that if a farmer decided to produce replacement heifer in owner farm of 36 percent of all born female calf should be kept as a replacement.

Table 2 Daily cow feed cost and cost of each Mcal and g/protein

Variable	USD
Each M/cal	0.165
Each g/protein	0.0006
Cow feed cost for maintenance	1.95
Cow feed cost for milk production	5.21
Cow feed cost for growth	0.31
Cow feed cost for pregnancy	1.02
Total feed cost	8.65

Cow fertility cost

The cost of each insemination was 30 USD. If the cow doesn't pregnant in the first insemination, she needs hormonal treatment that average of each hormonal treatment was 10 USD.

Economic values for milk yield and fertility traits

The most important trait was INS, milk yield, calving interval and stillbirth were 0.01, 0.06 and 7.8 percent as important as number of inseminations per conception, respectively. Estimated economic values for milk production, CI, INS and SB are shown in Table 3.

Table 3 Estimated absolute and relative (ratio to INS) economic values (USD) for milk production (M), number of inseminations per conception (INS), calving interval (CI) and one percent unit of stillbirth (SB)

Traits	Absolute economic value economic value ($/cow per year)	Relative economic value
M (kg)	0.193	0.0001
INS	-82	1.0000
CI (day)	-2.08	-0.0006
SB (%)	-1.27	-0.0779

A positive economic value was estimated for milk yield. Therefore selection to increase milk production should be considered in selection programs in Iranian Holstein population. An increase of 1 kg/yr in milk yield will cause 0.193 USD more profit per cow. Negative economic values were obtained for INS, CI and SB; meaning that an increase in either INS, CI or SB will decrease profit. An increase of CI by one day over the average calving interval will decrease profitability by 2.08 USD per cow/year. Estimated economic value for calving interval by González-Recio *et al.* (2004); Pérez-Cabal and Alenda (2003) and Plaizier *et al.* (1997) were -4.9 USD (US), -0.37 € and -4.7 USD per cow per year, respectively.

The economic loss associated to enlarging CI results an increase in food cost. To estimate economic values for calving interval we assumed that the dry period was constant. Therefore, a change in calving interval is the result of changes in lactation length. In this case, longer calving intervals imply that cows enlarge the last part of lactation (lower daily yields), which can be reducing the average daily milk yield per lactation.

Then, we would expect that lower yielding cows loose more income per day from enlarging calving interval than higher yielding cows. The negative economic value estimated for INS indicated that for each unit increase in INS, the profitability will decrease by 82 USD per cow/year, which is slightly larger than the 67.52 USD reported by González-Recio *et al.* (2004). In the present study, the economic values for two fertility traits (CI and INS) were estimated.

Economic value of INS is higher than the economic value of CI. Therefore if the aim is to improve fertility performance, INS is an important fertility trait that should be considered in the breeding goal. One unit increase in INS, will increase fertility cost (doses of semen, veterinary fee and hormonal treatment) and the cost associated with increasing calving interval.

One unit increase in INS causes an increase in CI interval of at least 21 days. It is obvious that cows with low conception rates need more INS. Oltenacu *et al.* (1981) and McMahon *et al.* (1985) reported an increase in net income of 3.50 USD and 2 USD per each unit increase in sire conception rate, respectively.

Economic value for stillbirth

Economic loss due to one percent stillbirth rate was -1.27 USD. Given that there is no specialized beef breeds in Iran, many farmers buy a male calf from dairy herds for fattening. This large economic value of stillbirth indicates that in Iranian dairy farms selling calves is the most important revenue for farmer after milk sales. In this study only direct stillbirth was considered. Therefore, indirect costs associated with stillbirth (decrease in milk culling risk) were not considered for calculation of economic loss due to stillbirth.

CONCLUSION

The results of present study suggest that improving number of insemination and milk yield, while reducing calving interval and the incidence of, stillbirth will have positive effect on the profitability of Iranian Holstein cows. The positive economic value was estimated for milk yield which indicates in Iranian economic condition selection based on milk production can be reasonable. Stillbirth should be included in the breeding goal because of its large economic value. Due to unfavorable genetic correlation reported between milk production and fertility trait and because of economically importance of milk production and fertility, it is better to include both milk yield and INS in the breeding goal.

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