Agricultural Economics Research Review
Vol. 28 (No.2) July-December 2015 pp 285-292
DOI: 10.5958/0974-0279.2016.00007.0

Economic Gains from Technological and Marketing Interventions in Goat Production in India: An *Ex-ante* Assessment

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Abstract

This paper has quantified the potential economic gains from technological and marketing interventions in goat production. A disaggregated analysis of net gain by individual intervention has been carried out so that more informative research and development programmes could be prioritized to enhance goat production in the country. The application of breeding intervention has been found to yield economic gains of ₹ 23713 million, which include ₹ 9977 million as cost of intervention. The health care intervention, which includes vaccination against important diseases and deworming may generate an additional income of ₹ 24064 million. An additional net gain of ₹ 14002 million has been estimated through nutritional intervention after deducting ₹ 29651 million as the cost of nutrition intervention. The net economic gain through marketing of kids at commercial age has been estimated to be ₹ 11842 million. This has been worked out after deducting cost of ₹ 13534 million for keeping animals for additional 4 months to attain the commercial age. The order of magnitude can be gauged that opportunity cost of technological interventions on health care, nutrition and marketing together are equivalent to about 1.24 per cent of total value of output (at current prices) from livestock sector in 2010-11 and 14.74 per cent of the value of output from goat sector for the year 2012.

Key words: Technological interventions, economic gains, marketing, goat production, India

JEL Classification: Q13, Q16

Introduction

India is a home to18 per cent of world goat population (FAO, 2015). Goats and their products accounted for about 8.5 per cent of value of livestock output (at current prices) in 2010-11. Over the period, the goat sector has witnessed a significant increase in output of its products, viz. meat, milk and skin. India is the largest producer of goat milk (4.85 Mt) and second largest producer of goat meat (0.6 Mt). Goat meat alone contributes about 54 per cent to the total value of output from the goat sector. The goat-rearing in India is widespread and is largely concentrated among resource- poor households which are landless or have tiny pieces of land. Households cultivating less than 2.0 ha land (marginal and small) are the custodian of more than 76 per cent of the total goats in the country (GoI, 2006-07). Therefore, goat-rearing has one of the most inclusive growth rates among all the livestock species (Singh *et al*., 2013). Demographic changes in livestock population in the country have also shown a shift that favour small ruminants, particularly goats (Dikshit *et al*., 2012).

Between 2007 and 2012, the goat population in the country declined from 140 millions to 135 millions, i.e. by 0.73 per cent annually (Livestock Census, 2012) probably because of high slaughter rate and depleting grazing resources. However, the average carcass and milk yields remained stagnant over this period. It could be due to the facts that most of the goats (65%) are kept on subsistence production system and are non-

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descript type with low yield of milk and meat. The production potential of goats is not being harvested due to a number of' interactive factors related to poor breeding, sub-optimal nutrition, improper health care, reproduction and poor access to these services and markets.

In India, the growth in goat population can be improved by technological interventions for cutting down mortality among kids and adult animals and enhancing productivity. The diseases in goats result in mortality ranging from 5 to 25 per cent in adults and 10 to 40 per cent in kids (Rekib and Vihan, 1997). Also, the prophylactic measures receive less attention, and vaccination coverage of animals is much below the level of effective protection (Ahuja *et al*., 2000). With large population base and untapped potential of goats, there is a scope to harvest more benefits in short period of time. This paper has quantified the potential economic gains from goat production through technological interventions. The study will help prioritize areas that need specific technological interventions to enhance the income of millions of poor goat farmers and other stakeholders.

Data and Methodology

The data for study were compiled from diverse sources. The data on goat population were collected from the Indian Livestock Census, 2012. Information on productive and reproductive parameters was compiled from different secondary sources, including authors' estimates and experts' opinion in some cases. Tabular analysis was carried out to estimate the potential economic benefits from technological interventions. The breeding intervention included supply of quality breeding bucks for genetic potential improvement. This might improve prolificacy, body weight of kids and milk yield. The economic gains were calculated on value of additional number of kids born, body weight gain and value of increased milk production.

