Productivity of cross-bred goats under smallholder production systems in the Eastern highlands of Kenya[1]

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Abstract

Dairy goats have become increasingly popular among smallholder mixed crop-livestock farmers. Their profitability will determine their growth within smallholder production systems. A survey was carried out in 114 farmer groups, representing 435 goat herds and 1676 goats. Data on reproductive and growth performance, milk production and flock dynamics (deaths, births, and sales) were collected between October 2001 and September 2003. The genotypes involved were the local East African goat, pure Toggenburg (T) and their crosses (F1) and 3/4T. Using the Livestock Productivity Efficiency Calculator (LPEC) as an input framework, herd structure, gross margins and herd growth were calculated based on feed efficiency. The parameter used was the annual total value of off-take per carrying capacity unit (CCU), which was defined as a standard livestock unit consuming 100 Mega joules of metabolisable energy (ME) per day. The goat enterprise proved to be profitable Annual gross margins of over US $259 were recorded indicating that dairy goat enterprises under smallholder production systems can be profitable, (the USD exchange rate at March 2005 was 77 Kenya shillings to US $1).

Introduction

Goat rearing is becoming increasingly popular among smallholder mixed crop-livestock farmers. Goat production is regarded as a feasible means to improve the income and nutrition of rural communities and to bring these communities into commercial marketing systems (Braker *et al.*, 2002). With the increasing human population and diminishing land sizes, it is becoming difficult for small-scale farmers with very small land holdings (many as small as 0.25 ha, including the homestead) to keep large ruminants. The goat has become very popular in recent years as a pathway out of poverty (Ahuya *et al.*, 2004). Currently, many non-governmental organisations (NGOs) working with resource-poor livestock keepers in medium to high potential areas are encouraging farmers to keep improved goat genotypes, which are mainly cross-breds between the exotic temperate and the indigenous tropical breeds.

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Cross-breeding is a way of realising quicker genetic improvement than by selection, matching genotype with the environment and benefiting from the complementarity of the breeds involved. The benefits that farmers enjoy include faster growth rates and more milk from the cross-bred goats. There are many goat cross-breeding programmes in Kenya and the eastern Africa region (Ahuya, 1997; Gichohi, 1998; Ayalew *et al.*, 2003;) which have been implemented with varying degree of success; but except for the FARM-Africa project in Ethiopia, very little attempt has been made to demonstrate comparative productivity of the genotypes involved. FARM-Africa, an international non-governmental organisation (NGO), introduced the British Toggenburg dairy goat, into the Eastern Highlands of Kenya through the Meru Dairy Goat and Animal Health Care Project, which has been used in upgrading the local goats for improved milk production and growth. A study (through the Livestock Production Programme (LPP, project R7634) was carried out to establish the profitability of goat enterprises in the Eastern Highlands of Kenya.

Productivity when applied to livestock refers to either level of production or efficiency of production (James and Carles, 1996). In any production system, productivity will be uniquely influenced by complex interactions of environmental, biological and socio-economic variables (Omore, 1998). The variables are interrelated and, therefore, should be looked at holistically to determine their relative importance and how changes in components affect the whole system. In terms of the efficiency of a production system, productivity is a ratio of units of outputs per unit of inputs to the system. This implies that all outputs must be reduced to the same units although the terms used for outputs might be different.

The most important factor hampering the determination of efficiency of ruminant livestock production in the past has been the difficulty of quantifying the economic value of feed, which is the most important input (James and Carles, 1996). Feeds available to ruminant livestock include crop residues and pastures which in most cases have no alternative uses. One approach to comparing the efficiency of livestock production, across different production or grazing systems, is to compare outputs per standardised energy input. The livestock productivity efficiency calculator (LPEC) (PAN Livestock Services, 1990) is a deterministic model developed to calculate output per unit of energy, taking into account other determinants such as reproduction and mortality rates. There are three important attributes of LPEC that make it appropriate in determining livestock productivity: it is a deterministic model developed to calculate output per unit of energy (does not include the effects of chance variation); it is a static model, in that it describes the state of a herd that is in equilibrium, but will indicate whether the herd is increasing or decreasing; it can be used across production systems and across genotypes. Variable and fixed costs of inputs, other than forage, can be subtracted from LPEC output to obtain both gross and profit margins respectively.

