Economic comparison of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia

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Abstract

Economic comparisons among Ethiopian Boran and their crosses with Holstein Friesian were made in the central highlands of Ethiopia. Data collected from experimental dairy cattle herds of the International Livestock Research Institute (ILRI) at the Debre Zeit Research Station, Ethiopia were used. The data of one year (2003 calendar year) were used for calculation of costs and returns. Comparisons of economic performance of the different genetic groups (Ethiopian Boran, 50, 75 and 87.5 per cent Holstein Friesian Inheritances) were made through calculations of profit per day per cow, profit per year per cow and cost per liter of milk production. The results indicated that the cost required to produce a liter of milk was significantly higher ($P<0.01$) for the Ethiopian Boran breed compared to all crosses. Ethiopian Boran cattle required more than double the amount required by the crosses. The costs were estimated at ETB[†] 3.17, 1.32, 1.39 and 1.17 for Ethiopian Boran, 50%, 75% and 87.5% crosses, respectively. Profit per day per cow and profit per year per cow were also much lower for Ethiopian Boran (ETB1.15 and 45.8, respectively) compared with the crosses (ETB15.3 and 4109.6 for 50%, 17.6 and 4760.6 for 75%, and 21.0 and 5700.7 for 87.5%, respectively) ($P<0.01$). The profit per day and profit per year for the 87.5% crossbreds were higher ($P<0.05$) than the amount for the 50% crossbreds. The 75% crosses did not have a significant ($P>0.05$) difference with 50 and 87.5% exotic blood levels. It was concluded that intensive dairy production with indigenous tropical breeds (Ethiopian Boran) is not economically feasible. Therefore, in such production systems crossbreds should be utilized.

Keywords: Ethiopian Boran; Holstein Friesian; Economic comparison; Central Ethiopia

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† 1 US Dollar= ETB (Ethiopian Birr) 8.67 in December, 2005

Introduction

The livestock sector has a significant contribution to the national economy of Ethiopia. However, the productivity of the livestock is extremely low. The average lactation milk production for the indigenous cows ranges from 494-850 kg under optimum management (EARO, 1999).

To meet the ever-increasing demand for milk and milk products in Ethiopia, genetic improvement of the indigenous cattle has been proposed as one of the options. Genetic improvement of the indigenous cattle, basically focusing on crossbreeding, has been practiced for the last five decades but with little success. Assessment of the overall impact of the crossbreeding work in Ethiopia is limited. Evaluation of the overall benefit of crossbreeding should capture both the biological and economic efficiency of the program. The majority of published studies on cattle crossbreeding in the tropics have focused on comparing biological efficiency of indigenous cattle with their crosses. Comparisons are generally restricted to reproductive and production traits. There have been few economic evaluations of cattle crossbreeding in tropical countries (Madalena, 1989; Kahi *et al*., 1999; Karugia *et al*., 2001). Indeed, in some of the studies it was indicated that biological efficiency did not translate into economic efficiency.

In Ethiopia, although some efforts (Kiwuwa *et al*., 1983; Haile-Mariam *et al*., 1993; Nigussie *et al*., 1998; Demeke *et al*., 2004a,b) were made in studying the biological performance of the crossbreds vis-à-vis the indigenous stock, economic comparisons of the different genetic groups has not been done to the best of our knowledge. This is the demand of the day particularly in light of stimulated global interest for cost effectiveness in breeding programs. Thus, there is a need to collect and analyze the information on the expected overall economic performance of the available breeds and their crosses at specific levels of resource availability and management and in discrete climatic conditions. This paper compares the economic performance of different genetic groups in central Ethiopia.

Materials and Methods

Source of data

Data collected from dairy cattle herds of the International Livestock Research Institute (ILRI) at the Debre Zeit Research Station, Ethiopia were used. The data of one year (2003 calendar year) were used for calculation of costs and returns.

Description of the farm

The Debre Zeit Research Station of the International Livestock Research Institute (ILRI) is located on the outskirts of the town of Debre Zeit, about 50 km south-east of Addis Ababa, in the Ethiopian highlands (8° 44'N and 38° 58'E), at an altitude of about 1850 meters above sea level. Average annual rainfall in the Debre Zeit area is about 866 mm. The annual average temperature is 18.7°C and the average monthly relative humidity is 52.4%.

