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The Concept and Calculation of Net Benefits from Goats in Ethiopian Smallholdings

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Abstract

Low adoption rates of introduced technologies in spite of manifestly increased production suggest that livestock developer and farmer value livestock differently. The purpose of this paper is to relate productivity more closely to the perspective of the farmer. The concept of productivity is reviewed from growth/lactation curves, through animal/flock indices to include socio-economic criteria. Inputs are focussed on limiting resources, common currencies of money or nutrient/energy used, and time standardised at one year. Net benefits of livestock to a household are calculated by aggregating the value added by physical products (meat, manure, milk) to socioeconomic benefits (saved interest/premium on credit/insurance) and deduction of purchased inputs. The result is expressed as net benefit per unit of the most limiting resources: land, labour, and flock metabolic size. If these criteria chosen for the unit net benefit are appropriate, then the ranking of the improved and indigenous livestock will reflect the choice of the farmer. A subsequent paper will test this hypothesis in a dairy goat development project in the Ethiopian highlands.

Keywords: Productivity index, Smallholders, Goats, Unit Net Benefits, Livestock development projects.

Introduction

The new millennium heralds a shift in emphasis in international livestock research from exotic to indigenous livestock production (Ørskov and Viglizzo, 1994, ILRI, 1997). Reasons for this change include: 1. the failure of many livestock improvement programmes, such as meat and dairy goat development projects, to live up to their expectations (Rischkowsky and Steinbach, 1997); 2. belated recognition that more use could be made of adaptive characteristics, such as disease tolerance (Trail *et al*., 1988) and parasite resistance (Allonby and Urquhart, 1973); 3. a realisation that neglect of indigenous livestock could see their extinction before there potential value has been explored (FAO/UNEP, 1998).

The failures of "improved" livestock projects are often not publicised except in grey literature (Mill, 1995; Bremer, 1995) and the reasons given usually relate to various aspects of under development, but they all have one thing in common, low adoption rates by the farmers. It is now being recognised that this lack of enthusiasm from the producers may be because they value other attributes in livestock besides their meat and milk (Jahnke, 1982). These less tangible benefits, which are included in an assessment by the farmer, should not be overlooked by the scientist (Peacock, 1987). The purpose of this paper is to develop this concept to the point at which it can be applied to the evaluation of livestock development projects (e.g. Peacock *et al*., 1990, FARM-Africa, 1997). The concept was already tested and applied for evaluation of a Dairy Goat Development Project in the Ethiopian highlands (Workneh Ayalew *et al*., 2003a,b).

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Concept of productivity

The term productivity is used interchangeably with efficiency of resource use, and defined as a ratio of output to input, with output and input given a variety of biological, physical or financial units (Spedding *et al*., 1981). The quantity so produced can be used as a guide for choosing between alternative systems if the numerator reflects a desired objective and the denominator a limiting constraint (Upton, 1989). The concept of productivity is commonly applied in animal agriculture to define production operations, compare or rank alternative options for production and to measure improvements (de Leeuw, 1990). However, productivity and efficiency are not necessarily the same; productivity explicitly refers to output per unit input, whereas efficiency relates more to output per unit cost.

In the context of smallholder subsistence agriculture, the objectives of keeping goats go beyond the products of meat, milk, fibre, manure and offspring, and include benefits in resource use, socio-economic and socio-cultural functions (Jahnke, 1982; Steinfeld, 1988; Devendra, 1992; Bosman and Moll, 1995; Schiere, 1995). Thus, if productivity is used as a criterion to compare management options or to measure improvements, it has to reflect the complex situation of smallholder goat production. It has to aggregate the many reasons the owner has for raising the animals and also incorporate the given constraints in resource use.

Goat products, functions and benefits

A typical example for livestock production in the context of smallholder subsistence agriculture is goat keeping in mixed farms in the Ethiopian Highlands (Table 1).