Materials and methods

Data on reproductive and growth performance, births, milk production, survival, deaths, and sales were collected from 435 herds of goats, of various genotypes, from the farm records of participating farmers, who were all members of one of 114 farmers' self-help groups, (Table 1). Monitoring was carried out monthly, between October 2001 and September 2003. The farmers' groups are voluntary self-help groups, with each group sharing a breeding buck. The buck is maintained by one of the group members at his/her home, which is referred to as a buck station, and is used to mate with the does belonging to both members and non-members. The farmers and their groups are participating in a community-based dairy goat genetic improvement and health care project that was undertaken by FARM-Africa in collaboration with the government of Kenya, in Central and South Meru Districts of Central Kenya. The farmers belong to the Meru Goat Breeders Association (MGBA), which is a community- based farmers' member organisation that supervises and coordinates the breeding activities of the improvement programme.

The goat genotypes involved in this study were the exotic dairy Toggenburg (T) breed, the indigenous meat breed, the East African (EA), and the F1 cross-breds arising from mating Toggenburgs with the EA, as well as the 3/4T x ¼ crosses that were obtained from backcrossing the F1s (TxEA) females to the Toggenburg males. The detailed mating plan and the project's approach are described by Ahuya (1997). Flock productivity parameters were calculated from the data collected from the 435 flocks comprising 1676 animals (Table 2). Discussions were held with farmers, MGBA officials and community leaders to identify the goat genotypes and breeds that the farmers preferred, including the breed standards, physical and productivity characteristics

Animals are managed under confinement or zero-grazing. They are fed indigenous and established fodders in a cut-and-carry system. The farmers have established forages such as *leucaena*, *sesbania*, mulberry (*Morus alba*) and *calliandra*, which are used mainly as supplements. The cross-bred animals are owned by the farmers, while the pure Toggenburgs belong to MGBA. There are also farmer groups that are outside the project area but have bought goats from MGBA members and are implementing an upgrading scheme alongside MGBA members, setting up their own breeder units and buck stations.

Each group meets and agrees on how the bucks should be managed, especially feeding policy. They are either fed individually or by all members of the group. Where the animals are fed by the group, a feeding-duty roster is operated. Nearly half the groups collectively feed the bucks, while the others rely on the buck keepers, for which they are paid. Minerals and water are provided daily. Veterinary treatment is carried out as necessary by the Community Animal Health Worker, (CAHW), who is a farmer chosen by the group. The CAHWs are trained and receive payment for their services, thus ensuring that veterinary help is available for livestock belonging to the resource-poor.

Table 1 *Goat genotypes monitored during the study*

Genotype	Female	Male	Total	Farmer groups
East Africa (EA)	388	70	458	
Pure Toggenburg (T)	189	129	318	
F1 (TxEA)	511	184	695	
Three-quarter T	110	95	205	
Total	1198	478	1676	114

An evaluation of cross-bred dairy goat productivity was carried out to assess the profitability of the dairy goat enterprise under a smallholder production system. Four genetic groups were involved in the study, but the majority of the herds were a mixture of pure and cross-bred goats. The genetic groups were: indigenous goats; cross-breds (T x Indigenous); ¾ T x ¼ Indigenous); and pure Toggenburg. The production parameters considered were mortality and culling rates, birthweight, mature weight and sales, kid survival rates, buck/doe ratio and lactation yield.

The LPEC was used as a framework for inputting production parameters and estimating the value of output per unit of forage input or carrying capacity unit (CCU)/year, where one (CCU) is equivalent to the feed supply providing 100 mega joules (MJ) of metabolisable energy (ME) per day. The economic indices calculated were gross margins (total output value less variable costs) per CCU and per goat.