Animals and management

Animals from four genetic groups were available and used for the study. These were: Ethiopian Boran, 50, 75, and 87.5 per cents of Holstein Friesian inheritance levels. Ethiopian Boran cattle are well adapted to semi-arid tropical conditions. They have a high degree of heat tolerance, are tolerant to many of the diseases prevailing in the tropics and have the ability to survive long periods of feed and water shortage. They are, however, comparatively low milk producers. On the other hand the Holstein Friesians, though less adaptive to the tropical environment have high milk production potential. The intent in crossbreeding is to combine these attributes of the genetic groups in the crossbreds. The cattle were not grazed because of problem of tick infestation. Thus, they were all stall-fed. Recorded amounts of green fodder and silage were provided. The animals were supplemented with concentrate mixture composed of (Wheat bran, noug (*Guizotia abyssinica)* seed cake, and molasses) based on milk production, two times per day. Clean water was provided *ad libitum*. Milking was done manually twice a day (mornings and evenings). Culling was based on productivity (low producers), age (old age) and health problems. Disease control was practiced through combined health management practices that included: vaccination for the important diseases (Black leg, Anthrax, Contagious Bovine Pleuropneumonia, Pasteurelosis and Foot and Mouth Disease), deworming (every six months) and treatment as the disease occurred.

The data

Comparisons of economic performance of the different genetic groups were made through calculations of the following parameters:

1. Profit per day per cow
2. Profit per year per cow; and
3. Total variable cost per liter of milk production.

These calculations demand correct identification of the costs and returns. Costs considered in this analysis include: feed (concentrate, hay and silage) cost, veterinary cost and labor (milking, feed collection, feeding and cleaning) cost.

Sources of income in dairy enterprise could be many and varied. However, because of availability of record and suitability for computation, income from the sale of milk and dung were considered. Dung output from each animal was computed based on results from a study by Tesfaye (2002) which found mean fecal dry matter yield per kg of live weight of 6 grams and 5 grams for crossbred and local Boran cows in Ethiopia. Profit was calculated as the difference between gross revenue (returns) and total variable cost.

The economic comparison was made under the following assumptions/conditions:

4. Herd size of 159 cows was considered;
5. The comparison is made with an intensive dairy enterprise in mind;
6. Indigenous genetic resources have existence, option, cultural and recreation values that are lost when full-scale crossbreeding is undertaken. These non-market values present formidable estimation problems and are not considered in this analysis.

Market price of inputs and outputs

Data on variable costs was collected for partial budgeting. The calculated input cost in local markets for feed, veterinary and labor for each genetic group is detailed in Table 1. Irrespective of the genetic groups, revenue for milk per liter was ETB 3.00, where as dung price per kg was ETB 0.05.

Statistical and financial analyses

Financial analysis was performed by employing partial budgeting method (Hyman, 1989) on each animal in the genetic groups based on data collected on price of variable costs (feed, veterinary and labor) and outputs (milk and dung). Subsequently, statistical differences in profit per day per cow, profit per year per cow and cost incurred to produce a liter of milk for the genetic groups were tested using the Generalized Linear Model (GLM) procedures of SAS (SAS, 2002).

Table 1. Costs and returns used for economic comparisons

Items	Ethiopian Boran	50%	75%	87.5%
Fecal out put (kg, dry matter/day)	1.75	2.33	2.36	2.34
Concentrate intake (kg/day/cow)	3.255	5.62	6.37	7.54
Silage intake (kg/day/cow)	6.815	11.76	13.34	15.78
Forage intake (kg/day/cow)	0.83	1.43	1.63	1.92
Costs (ETB/day/cow)				
Veterinary	0.010	0.014	0.036	0.051
Feed (concentrate)	2.54	4.38	4.97	5.88
Feed (silage)	0.75	1.294	1.467	1.736
Feed (forage)	1.154	1.991	2.258	2.671
Labor (ETB)	0.74	1.69	1.69	1.69
Total cost	5.194	9.369	10.421	12.028
Returns (ETB/day/cow)				
Dung	0.09	0.116	0.118	0.118
Milk	6.26	24.55	27.94	32.95
Total return	6.35	24.666	28.058	33.068
Price of milk, ETB/kg	3	3	3	3
Price of dung, ETB/kg	0.05	0.05	0.05	0.05