Table 1. Subsistence goat production in the Ethiopian highlands

Products/Functions/Benefits	**Input/Resources used**
Physical:	Household Resources:
• 'Meat': monetary value of live animal	• Goats (flock): in metabolic body weight
• Milk: value of off-take for sale and/or home consumption	• Land: in hectare
• Manure: market value or monetary chemical equivalence with inorganic fertilizers	• Labour: in hours
Socio-economic:	External Inputs:
• Asset/financing: additional value of flock outflow	• All purchased inputs: in monetary value
• Security/insurance: value embodied in average stock, or that in forced outflow	
• Employment	
• Integration (resource use: land, feed, labour)	
Socio-Cultural:	
• Meeting social obligations	
• Fulfilment of cultural needs	

Source: Adapted from Jahnke (1982); Steinfeld (1988); Devendra (1992), Bosman and Moll (1995); Schiere (1995).

Evaluating goat production in this context has to include the broader perspective of functions and benefits with the products. The aggregate of physical, socio-economic and socio-cultural gains made from goats can be referred to as benefits (Jahnke, 1982). The inputs applied to goat production can be accounted for when they are divided into two: the household resources of capital for goats, land and labour, plus those inputs purchased from outside. This framework provides a realistic context to relate the benefits realised with the resources employed, and to work out the net benefits.

Official estimates of national goat meat production measure only slaughter by farmer and consumer (FAO, 1999). This narrow definition of meat production ignores the traffic in live goats, which are bought, then sold on at a higher body weight, or transferred to other households on loan, lease or as a gift. The transfers occur when there are shortages of feed, food, or labour, and are as important as marketing transactions. The value of the transaction can be calculated from the net change in body weight of the flock (Bosman and Moll, 1995). Milk suckled by the offspring is also accounted for in this broader definition of meat. The milked out yield for sale or home consumption could be converted in liveweight equivalents and then be added to the meat production. However, in the Ethiopian case, where the milk is often at least partly sold, it is more appropriate to use the monetary value.

Although manure is not marketed, its use as organic fertilizer is a vital input function for the farm. It transfers nutrients from pastures and verges to cropping land, and speeds up the recycling of crop residues, thereby adding value to them, and further integrating crop and livestock production for better use of the resources (Stangel, 1995).

Many of the socio-economic benefits from the goat flock can be expressed in financial terms. For example, capital on the hoof keeps pace with inflation. Goats are used to help adjust the consumption and savings of the household's income over time, by balancing the current cash needs against anticipated or unexpected cash needs of the future (Jahnke, 1982; Winrock International, 1992; Sansoucy *et al*., 1995). As Bosman and Moll (1995) have pointed out, physical production alone does not explain the widespread keeping of goats by smallholders in southwestern Nigeria where meat was the sole product. Under circumstances where the formal markets to manage finances or to deal with risk and uncertainty are very weak or do not exist, smallholder households use informal arrangements, self-financing and capital accumulation. Thus goats provide security, although they themselves are not without risk from disease and theft, particularly if they are exotic genotypes (Laes-Fettback, 1989).

There remain some functions of goats that do not translate easily into monetary values, such as the strengthening of social bonds by sharing resources, which can be reciprocated in the future. Until these socio-cultural roles have been included in the calculation, the net benefit of the goat may still be underestimated.

Beyond conventional productivity indices

The measurement of productivity is being continually developed, from growth and lactation curves, through productivity indices, to the inclusion of socio-economic criteria; see reviews by Peacock (1987), Amir and Knipscheer (1989) and Bosman and Udo (1995).

A useful index was developed by ILCA (1979) for cattle, which measured productivity in terms of the weight of the yearling calf and the calf equivalent of milk taken by the herdsmen, divided by the weight of the dam maintained annually. Corrections for differences in mature cow size were made by using dam metabolic weight. A similar index was applied to small ruminants, except that the weight of the progeny was taken at weaning (5 months), although production was still expressed on an annual basis. In order to compare large and small stock in the same index, production was expressed on an annual basis in terms of what the female weaned, the kid or lamb equivalent of milk was corrected according to the total milk solids, and the metabolic weight used (King, 1983). Parallel developments were being made with a herd productivity index, known as off-take rate, which was defined as kilogram live weight produced per unit of the average kilogram live weight of the flock maintained over some specific period (Wilson, 1982; Knipscheer *et al*., 1984).

