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Ecological and socio-economic assessment of the implementation of hair sheep into small scale cattle farms to reduce deforastation in the tropical rainforest of Ecuador

G RAHMANN[1], J FISCHER[1], A HERRERA[2] & C CLAUS[3]

[1]Dept. of International Animal Husbandry, University of Kassel, Steinstrasse 19, 37213 Witzenhausen, Germany, Tel. +49 5542 98 1207; FAX +49 5542 98 1250; Rahmann@wiz.uni-kassel.de

[2]Unidad de Producción Ovina - Caprina. Panamericana Sur, km 1,5, Riobamba, Ecuador, profors2@org.ec

[3]Dept. of Fodder Crops and Rangeland Ecology, University of Kassel, Nordbahnhofstrasse 1a, 37213 Witzenhausen, Germany, Claus@wiz.uni-kassel.de

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Abstract

In an interdisciplinary research project, carried out from September 1996 to October 1998, an analysis was made whether hair sheep keeping in the tropical rainforest of Sucumbiós/Ecuador allows an ecological and socio-economic sustainable land use. In the region ecological and socio-economic conditions exist which allow hair sheep keeping. The farms have unused fodder resources which can be used by sheep. Hair sheep can adapt to tropical humid sites and make use of their high production potential under these conditions. The integration of hair sheep keeping into agro-silvo-pastoral and silvo-pastoral systems is profitable. In the silvo-pastoral systems hair sheep keeping cannot compete with cattle keeping. With adapted stocking rates and pasture management hair sheep keeping in agro-silvo-pastoral and silvo-pastoral systems is ecologically acceptable.

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In an interdisciplinary research project, carried out from September 1996 to October 1998, an analysis was made whether hair sheep keeping in the tropical rainforest of Sucumbiós/Ecuador allows an ecological and socio-economic sustainable land use. In the region ecological and socio-economic conditions exist which allow hair sheep keeping. The farms have unused fodder resources which can be used by sheep. Hair sheep can adapt to tropical humid sites and make use of their high production potential under these conditions. The integration of hair sheep keeping into agro-silvo-pastoral and silvo-pastoral systems is profitable. In the silvo-pastoral systems hair sheep keeping cannot compete with cattle keeping. With adapted stocking rates and pasture management hair sheep keeping in agro-silvo-pastoral and silvo-pastoral systems is ecologically acceptable.

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1 Introduction

With the beginning of oil exploitation in Sucumbíos and the construction of roads in the Seventies, poor people from the highlands of Ecuador moved into the tropical rainforest to find jobs and to start farming. The settlements, of an average size of 50 hectare per farm, were cleared to establish cash crop production like coffee and cocoa. Later on farmers started with cattle keeping on artificial pastures (ROEDER 1994). Not adapted land use led partially to degradation, mainly due to cattle keeping (KAISER & KLINGE 1995). Since 1991, the German Agency for Technical Cooperation (GTZ) has tried to develop more sustainable land use systems in the region (PROFORS-Project). The introduction of hair sheep into existing farming systems was part of this approach. In an interdisciplinary research project - funded by the GTZ (Flanking Programme for Tropical Ecology - TÖB) - the ecological and socio-economic impacts of hair sheep keeping were evaluated in an applied research approach. The survey focussed on the comparison between hair sheep and cattle keeping.

2 Methods

Research was carried out from November 1996 to May 1998 on small scale farms in the province of Sucumbíos in Ecuador (Figure 1). Out of approximately 130 farms with hair sheep, 33 farms were chosen for collecting basic data and 25 farms for a detailed investigation. Together the 25 farms had approximately about 320 hair sheep. Management conditions in sheep keeping on these farms covered a basic standard. The farms chosen were classified into four different farming systems (FS):

- FS 1: separate grazing of hair sheep and cattle on artificial pastures (silvo-pastoral).
- FS 2: free range grazing of hair sheep on artificial pastures, mixed grazing with cattle (silvo-pastoral).
- FS 3: hair sheep grazing in coffee plantations (agro-silvo-pastoral).
- FS 4: combination of farming system 2 and 3 (agro-silvo-pastoral).