The proposed technological interventions of disease management included: vaccination against *Peste des petits ruminants* (PPR), goat pox (GP), enterotoxaemia (ET) and foot and mouth disease (FMD). Beside vaccinations, deworming of goats (twice in a year) has been suggested as a technological intervention for better goat health care and productivity. The economic gains of health care intervention have been estimated by the value of animals survived due to reduction in mortality. Under the nutrition intervention in goats, strategic supplementation was suggested at the rate of 175 grams of concentrate feed for fattening kids for 180 days and 200 grams per day to each breeder does with ad-lib iodized salt for 90 days. It covered the period of one month of advance pregnancy and two months of lactation. The gain from nutrition intervention was worked out by calculating the value of additional weight gain in male kids and increment in milk yield of does. The capacity building of different stakeholders on scientific goat-rearing and marketing strategies, like sale of kids at commercial age through efficient channel is important to enhance net returns in goat-rearing. Finally, the net economic gains from different interventions were calculated to estimate potential gains in monetary terms from intervention of various technical inputs. The estimates were based on goat population as per Livestock Census 2012 under different age groups and functional categories. The slaughter rate and transaction cost of intervention have not been considered. The parameters, values and assumptions used are given in Table 1.

A formal framework was formulated to determine the potential economic gains. The model was a static one and all the variables and parameters involved related to point of time.

Estimation of Economic Gain from Breeding Intervention

The potential economic gains from breeding interventions were estimated for non-descript goats. Of the total goat population, about 63.5 per cent were of non-descript goats. The probable economic gain from breeding intervention is given by Equation (1):

$$KBnd = Pg * B * ND * KR \quad \ldots(1)$$

where, *Pg* denotes the population of female goats in a year, *B* is the proportion of breedable population of goats, *ND* is the proportion of non-descript goats, and *KR* denotes the improved kidding rate.

The number of kids survived may be given by Equation (2):

$$KBnds = KBnd - (KBnd * Km) \quad \ldots(2)$$

where, *KBnds* is the number of non-descript kids survived and *Km* is the rate of kids mortality. The male

Table 1. Different parameters and their values in goat production, 2012

Parameter	Values	Sources
Goat population in 2012 (million)	135	Indian Livestock Census 2012
Proportion of breedable goats (%)	45	Indian Livestock Census 2012
Proportion of non-descript goats (%)	63.5	Indian Livestock Census 2007
Kidding rate	1.5	Annual AICRP Report (PC-goat) 2012-13
Kid mortality (%)	20	Singh *et al*., 2013
Male female ratio	50:50	Annual AICRP Report (PC-goat)
Buck to doe ratio	1:25	Annual AICRP Report (PC-goat) 2012-13
Average weight gain of male kids due to breeding with superior buck (kg)	1.65	Singh *et al*., 2013
Increase in milk per goat per lactation (litres)	11	
Sale price of goat milk (₹/kg)	20	NAIP comp-3 Report-2014
Daily maintenance cost of superior breeding buck (₹/day)	6	CIRG (2015)
Proportion of young stock and other growing goats (%)	45	Indian Livestock Census 2012
Mortality among kids without prophylactic measures (%)	18	Singh *et al.,* 2013
Mortality among kids after intervention (%)	07	
Mortality among adults without prophylactic measures (%)	12	
Mortality among adults after intervention (%)	05	
Veterinary expenses on prophylactic measures (₹/animal/year)	50	Multiplier Flock Survey Report, 2015
Meat yield of live body weight (%)	50	Singh *et al.,* 2010
Average body weight of the male kids at 5-6 months (kg)	10.5	Market survey
Average body weight of the male kids at 9-10 months (kg)	16.5	
Cost of feed (₹/kg)	14.0	Market survey
Proportion of goats sold at 5-6 months (%)	50	Market survey
Average sale price of goat (₹/kg lives weight)	150	Market survey
Expenses to retain goats for next 4 months (₹/animal)	480	Authors' estimates

to female ratio was 50:50. Finally, the economic gains due to breeding intervention were estimated in three ways: (i) additional kids born due to improved prolificacy, (ii) weight gain by male kids, and (iii) incremental milk production. The weight gain through breeding intervention is cumulative and will be achieved in long period/generations. The potential economic gains due to breeding intervention were estimated by Equation (3):

$$PGbi = (Mknds * Wg * Vbw) + (Fknds * Mg * Vm) \quad \ldots(3)$$

where, *Mknds* and *Fknds* are the numbers of non-descript male and female kids respectively; *Wg* and *Mg* are the additional body weight gain and incremental milk yield in male and female kids, respectively. *Vbw* and *Vm* denote the per kg value of body weight and goat milk. The net economic gains from breeding intervention were given by Equation (4) after deducting maintenance cost (*Mc*) of breeding bucks from gross economic gains through breeding intervention (*PGbi*):

$$NEGbi = PGbi - Mc \quad \ldots(4)$$

Estimation of Economic Gains from Health Intervention

The probable economic gains from health interventions can be given by Equation (5):