Modified versions of these indices were used to assess overall reproductive performance at the flock level by Peacock (1987), who redefined the Flock Productivity Index to express the overall change in the flock with reference to the initial flock size. Peacock (*loc. cit.*) also showed that setting the index from the perspective of the owners, as in the case of her traditional index, reflected the production objectives or priorities of the producers. She then highlighted the fact that different indices lead to different orders of ranking of the same production systems. Therefore, care was needed in choosing an index appropriate to the purpose of the analysis. Peacock suggested that productivity indices should possess the following characteristics: (1) the output should include all relevant components; (2) the input should be the most limiting resource or the one which most urgently requires improvements; (3) the time period should be one year; and (4) the units of the index should be associated with the type of output and the purpose of the analysis.

Bosman and Udo (1995) further improved the index by including all flock entries in the numerator, replacing the initial flock size in the denominator by the average flock size, and standardising the index to one year. The conversion of live weights to monetary values produced what can be called the return to capital on the average flock. The next step was to quantify the socio-economic functions of the goats to the smallholder, by estimating the financing and security benefits from the total off-take and average stock, respectively. This was done by Bosman and Moll (1995) for a goat production system in Nigeria, where meat was the only product, but where there was clear evidence that the goats had additional asset and security functions. This approach can be extended to accommodate milk as well as manure, which are valuable products of goats in the Ethiopian highlands, and so determine the aggregate productivity for all the major outputs at the flock level**.** This aggregation of all the benefits from biological and quantifiable socio-economic functions into a common unit then yields the total benefits from the goat flock.

There are other units of measurement, besides weight and money, which can be used, depending on the purpose of the evaluation. For example, dietary energy equivalents (Upton, 1985), or a combination of monetary value for traded items and protein and energy values for subsistence produce (Cossins and Upton, 1987) have been used to describe pastoral production systems. This approach was not used in the Ethiopian highlands, because it was difficult to use these units for manure, and distinguish between marketable and consumption products. Aggregation of socio-economic functions with physical products also makes it difficult to attach energetic or protein equivalents to the benefits from non-food utilities. Therefore, Behnke's (1985) approach of assigning monetary values to both subsistence and marketable products was adopted, although market values do not necessarily reflect nutritive values of food products. Actual prices were taken for marketed products, and estimated prices applied to subsistence transactions. It follows, therefore, that the relevant market price to attach to home consumption is the price that farmers would have to pay if the produce were to be purchased. The farmer correctly attaches a higher price to production for home consumption than to production for sale because he would have to pay the retail price for what he buys and receives the farm gate price for what he sells (Kaufmann, 1998). The seasonal fluctuation of market prices can be handled by applying the current market prices of all the outputs and inputs.

The denominator of the productivity index should reflect the most limiting input, as already stated, and so emphasise the efficiency of its use in the system (Upton, 1989). The animal is the main limiting factor for the economic viability of commercial ranching, whereas land is the main constraint for pastoral production systems (Ruthenberg, 1980; Behnke, 1985; Ørskov and Viglizzo, 1994). In the highlands where common grazing areas have been declining due to population pressure, crop thinning and weeds from the cultivated land provide a large part of the supplementary feed available to the goats (Workneh Ayalew, 2000). Thus, the size of cultivated area has to be considered a limiting factor. However, there is no evidence to show that land is any more limiting to the total flock output than the total labour at the disposal of the households, or than the biomass of goats to be maintained. Children, housewives, householders and casual visitors are involved in accomplishing the daily chores of goat husbandry. It was also observed in the same area that 63% of total labour input on goat husbandry went into provision of feed (Workneh Ayalew, 2000). Although the opportunity costs of labour of especially children and those who are unable to help in other farm operations may be low or zero (Ørskov and Viglizzo, 1994), the labour input of women and older children is shared with other habitual duties. The lack of a formal labour market in subsistence and pastoral production systems makes it difficult to attach a market value to the labour input. But the indices can be calculated on the estimated absolute amount of labour time.