ETB, Ethiopian Birr

Results

Biological information as basis for economic comparisons

Results of the genetic evaluation of Ethiopian Boran and their crosses with Holstein Friesian are presented elsewhere (Haile, 2006). As basis for the present study, however, brief account of the major results are summarized. Crossbreeding of Ethiopian Boran with Holstein Friesian had improved growth, reproductive and milk production performance of the crossbreds over those of Ethiopian Boran breed. The Ethiopian Boran were consistently lighter than all their crosses with the Holstein-Friesian at birth, weaning, six months, one year, eighteen months and at two years. The Ethiopian Boran breed also had poor reproductive (as judged by calving interval, days open, age at first service, age at first calving and breeding efficiency) and production performance (evaluated based on lactation milk yield, 305 days milk yield, daily milk yield, lactation length and lifetime milk yield) compared to all the crosses.

Comparison among the crosses with different levels of exotic inheritance (50, 75, 87.5 percents) revealed no clear-cut superiority of any of the genetic group for growth and reproductive performance except for calving interval and days open which were shorter for 50% crosses compared to the 75% crosses. Lactation milk yield, 305 days milk yield and daily milk yield showed an increasing trend as exotic inheritance level increased. However, lifetime milk yield was higher in 50% exotic inheritance compared to 75% and 87.5% crosses.

Weight differences during the study period (2003, calendar year) among the genetic groups were marked (Table 2). All the crosses had significantly higher (P<0.01) body weight than the Ethiopian Boran breed. The crosses, however, had no differences (P>0.05) among themselves. Daily milk yield per cow for the study period was also significantly (P<0.01) different among the genetic groups. The Ethiopian Boran breed had the lowest yield amongst all the genetic groups. The 87.5% exotic inheritance crossbred cows had more daily milk yield than the 50% crosses but not significantly so with the 75% blood level.

Table 2. Least square means (±SE) for differences of genetic group on economic comparisons

Effect and level	Number	Body weight (kg)	Daily milk yield (kg)	Cost per liter (ETB)	Profit per day (ETB)	Profit per year (ETB)
Overall	159	380±4.6	7.6±0.28	1.76±0.08	13.8±0.83	3654±254
CV (%)		12.7	37.5	50.2	61.7	70.7
GG		**	**	**	**	**
50	78	388±5.5[a]	8.2±0.32[a]	1.32±0.09[a]	15.3±0.98[a]	4109.6±300[a]
75	41	394±7.6[a]	9.3±0.45[b]	1.39±0.13[a]	17.6±1.36[ab]	4760.6±414[ab]
87.5	14	389±13.0[a]	11.0±0.77[b]	1.17±0.22[a]	21.0±2.32[b]	5700.7±709[b]
Eth. Boran	26	350±9.5[b]	2.1±0.57[c]	3.17±0.16[b]	1.15±1.70[c]	45.8±520[c]

**, P<0.01; GG, genetic group

Least squares means with same superscript in the same column indicate non significance

Economic comparisons

Summary of costs and returns used for economic comparisons among the genetic groups are presented in Table 1, whereas, results of the analysis are given in Table 2. When the economic merits of the genetic groups were studied, the cost required to produce a liter of milk was significantly higher (P<0.01) for the Ethiopian Boran breed compared to all crosses. Ethiopian

Boran cattle required more than double the amount required by the crosses. The costs were estimated at ETB* 3.17, 1.32, 1.39 and 1.17 for Ethiopian Boran, 50%, 75% and 87.5% crosses, respectively. Profit per day per cow and profit per year per cow were also much lower for Ethiopian Boran (ETB1.15 and 45.8, respectively) compared with the crosses (ETB15.3 and 4109.6 for 50%, 17.6 and 4760.6 for 75%, and 21.0 and 5700.7 for 87.5%, respectively) (P<0.01). The profit per day and profit per year for the 87.5% crossbreds were higher (P<0.05) than the amount for the 50% crossbreds. The 75% cross did not have a significant (P>0.05) difference with 50 and 87.5% exotic blood levels.

Discussion

It was noticed that as the level of exotic inheritance increased the benefit in terms of profit had substantially increased. However, Madalena *et al*. (1990) used a profit function that, in addition to milk sales, included returns from sales of calves and culled cows and concluded that maximum profit was obtained utilizing F1 (Holstein Friesian x Guzera) females, over a wide range of simulated economic situations, suggesting that organization of continuous F1 heifer replacement programs may have a sound economic basis in Brazil. Kahi *et al.* (1999) compared economic performance utilizing data on accumulated lifetime performance of crosses of Ayrshire, Brown Swiss, Friesian and Sahiwal cattle from a dairy ranch in the lowland tropics of Kenya. There was no significant difference in the additive breed effects of the *Bos taurus* breeds for profitability indicating that greater genetic differences among breeds does not necessarily lead to greater economic benefits. Therefore, it was indicated that breeding decisions aiming to increase herd production efficiency should not solely be based on lactation and reproductive performances of cows but also on their relative economic efficiency.