$$PGhi = [P_k(Mb_k - Ma_k) * V_k] + [P_a (Mb_a - Ma_a) * V_a] \quad \ldots(5)$$

where, P_k and P_a denote the number of kids and adults in the year 2012, respectively; *Mb* and *Ma* are the rates of mortality before and after intervention among kids and adults, respectively. V_k is the value of survived kids and V_a is the value of survived adults. The net economic gain from health intervention was given by Equation (6) after deducting expenditure made on veterinary care (V_c):

$$NEGhi = (PGhi) - (Vc) \quad \ldots(6)$$

Estimation of Economic Gains from Nutrition Intervention

The potential economic gains from nutrition intervention may accrue in two ways: (i) increment in body weight of male goats due to supplementation of concentrate feed, and (ii) improvement in milk yield of breeding does. The body weight gain by adult goats may be estimated by Equation (7):

$$PGwg = Pmg * Ibw = Vbw \quad \ldots(7)$$

where, *Pmg* denotes the male goat population. The male goat population considered for calculation was the summation of 80 per cent of male kids (less than 1 year) and 60 per cent of males of more than 1 year of age, *Ibw* is the incremental body weight gain due to supplementation of concentrate and *Vbw* is the value of weight gain in terms of ₹/ kg of live weight.

Similarly, the economic gains from improvement of milk yield in breeding does can be given by Equation (8):

$$PGmg = Pm * Imy * Vm \quad \ldots(8)$$

where, *Pm* is the population of milch goats (in-milk + dry); *Imy* is the incremental milk yield and *Vm* is the value of goat milk (₹/kg).

The total economic gains through nutrition intervention in goat production may be given by Equation (9):

$$PGni = PGwg + PGmg \quad \ldots(9)$$

Finally, the net economic gains from nutrition intervention can be denoted by Equation (10):

$$NEGni = (PGni - Fc) \quad \ldots(10)$$

where, *Fc* is the cost of additional concentrate feed fed to the males and breeding does.

Estimation of Economic Gains from Capacity Building/Market Intervention

Capacity building on emerging market strategies encourages goat farmers to adopt technologies and improve their returns. Linking goat farmers with markets/quality buyers and motivating them to sell their animals at commercial age are some of the important strategies. The potential economic gains from marketing interventions may be given by Equation (11):

$$PGmi = \{Pk * P * Wg * Vbw\} \quad \ldots(11)$$

where, *Pk* denotes the kid population (male + female); *P* is the proportion of kids sold at their commercial age; *Wg* is the additional body weight gain, and *Vbw* is the value of body weight gain.

The net economic gains can be worked out by Equation (12) where *Rc* is the total cost incurred to maintain kids for next four months to attain commercial age.

$$NEGmi = (PGmi - Rc) \quad \ldots(12)$$

It may be mentioned here that interventions have their interactive effects. These interventions are interlinked and have additive effect on each other. Therefore, precise estimation of gains for each intervention is not easy. For instance, deworming reduces morbidity among goats, but at the same time also increases body weight. Similarly, supplementation of concentrate feed at advance pregnancy not only increases milk yield but also increases kid's growth rate, health of does and kidding rate (reproductive efficiency) and its productive life. In the same manner, genetic intervention enhances the potential of animal for prolificacy, weight gain, milk yield, kidding rate, feed conversion efficiency and disease resistance.

Results and Discussion

Economic Gains from Breeding Intervention

India has 24 registered goat breeds. The majority of goats (about 63.5%) belong to non-descript category and the productivity of these goats is low. The unsatisfactory growth in productivity is attributed to indiscriminate breeding, lack of field based genetic improvement programmes (breeding with superior bucks) and knowledge gap among goat farmers. The recent trends in goat population have indicated pressing need for breeding interventions.

The present estimates of probable economic gains through breeding intervention in goats in general and non-descript goats in particular were based on 61 millions of breedable goats (62 % of total female goats), of which 38.6 millions were non-descript breedable goats. The data presented in Table 2 indicate that economic gains of ₹ 10834 million may be generated

Table 2. Economic gains due to breeding intervention

Particulars	Value
Number of breedable goats (millions)	60.83
Number of non-descript breedable goats (millions)	38.62
Number of additional male kids born and survived (millions)	2.46
Number of additional female kids born and survived (millions)	2.46
Value of additional male and female kids born and survived (in million ₹)	10834.20
Value of increased body weight of male kids (in million ₹)	6703.66
Value of increased milk production (in million ₹)	6175.49
Cost of intervention: Maintenance cost of bucks (in million ₹)	4659.00
Cost of maintenance of kids (in million ₹)	5318.61

as a the value of additional kids born due to improvement in prolificacy. About ₹ 6703 million could be earned by increased body weight of the male kids through improved breeding and ₹ 6175 million could be earned by increased milk production. The maintenance cost of required bucks and additional kids was estimated to be ₹ 4659 million and ₹ 5318.61 million, respectively.