The reasoning behind using the animal itself as the limiting input is its consumption of feed and the capital invested in the animal. The total number of goats in the flock has to be converted into food consumption requirements (Upton, 1993), which can be done by estimating the total maintenance energy requirement from the metabolic body size of each animal (NRC, 1981; Morand-Fehr, 1981; Schmidt-Nielson, 1984). The use of metabolic weight allows comparisons of biological efficiency between breeds. However, it should be noted that the maintenance requirements of meat goats appears to be about 80% of that of dairy goats per metabolic kilogram, according to the limited data available (NRC, 1981).

It is apparent from the foregoing review, that it may be unrealistic to select one limiting input to smallholder production of Ethiopian highlands, when land, labour, and goats are used in common and simultaneously for several production functions. Therefore, the Unit Net Benefits from the flocks will be calculated for all the three resources used. This approach also captures the interaction between the inputs without limiting the depth of analysis on each of the factors of production.

Calculation of net benefits

Physical products

The technique of Value Added (VA) was applied to aggregate the net value (benefit) gained in terms of physical products (live animal, milk, manure). The Value Added to the flocks was determined as the difference in monetary value between the value of gross output and the value of inputs purchased from outside the farm. The cost of inputs produced on farms (e.g. crop residues, other feeds) is, therefore, not considered in this perspective.

Meat production, in its broader definition of the net body weight change in the stock and flow of whole flock, during the observation period was quantified as:

$$Y_k = FS_k - IS_k + S_k - P_k + OT_k - IT_k + C_k$$

Where **Y_k** = net production of goats (kg) of the **k^{th}** flock during the observation period,

FS_k = body weight (kg) of the **k^{th}** flock at end of observation period (final stock),

IS_k	= body weight (kg) of the k^{th} flock at start of observation period (initial stock),
S_k	= body weight (kg) (estimate) of all goats sold out of the k^{th} flock,
P_k	= body weight (kg) of all goats purchased into the k^{th} flock,
OT_k	= body weight (kg) (estimate) of all goats transferred out of the k^{th} flock,
IT_k	= body weight (kg) of all goats transferred in to the k^{th} flock, and
C_k	= body weight (kg) (estimate) of all goats slaughtered in the k^{th} flock.

A regular monthly body weight recording of all goats in study flocks was undertaken for this aggregation. Furthermore, all incoming goats were weighed within a week of entry. The concept of net production accounts for all temporal weight gains and losses during the observation period.

The net production of goats (Y_k) was converted to its monetary value (YM_k) by multiplying the respective current (estimated) body weights of each of the variables in the model with the estimated unit prices (per kg of body weight). The recorded prices of goats sold or purchased provided the basis to estimate the unit prices per unit body weights of inflow and outflow. The average unit prices of goats (per kg body weight) were estimated from 215 observed sales and purchase records. The observed prices were divided by estimated body weights of the goats to arrive at unit prices per kg of body weight. These averages were found to be significantly influenced by body weight of the goat as well as its location, breed, sex and the direction of its movement (i.e. sale or purchase). A mixed linear model was applied to estimate coefficients for the co-variate (body weight) and the fixed effects (breed, sex, case). These coefficients were then applied in multiple linear regression equations to estimate the unit prices (per kg of body weight) of goats sold and purchased, where body weight was used as a covariate and location, breed, sex and type of transaction (sale/purchase) were used as fixed effects. The resultant coefficients were also applied to predict the unit prices (per kg of body weight) for goats slaughtered, transferred and those in stock according to how the household would pay or receive if transactions were in cash.