Many of the studies on economic comparisons have not looked into the different exotic inheritance levels. Rather, they mainly compared local cattle with crossbred at specific blood level. Indeed, many reported the advantages, in financial terms, of the crosses over the local indigenous breeds. For example, Kumar (1999) in a study of economic analysis of technological change on milk production observed that the average cost per liter of milk

* 1 US Dollar= ETB 8.67 in December, 2005; § 1 US Dollar= Rupees (Rs.) 45.70 in June, 2006

production from milch animal was markedly lower in case of crossbred cows (Rs.[§] 6.27) as compared to the local cows (Rs. 7.90). Similar results have also been obtained by Ram *et al*. (1981), Sharma and Singh (1985) and Kalra *et al*. (1995). Pandit (2002) carried out a detailed study to find out economic benefits of crossbred cows vis-à-vis locals and indicated that the average cost per kg of milk production was lower in case of crossbred cows (Rs 9.07) compared with that of local cows (Rs. 12.40). Net profit per kg of milk was found to be more (Rs. 2.24) for crossbred while it was negative (Rs. -0.54) for local cow. In the same study it was also indicated that net return per animal was Rs. 16.91 per day for crossbred but negative (Rs. -0.79 per day) for local cows.

The household impacts of smallholder-market-oriented dairying have been analyzed to test whether gains in real income from technical change or commercialization may translate into food consumption of the poor and nutrient intake in a pilot research project implemented in Holeta area (Ethiopia) between 1993 and 1998 (Ahmed *et al.*, 2000; 2002). Within the study area, crossbred cow yield a gross margin of ETB 937/cow/year, or more than seven times the gross margin of a local cow (ETB 120 /cow/year) in 1997. This result mirrors that of a similar study by a smallholder dairy development project in the central highlands of Ethiopia in 1998, which shows gross margin of ETB 865/cow/year for crossbred cow with milk production of 700 liters annually (Ojala, 1998). The gross margins estimated for crosses in these studies are smaller compared to results of the present study. This could be a reflection of differences in profit between on-farm and on-station studies, as the present study is based on records of institutional herds.

Although many studies, including the present one, have revealed the economic advantages of crossbred cattle compared with local in many parts of the tropics, it should be noted that indigenous genetic resources have existence, option, cultural and recreation values that are not considered in classical economic analysis. Although these non-market values present formidable estimation problems, an overall assessment of the economic benefit of a crossbreeding program need to capture these benefits which are indeed lost when full-scale crossbreeding is undertaken. Thus, results of these studies should be examined carefully.

Additionally, it is worth mentioning that the difference, in economic efficiency, between the crosses is not inline with the results of biological variation, where the crosses didn't differ in a consistent manner for the dairy traits studied, although 50% crosses were at advantage for some of the traits. This could possibly be because of two reasons: (1) labor cost that is expected to vary between the crosses is assumed similar because of difficulty in partitioning; (2) the economic assessment focused on milk and manure output only. This leaves out reproduction, growth, longevity etc which could some how affect the computation.

Conclusions

The Ethiopian Boran required more than double the cost required to produce a liter of milk compared to crosses. Profit per day and profit per year were also much lower for Ethiopian Boran. It was also demonstrated that as the level of exotic inheritance increased the benefit in terms of profit has substantially increased. It is concluded that intensive dairy production with indigenous tropical breeds (Ethiopian Boran) is not economically feasible. Therefore, in such production systems crossbreds should be utilized. It is also recommended that such economic evaluation be carried out for the different production systems prevailing in the country, preferably with considerations of non-traded benefits of indigenous cattle.

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References

Ahmed M., Jabbar M. and Ehui S. 2000. Household level economic and nutritional impacts of market-oriented dairy production in the Ethiopian highlands. *Food Nutr. Bull.* 21(4): 460-465.

Ahmed M., Ehui S. and Mohamed-Saleem M.A. 2002. Adoption of crossbred cow technologies and increased food security among smallholder dairy farmers in the East African highlands. *J. Crop Prod.* 6:319-337.