Economic Gains from Healthcare Intervention

The mortality due to high disease incidences in goat production is responsible for high economic losses (Kumar *et al*.,2003; Singh and Prasad, 2008). Peste *des petits ruminants* (PPR), goat pox, enterotoxaemia and foot and mouth disease (FMD) are the major diseases of goats. These diseases cause mortality and morbidity losses in goats resulting in low productivity and population (flock size). Mortality in kids and adult goats is reported to be 20 per cent and 10 per cent, respectively due to major diseases (Paliwal *et al*., 1978; Krishna *et al*., 1979). The annual economic losses due to diseases have been estimated as ₹ 11720 million (Kumar *et al*., 2004).

India's goat production system may generate additional output in terms of animals prevented/ survived from diseases and other ailments by adopting vaccination and prophylactic measures. The data on kids and adult population, mortality with and without intervention, cost of prophylactic measures and related parameters are given in Table 3. The estimates of economic gains from health intervention include animal survived due to reduction in mortality due to adoption of prophylactic measures (Table 3). The value of goats survived/saved was estimated to be ₹ 24064 million. The cost of prophylactic measures which included vaccination, deworming, treatment and general health care, was ₹ 6758 million.

The mortality among kids is expected to be reduced by 11 percent through healthcare intervention. The properly implemented healthcare interventions in goats would reduce mortality from 29.4 per cent to 4.2 per cent (Singh *et al*., 2013). And, the economic losses due to diseases could be reduced up to 70 per cent by taking prophylactic measures in time (Kumar *et al*., 2003).

Economic Gains from Nutrition Intervention

India's goats are predominantly kept under extensive management system. There is high dependence on common resources of goat farmers as majority of them are landless, marginal and small farmers. Further, there is a large gap between demand

Table 3. Economic gains due to healthcare intervention

Particulars	Value
Population of adult goats (millions)	135
Mortality among kids before intervention (%)	18
Mortality among kids after intervention (%)	7
Mortality among adults before intervention (%)	12
Mortality among adults after intervention (%)	5
Value of kids saved due to health intervention (in million ₹)	8787.88
Value of adult saved due to health intervention (in million ₹)	15277.03
Total value of goat saved (in million ₹)	24064.91
Cost of health interventions (in million ₹)	6758.65

Table 4. Economic gains due to nutrition interventions

Particulars	Value
Male goat population (millions)	26.66
Concentrate feeding to kids and growing adult @ 0.175 kg/ day for 180 days (kg)	31.5
Increase in body weight over and above normal @ 30% at 9 months of age (kg)	4.95
Total increase in kids body weight at national level (in million tonnes)	0.13
Cost of additional feed (in million ₹)	11757.09
Value of increase live body weight (in million ₹)	19795.09
Milch goat population (millions)	71.01
Total milk gain (million tonnes)	1.19
Value of milk gain (in million ₹)	23859.67
Cost of additional feed fed to breeding does (in million ₹)	17894.80

and supply of livestock feed (Anonymous 1976; Singh and Mujumdar, 1991; Ramachandra, *et al*., 2007). The feed scarcity is the most important constraint, and accounts for nearly half of the total losses in dairy production (Birthal and Jha, 2005). Moreover, feed and fodder alone constitute about 60-65 per cent of total cost incurred in goat production. Studies indicated deterioration in quantity and quality of common property resources in different regions (Jodha, 1992). Under this technological intervention, the farmers are advised to feed concentrate in appropriate quantity to their goats. Information provided in Table 4 reveals that feed supplementation of growing kids with 175 g of concentrate for 180 days may increase 30 per cent of their body weight until 9-10 months of age and additional 0.13 Mt live weight may be harvested from the present stock of male kids (80%) and adult males (60%). This additional weight can be translated into the value of ₹ 19795 million with additional feed inputs of ₹ 11757 million to supplement concentrate for the goat population.

The improved feeding may also affect milk yield of breeding does. Taking milch goats (in-milk and dry) as base for calculation with 50 percent improvement over the current milk yield, the additional milk production would be 1.19 Mt, valued at ₹ 23859 million. The cost of additional feed to breeding does was ₹ 17894 million. It covered one month advance pregnancy and two months of lactation period.