The total milk off-take was estimated from a weekly regular recording of all lactating goats in all study flocks throughout the observation period. The current prices of milk were then applied to determine the monetary values (MMk).

Because manure was not widely marketed in the area, but invariably used as organic fertilizer, a multistage procedure of valuation of manure was developed and applied using available empirical evidence on the chemical composition and solubility of its key nutrients. Manure collected from barns is habitually dumped into compost pits for use as organic fertilizer. Manure deposited during grazing on crop fields or grazing plots is also considered useful to the landowner or the community at large. Firstly, the faecal dry matter output was estimated at the level of individual animal. Then, a chemical equivalence of the manure was sought with respect to nitrogen and phosphorus and related to current unit prices of these two key elements in commonly applied inorganic fertilizers, Diammoniumphosphate (DAP) and Urea. The additional contribution of manure to soil physical properties was estimated from known residual effects that relate to slower release of nutrients as well as improved water holding capacity and pH. The total faecal output was estimated by the regression equation developed by Fernández-Rivera *et al.* (1995), on the basis of total (24-hour) manure production, using the physical constraints model of Ellis *et al*. (1988), which assumes that faecal output is a constant percentage of the fat-corrected metabolic body weight of an animal in stable metabolic and physiological state. The equation for goats was taken as:

$F = 26.5g\ DM / kg\ W^{0.645}$

where F is the daily faecal dry matter, and W is the average body weight.

The average nitrogen content of this faecal dry matter output was taken to be 1.56% (Schlecht *el al*., 1997). Urine was also valued along with faeces, because in the study area practically all the dirt and scrapings of barns with the leftover feed soaked in urine is dumped into compost pits with the faeces. For the purposes of this study, and based on the evidence presented by NAS (1983) and Schlecht *et al*. (1997), total N excretion through urine was estimated to be equal to N excretion through manure. Loss of nitrogen from composted manure in the form of volatilisation and the subsequent uptake of nitrogen by crops (Gilbertson *et al*., 1981; Jenkinson, 1982) was taken to be equivalent to similar losses of ammonia nitrogen and crop uptake from the common inorganic fertilizers (Bock, 1984; Tisdale *et al*., 1985). The overall phosphorus content of goat manure was taken to be 0.55% of faecal dry matter (Somda *et al*., 1995).

Residual effects of manure are present three years after application (ILCA, 1993), and the reported crop response to these residual effects range from a low of 42% to a high of 113% (Ikombo, 1989; Onim *et al*., 1990; Williams *et al*., 1995). A more conservative estimate of 33% additional benefits was taken for the purpose of this study, because the residual effects are partly due to slow release of nutrients in manure. Therefore, the estimated nitrogen and phosphorus equivalents were multiplied by a factor of 1.33 to arrive at the total estimated value of manure.

The commonly used inorganic fertilizer DAP contains on the average 18% of nitrogen and 21% of phosphorus, i.e. 39% of soluble nutrients. This, at the current commercial rate of DAP (Birr 140[1] per 50 kg bag), gives an average price of Birr 7.2 per kg of soluble nutrient. Similarly, Urea contains about 45% soluble nitrogen, which at current price of Birr 150 per 50kg bag gives a unit nutrient price of Birr 6.7 per kg of soluble nitrogen. Because farmers in the study area commonly purchase both inorganic fertilisers, the average unit price of the nutrients of Birr 7.0 was used per unit of soluble nutrient. This rate was applied to estimate the equivalent value of manure from goats (FM_k).

Thus the sum of the monetary values of net meat production (YM_k), milk off-take (MM_k) and manure (FM_k) utilised during the same observation period gave gross output (G_k) of the k^{th} flock during the observation period, i.e.,

$$G_k = YM_k + MM_k + FM_k$$

To arrive at total Value Added of the k^{th} flock (VA_k), the sum total of purchased inputs (I_{kj}) specifically used for the flock during the observation period was deducted from G_k; i.e.

$$VA_k = G_k - \sum I_{kj}$$

Where VA_k = total Value Added of the k^{th} flock during the observation period,

G_k = gross output (in monetary value), and

[1] 1 US$= Birr 7.15 (September, 1998)

ΣI_{kj} = sum (in monetary value) of all inputs (**j**=1,...,n) purchased and utilised in the k^{th} flock[2].