Demeke, S., Neser, F.W.C. and Schoeman, S.J. 2004a. Estimates of genetic parameters for Boran, Friesian, and crosses of Friesian and Jersey with the Boran cattle in the tropical highlands of Ethiopia: reproduction traits. *J. Anim. Breed. Genet.* 121: 57-65.

Demeke, S., Neser, F.W.C. and Schoeman, S.J. 2004b. Estimates of genetic parameters for Boran, Friesian, and crosses of Friesian and Jersey with the Boran cattle in the tropical highlands of Ethiopia: milk production traits and cow weight. *J. Anim. Breed. Genet.* 121: 163-175.

EARO, 1999. Livestock Research Strategy: Executive Summary. EARO (Ethiopian Agriculture Research Organization), Addis Ababa, Ethiopia.

Haile Aynalem, 2006. Genetic and Economic analysis of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia. PhD Thesis, National Dairy Research Institute, Karnal, India.

Haile-Mariam, M., Banjaw, K., Gebre-Meskel, T. and Ketema, H. 1993. Productivity of Boran cattle and their Friesian crosses at Abernossa Ranch, Rift Valley of Ethiopia. I. Reproductive performance and preweaning mortality. *Trop. Anim. Health Prod.* 25: 239–248.

Hyman D.N., 1989. Economics. Published by Richard, D.I, Inc, Homewood, Boston.

Kahi, A.K., Thorpe, W., Nitter, G. and Gall, C.F. 1999. Economic evaluation of crossbreeding for dairy production in Kenya. Deutscher Tropentag 1999 in Berlin. Session: Sustainable Technology Development in Animal Agriculture.

Kalra, K.K., Singh, R.V. and Chauhan, A.K. 1995. Economic analysis of milk production and disposal in rural areas of Haryana. *Indian J. Dairy Sci.* 48(9): 546-550.

Karugia, Josef T., Mwai, Okeyo A., Kaitho, Robert, Drucker, Adam, Wollny, Clemens B.A. and Rege, J.E.O. 2001. Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study. FEEM Working Paper No. 106.

Kiwuwa, G. H., Trail, J. C. M., Kurtu, M. Y., Getachew, W., Anderson, M. F. and Durkin, J. 1983. Crossbred dairy cattle productivity in Arsi region, Ethiopia. ILCA Research Report No. 11. ILCA, Addis Ababa.

Kumar, A. 1999. Economic analysis of technological change in milk production in middle-Gangetic plain region of Bihar. PhD. Thesis, National Dairy Research Institute, Karnal, India.

Madalena, F. E., 1989. Cattle breed resource utilization for dairy production in Brazil. *Brazilian J. Genet*. 12(3):183-220.

Madalena, F.E., Teodoro, R. L., Lemos, A. M., Monteiro, J. B. N. and Barbosa, R. T. 1990. Evaluation of strategies for crossbreeding dairy cattle in Brazil. *J. Dairy Sci.*, **73**: 1887-1901.

Negussie, E., Brannang, E., Banjaw, K., Rottmann, O. J. 1998. Reproductive performance of dairy cattle at Asella Livestock Farm, Arsi, Ethiopia. I. Indigenous cows versus their F_1 crosses. *J. Anim. Breed. Genet.* 115**:** 267–280.

Ojala, R. 1998. Gross margin and production cost calculations of milk production at different production and management levels. Smallholder Dairy development Project (SDDP), Addis Ababa, Ethiopia

Pandit, M.C. 2002. Economic analysis of technological change in milk production in Deoghar district of Jharkhand. MSc Thesis, National Dairy Research Institute, Karnal, India.

Ram, K., Singh, K. and Tomar, O.S. 1981. Cost of milk production for various breeds of cattle and buffaloes at National Dairy Research Institute, Karnal. Annual Report. pp 176-177.

SAS, 2002. Statistical Analysis Systems for mixed models. SAS Institute Inc., Cary, NC, USA.

Sharma, P.K and Singh, C.B. 1985. Cost of milk production of milch animals in Karnal district. *Livest. Advisor.* 10(10): 51.

Tesfaye Kumsa 2002. On-farm use of multi-purpose F_1 crossbred cows in the mixed crop/livestock Highland production systems of Ethiopia. PhD Thesis, the Royal Veterinary and Agricultural University, Copenhagen, Denmark.