Economic Gains from Marketing Intervention

The capacity building programmes are important in goat production as majority of goats are reared by the socio-economically weak people. These programmes lead to improved profitability and create positive attitudes towards goat farming. Goat rearing as well as marketing are often done with high negligence and through inefficient channels. There is high demand of tender goat meat in the domestic market and in the middle east countries .The impressive growth in meat production in the country is mainly due to slaughter of increased number of animals. The productivity of goats continues to remain low and slaughtering of premature animals for meat is a national waste (Ravishankar and Birthal, 1999).

We also estimated losses that can be avoided through marketing of goats at their commercial age (9-12 months). There is necessity to create awareness among goat farmers for the appropriate age of sale. Studies have revealed that in villages the majority of kids are sold when they are less than 6 months old under distress sale (Singh *et al.,* 2013). Goat slaughter between 9 and 12 months of age when their body weight is 16.5-20.0 kg would yield an additional body weight of 0.169 Mt valued at ₹ 25376 million (at ₹ 150/ kg live weight). If we assume expenses on goats as ₹ 4.00 per day per goat, the total expenses on retaining goats for the next 4 months would be ₹ 13534 million, and therefore probable net gains from selling animals at 9-12 month will be ₹ 11842 million.

The estimates of net probable gains by broad group of interventions are provided in Table 6. The annual gross gain by all types of interventions has been estimated to be ₹ 116809 million, the cost of intervention has been estimated as ₹ 59922 million and the net gain has been worked out to be ₹ 56887 million.

The order of magnitude of these interventions can be gauged while comparing it with the total value of

Table 5. Economic gains due to marketing intervention

Particulars	Values
Body weight of kids sold between 3-5 month (kg)	10.5
Body weight of kids sold between 9-12 month (kg)	16.5
Difference in body weight (kg)	6.0
Addition to body weight (million tonnes)	0.169
Value of increased body weight (in million ₹)	25376.76
Expenses to retain animals for next 4 months (in million ₹)	13534.28
Net gain from the marketing animal at 9-12 months of age (in million ₹)	11842.49

Table 6. Net economic gains from proposed technical interventions in goat production

(in million ₹)

Interventions	Gross gain	Cost of intervention	Net gain
Breeding			
Additional kids born and survived due to improved prolificacy	10834	5318	13735 (24.15)
Improvement in body weight	6703	4659	
increment in milk yield	6175		
Healthcare			
Reduction in mortality due to health intervention	24064	6758	17306 (30.42)
Nutrition			
Body weight gain due to nutrition intervention	19795	11757	14002 (24.62)
Improvement in milk yield	23859	17894	
Marketing			
Sale of kids at their commercial age	25376	13534	11842 (20.82)
All	116809	59922	56887 (100.00)

output from the livestock sector; it was equivalent to about 1.24 percent of the total value of output from livestock (at current price) in 2010-11. These gains were also equivalent to 14.74 percent of the value of output from the goat sector. The cumulative effect of all the interventions may have benefits more than expectations. A disaggregated analysis of net gain by individual intervention is more informative and helpful to prioritize research and development programmes to enhance goat production in the country. Implementation of breeding, healthcare, nutrition and marketing interventions may yield a net gain of ₹ 13735 million, ₹ 17306 million; ₹ 14002 million and ₹ 11842 million, respectively. The share of different interventions in total net gain reflects that healthcare interventions constituted 30 percent of the total gain. This may be due to low intervention cost with high gross economic gains. The other interventions, viz. nutrition, breeding and marketing shared 24.62 per cent, 24.15 per cent and 20.82 per cent, respectively to the total net gain.

There were some caveats also in these estimates. We have used the best values of the parameters available to us, yet there could be some measures of uncertainty in these values. The estimate given for the probable economic gains should be taken as order of magnitude rather than precise numbers.

Conclusions

The study has revealed that goat production in India could be increased by adopting technologies and inputs pertaining to healthcare, nutrition, breeding and know-how. The order of magnitude can be gauged that opportunity cost of technological interventions on healthcare, nutrition and marketing together are

equivalent to about 1.24 per cent of the total value of output from livestock sector (at current prices) in 2010-11. There is a need for concerted efforts on intensification of transfer of technologies and delivery of extension services on improved goat production and management practices with a convenient access to resources, technologies and markets. Further, the problem-specific research and development programmes should be prioritized to improve income and nutrition of goat farmers.

Acknowledgements

The authors sincerely thank Dr P.S. Birthal, Principal Scientist, National Institute for Agricultural Economics and Policy Research, New Delhi, for suggesting improvement in the manuscript. They are also grateful to the anonymous referee for providing helpful suggestions.

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Received: December, 2014; Accepted: September, 2015