Goat flocks used were grouped in six different classes: 1) suckling females (<4 months); 2) weaned females (>4 months); 3) Breeding females (after first kidding); 4) suckling males (<4 months), 5) weaned males; and 6) Breeding males (bucks over 12 months). For each class of goat, production parameters, mortality, culling rates and kidding rates were calculated on an annual basis. Net sale rates were calculated by subtracting the number of goats bought from the numbers recorded as sold. The net sale rates for does and bucks were considered as culling. Goat prices were determined by MGBA members after considering the demand for goats and the prevailing market prices.

Results and discussion

Flock sizes and reasons for keeping goats

The average flock size was four goats (range 1-22) of mixed genotypes, with the majority of farmers indicating their desire to keep only cross-bred goats. The main reason for this was the cross-breds' potential for higher milk production compared to indigenous goats. An earlier study (Ahuya *et al.,* 2003) showed that cross-breds, both F1 and ¾ Toggenburgs, produced 2.6 and 3.6 litres per day respectively, compared to the 300 ml produced by the indigenous East African goat. For the majority of the farmers interviewed, this trait was the reason for wanting to join or start a dairy goat enterprise. Table 2 shows the reasons why farmers kept goats.

Table 2 *Reasons given by farmers for keeping cross-bred goats*

Traits	Percentage (n= 386)
Milk Production	54
Growth rate (increased income)	25
Manure	19
Other (traits mentioned were, docility, udder size, good, well-placed teats)	2

Survival rates and health problems

The survival rates up to weaning of the cross-bred and pure Toggenburgs were very good, attributed by farmers to the training they received to improve their management skills. Most farmers indicated that they had been worried that the animals, especially the Toggenburgs, might not survive. The Toggenburgs had the lowest survival rate at 92 per cent while F1 and three quarter Toggenburgs were 94.83 per cent and 94 per cent respectively, and similar to earlier results, (Ahuya *et al.*, 2002). The farmers also attributed this relatively high survival rate to the availability of animal health services provided by the CAHWs. The major diseases attended to by CAHWs (Table 3), were worm infestations, pneumonia and coccidiosis, the first two controllable by providing adequate housing. A raised slatted floor will drastically reduce worm burdens, by allowing contaminated faeces to fall under the floor, while a well positioned and properly ventilated house can reduce the incidence of pneumonia.

Table 3 *Types of disease treated by community animal health workers (CAHWs)*

Disease	Percentage of total cases treated	Remarks
Worms	70	Mainly *Haemonchus*
Pneumonia	8	
Diarrhoea	3	
Coccidiosis	5	
Parasites	3	
Others(mineral deficiencies)	11	Mainly giving advice

Herd structure and annual profitability

Tables 4 shows the herd structure, which is typical of that seen locally, with weaned males tending to outnumber females, especially in the breeding units. Table 4 also shows the number of each type of animal per carrying capacity unit (CCU). It is clear that replacement stock is adequate to sustain an annual herd growth of 25 per cent.

Table 5 shows annual profitability, excluding the value of the manure that is used on the farm, contributing to improved crop yields from goat keepers' fields. Both net profit and gross margins were calculated directly from the LPEC output. In calculating these, cost of purchased feeds was ignored, since most farmers indicated that they rarely purchased any feed for their animals, except for mineral licks. However, most farmers admitted that before the goat project was introduced their goats were not properly managed.

Table 4 *Herd structure, metabolisable energy (ME) requirement and output values for dairy goats on smallholder dairy farms in Meru Central ands South Districts, Kenya*

***Class of stock** (see text for details)	Percentage of herd	ME/Day	No/CCU	Value/Animal (US $)	*CCU (US $)
Breeding females	29	14.84	2.91	33.5	23.7
Suckling females (replacements)	2	4.17	0.23		
Weaned females (replacements)	15	7.83	1.58	52	33.9
Suckling females (surplus)	2	4.17	0.17		
Weaned females (surplus)	12	7.82	1.18	39	1.36
Breeding males	1	11.51	0.09	26	.68
Suckling males (replacements)	0	5.01	0.06		49.26
Weaned males (replacements)	0	9.20	0.07	39	.71
Suckling males (surplus)	4	4.7	0.09		187.3
Weaned males (surplus)	3	8.3	2.57	26	8.8
Total	100		3.34		298