Socio-economic benefits

Up to three quarters of goat disposals in study households during the study period were forced outflows (sales, slaughter, gift, transfer) to serve immediate financing and insurance needs (Workneh Ayalew *et al*., 2002). The financing benefits were estimated based on the concept that in a subsistence economy the value embodied in the flock and the opportunity of using the animals for specific purposes at the desired time without having to pay in the form of interest rate or insurance premium confers measurable benefits to smallholder households (Bosman and Moll, 1995). Hence, the benefits in financing ($\mathbf{F_k}$) of the k^{th} flock during the observation period were the additional values embodied in the outflow determined as:

$F_k = OM_k \times f$

Where OM_k = monetary value of flock outflow ($C_k + S_k + OT_k$), and

f = financing factor, estimated from the opportunity cost of credit in the study area.

The opportunity cost of credit (cost of alternative sources of credit) was sought from the available credit services. Formal credit institutions were out of reach of the smallholder farmers. Informal credit is very common; however, the population being predominantly Muslim, stated interest rates are not acceptable. The few studies undertaken on informal credit (Lakew Birke, 1966; Demissie Gebre-Michael, 1974) reported that lenders usually arrange for the interest to be paid in kind, in terms of labour, or in reduced produce prices, leading to effective interest rates as high as 40% per year, or even 200% for grain and cash credit (Bezabih Imana, pers. comm.[3]). During the study period 133 (84%) of the 158 study households have taken at least one form of credit. Only 21 (4%) of the 560 credits recorded were with a stated annual interest rate of 18% (for fertilizer) and 100% (for seed grain); the rest was reported to be not directly charged. Most of the reported credit was delivered by small kiosks and traders in the villages in the form of sold household supplies. In the four study villages the average sizes of credit delivered to a household during the study period varied from Birr40 to 117, which were comparable to the price of a medium size goat in the local market. There was insufficient evidence to apply estimates of interest rates from the informal credit market and so the current interest rates of the formal credit market were applied. The observed commercial interest rate of 10% for short and medium term credits during the study period was taken to estimate the financing coefficient (f).

The insurance (security) benefit was estimated based on the annualised current livestock (weighted average body weight of the whole flock), assuming that the whole stock is available to provide household security through liquidation at any one time if the need arises.

The benefit in security from raising the goats (S_k) was then calculated as:

$S_k = W_k \times s$

[2] The cost of farm produced inputs such as crop residues used as feed is not considered in these calculations because these are not procured from outside the farm.

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Where W_k = monetary value of average (weighted) current stock of the k^{th} flock, and

s = insurance factor of the study area, estimated from the opportunity cost of insurance.

An opportunity cost of insurance (cost of alternative sources of insurance) existed although none of the study households bought insurance from the formal market during the study period, as these services were effectively inaccessible to them. However, almost every household was a member of the informal village-level community insurance groups, which pay out to any member facing major difficulties. A total of thirteen cases of informal insurance pay-outs (i.e. total sum paid to recipient) were observed among the study households, where from 50 to 170 members of the community contributed different amounts in cash to assist households with various difficulties (Table 2).