* CCU = carrying capacity unit (see text for details)

Table 5 *Gross margins and annual net profit per carrying capacity unit (CCU, see text) for dairy goats on smallholder farms in Meru Central and South Districts, Kenya*

	Value per unit (US $)	Off-take units/CCU year	Value (US $/CCU/Year
Output			
*Culled breeding females	33.5	0.69	27
Mature surplus females	52	0.71	55
Mature replacement females	26	0.03	1.45
Culled breeding males	39	0.01	.84
Mature surplus males	33	0.20	90.6
Milk (kg)	.25	721	177.8
Costs			
Other costs per animal[a]			29.5[a]
Purchased feed costs per animal[b]			
Net profit per CCU/year	259.5	(29.5)	323.19
Gross margin per CCU/year	295.6		

*See text for goat classes.

[b] These costs include veterinary inputs, goat investment, buildings and labour

[b] these costs only include variable veterinary inputs (drugs and fees)

Using the above information, herd growth was calculated as shown below and the result indicate a growth of 26%.

$$\text{Herd Growth} = \frac{\text{off take value of surplus heifers}}{\text{CCU of breeding does/yr}} \quad \frac{0.18}{0.70} = 0.26$$

Conclusion

Dairy goat enterprises are profitable and can contribute significantly to the improvement of livelihoods of the rural communities in medium to high potential areas of Eastern Kenya, and elsewhere with similar agro-ecological conditions. Goat rearing under the 'cut-and-carry' system of feeding can be successful under smallholder production systems, especially where farmers can grow improved tree fodders, often to mark boundaries and as live hedges.

References

AHUYA, C. O., (1997) Community based goat improvement project in Meru Central and South districts: The FARM-Africa experiences. In: *Proceedings of Goat Development in Eastern Africa, Workshop, 8-11th December, 1997, Izaak Walton Inn, Embu, Kenya.* Ahuya, C.O. and Van Houton, H. (Eds). FARM-Africa, Nairobi, Kenya.

AHUYA, C. O., OKEYO, A. M., MOSI, R. O., MURITHI, F. M. and MATIRI, F. M. (2002). Body weight and pre-weaning growth rate of pure indigenous, Toggenburg goat breeds and their crosses under smallholder production systems in Kenya. Paper presented at BSAS International conference in Merida, Mexico.

AHUYA, C. O., OKEYO, A. M., MOSI, R. O. (2003). Growth survival and milk production performance of Toggenburgs and their crosses to East African and Galla goat breeds in the Eastern slopes of Mount Kenya. Paper presented at LPP International Workshop on Small Ruminants Research and Dissemination, 3rd–7th March, 2003, Embu, Kenya

AHUYA, C.O, OKEYO, A.M, MWANGI D. M. and PEACOCK C. (2004) Developmental challenges and opportunities in the goat industry: The Kenyan experience. Paper presented at the 8th International Conference on Goats, July 4-9th, 2004, University of Pretoria, Pretoria. South Africa.

AYALEW, W., RISCHKOWSKY, B., KING, J.M., BRUNS, E., (2003). Cross-breds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. *Agricultural Systems* (76), 1137-1156.

BRAKER, M. J. E., H. M. UDO, and E. C. WEBB, (2002). Impacts of intervention objectives in goat production within subsistence farming, South African Journal of Animal Science 2002, 32(3).

GICHOHI, C. M. (1998) Overview of the goat industry in Kenya: - strategies and the way forward. In Ahuya C. O. and van Houton H. 1998). Goat Developments in East Africa:- practical experiences and the way forward. Meru, Kenya.

JAMES, A. D., and CARLES, A. B. (1996). Measuring the productivity of Grazing and foraging livestock. Agricultural Systems, vol. 52. No 2/3, pp 271-291.

OMORE, A. (1998). Productivity of cattle on smallholder dairy farms in Kiambu District, Kenya Unpublished survey report.

PAN LIVESTOCK SERVICES LTD. (1990). The Livestock Production Efficiency Calculator (LPEC) User Guide. University of Reading, Department of Agriculture, Early Gate P.O. Box 236, Reading, UK.