Table 2. Observed informal group insurance pay-outs and calculated insurance coefficients during the study period

Observed cases	Total pay-out (Birr[a]) (a)	No of participating households (b)	Average pay-outs Birr/household c= (a/b)	Calculated insurance coefficient (%) (c/a)
Husband dies	1160	170	6.82	0.59
Father dies	250	110	2.27	0.91
Step mother dies	210	120	1.75	0.83
Husband dies	800	150	5.33	0.67
Son dies	960	150	6.40	0.67
Husband dies	600	140	4.28	0.71
Son dies	250	100	2.50	1.00
Grand son dies	100	50	2.00	2.00
Rebuild a house	500	100	5.00	1.00
Relative dies	480	130	3.69	0.77
Relative dies	230	100	2.30	1.00
Fire accident	730	120	6.08	0.83
Wedding ceremony	750	120	6.26	0.83
Average	540	120	4.50	0.83

[a]1 US$= Birr 7.15 (September, 1998) Source: Workneh Ayalew (2000)

Because these community-level group insurance services are operated without profit with low management costs, the cost of insurance is equal to the annualised average pay-outs. All the contributions are readily paid out in insurance payments. Thus the theoretical coefficient of insurance was calculated as the ratio of the average of contribution of the households (i.e., Birr 4.50) to the average of total pay-outs (i.e., Birr 540), or 0.83 %.

This coefficient was then multiplied by the average frequency of cases that initiate insurance contributions. The observed village level insurance services also cover adjacent communities outside the study villages. Thus the actual frequency of cases that initiated insurance contributions by the sample households was greater than the recorded 13 insurance payments to study households. Focus group discussions with leaders of these informal insurance groups revealed descriptive figures on membership and type of insurance cases during the study period. These observations provide a weighted average annual frequency of insurance cases of 9.95%. The insurance coefficient for calculating the security function of goats (**s**) was, therefore, estimated to be 0.83 x 9.95, or 8.25%.

The net benefits realised (NB_k) from raising goats in the k^{th} flock during the observation period was then calculated as the sum of Value Added (VA_k), benefit from financing (F_k) and benefit from insurance (S_k); i.e.

$NB_k = VA_k + F_k + S_k$.

The total net benefits were then divided by the three major resources used to produce the benefits, namely size of cultivated land, metabolic body size of the annualised average flock size and the estimated household labour input.

Evaluation of livestock development projects

The idea of aggregating production at the flock level is not new, nor is the application of 'traditional' indices that reflect the owner's preferences (e.g. Peacock, 1987). The procedure for quantifying some of the socio-economic functions to measure the realised benefits is a recent development (Bosman and Moll, 1995; Ifar, 1996). In fact, it has been developed further by Slingerland (2000), who argues that the financing and insurance benefits of livestock in the smallholder economy also have costs. However, in the context of Ethiopian smallholders, these costs are generally considered low compared with those of alternatives. Manure has also been undervalued, despite a long history of profitable use (Stangel, 1995). Its contribution to the overall benefit from livestock is one of the reasons that led to reassessment of the contribution of livestock to the national economy (Sansoucy *et al*., 1995).

The broader aggregation of benefits and the calculation of three productivity indices in relation to the crucial resources as proposed in this paper:

- take account of the hidden costs of poor nutrition, morbidity and mortality by making comparisons at the level of the whole flock,
- include net body weight change in the stock and flow of goats in the definition of meat,
- allow manure to be ranked with meat and milk,
- provide an evaluation of most benefits irrespective of the form in which they are realised,
- help to distinguish which of the crucial resources are used more efficiently.

If our criteria produce an index, which is closer to the perspective of the poor smallholder than previous ones, then it will help to better evaluate the adoption and effectiveness of introduced technologies in livestock development projects. This hypothesis was examined in related papers, which evaluated the benefits from crossbred relative to indigenous goats (Workneh Ayalew *et al*., 2003a) as well as the response of indigenous goats to improvements in level of management (Workneh Ayalew *et al*., 2003b) in the Dairy Goat Development Project in the Ethiopian highlands (FARM-Africa, 1997). This concept can be applied to similar evaluations of livestock development projects, and particularly those with components for genetic improvement. Obviously, application of this concept entails thorough understanding of the livestock production system, appreciation of the smallholder farmers' perspective of benefits from livestock, and extensive data collection to quantify inputs as well as outputs.

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