[Figure 1]

Figure 1: Map of Sucumbíos/Ecuador

The farms chosen were visited regularly by scientists to collect data on ecology, animal husbandry and socio-economic aspects. The techniques of Rapid Rural Appraisal (RRA) were used to start the investigation. The livestock keeping on the farms was analysed as far as reproduction, animal health, productivity and profitability were concerned. The carrying capacities of plantations and artificial pastures and the fodder value of the vegetation were assessed, and the climatic and edaphic conditions evaluated. Vegetation sampling and measurements of the influence of animal grazing on the pastures were carried out as well.

3 Frame conditions in the survey region

3.1 Ecological conditions

The climate in the survey region is perhumid as typical for tropical rainforests (Figure 2). Each month has rainfall of more than 100 mm. The highest rainfall in Lago Agrio occurs in May (365 mm) and the lowest in January (192 mm). The annual rainfall oscillates between 3,500 mm in Lago Agrio (300 m asl) and 5,400 mm in Lumbaquí (500 m asl). The average temperature is between 26.5 °C in Lago Agrio and 23.9 °C in Lumbaquí.

[Figure 2]

Figure 2: Climate of Sucumbíos

The rainforest is the natural vegetation but it has been partially felled to establish cash crop production and artificial pastures. The soils of such farm land is classified as Inceptisols (US soil taxonomy) (SCHWINN 1987, PROFORS 1993). This means that they are relatively young and fertile, compared to the soils in the deep rainforest in the Amazon basin.

3.2 Socio-economic conditions

Due to oil exploitation immense migration of poor and often landless people had been seen after the establishment of roads into the research area of Sucumbíos. Beside the roads (first

line) the people started to cut the virgin rainforest illegally to establish farm land: "man without land moved to land without man". After the first line of settlements along the roads was occupied, the second line was created, two kilometres further inside. Currently, the 8th line is being used for new farm settlements, 16 km away from the roads. In order to have the land registered permanent cultivation was required, the average farm size being about 50 hectares (250 m x 2,000 m). In 1990, only 51% of the farms held a legalized private property registration. Currently, a typical farm consists of 41% artificial pasture, 14% cash crops (mainly coffee and cocoa) and 41% of the land remains primary and secondary rainforest. The farms represent "low input - low output" systems. The farm work is mostly done by family labour, additional casual workers are employed particularly for coffee harvesting and clearing pastures. Shortage of labour is typical for most farms.

With the establishment of artificial pasture in the region, cattle keeping started in the early Seventies. The pastures are fenced and rotational grazing of cattle is usual. Nowadays, there are about 42,000 cattle in Sucumbíos, mainly dual purpose cattle. Milk yield is low and serves for selling and subsistence purposes, beef production is for selling. The keeping conditions of cattle are fair. Animal husbandry enjoys a high status for farmers and takes over the function of investment.

In 1990, 100 hair ewes were introduced into the province by PROFORS. Presently, about 120 to 140 farmers keep approximately 1,000 ewes, mainly in the first and second lines beside the roads. Crossbreeds of Barbados Blackbelly (local: Barriga Negra) and Pelibuey-West African (local: Sudan) predominate. The sheep are used for lamb and mutton production. Free range grazing is the most practised form of keeping, with labour input minimized. Farmers do not practise controlled breeding. In the province in general, sheep keeping management lackes technical skills, often housing and salt supply are the only ones realized. Sheep generally need better infrastructure (e.g. special houses and fences) on the farm than cattle. In the province, there exists a market for cattle and beef whereas a regular market for sheep and mutton does not exists until now.

Hair sheep keeping has taken on well on the farms but the status is lower than for cattle. The meat is consumed and is well appreciated. Therefore, hair sheep are recognized as complementary livestock to cattle but not as a substitute. A recently founded hair sheep association (ACOAS) is trying to train farmers in animal health, nutrition and animal husbandry.

4 Results

4.1 Pasture productivity and carrying capacity

Brachiaria decumbens is the most frequently used grass for seeding on artificial pastures. The productivity amounts to 6.5 to 11 tons dry matter (DM) per hectare and year, depending on soil fertility, livestock rotation, defoliation rate and spittlebug (*Mahanarva sp., Zulia sp*.) damage (VALERIO et al. 1996, FISHER & KERRIDGE 1996). The unusual mean stocking density on *Brachiaria decumbens*-pastures with rotational grazing consists of 0.6 Livestock Units (1 LU= 400 kg liveweight) cattle per hectare and year. With mixed grazing, 0.5 LU ha^{-1} a^{-1} sheep continuously graze in addition to cattle, thus reaching a better fodder utilisation. *Brachiaria decumbens*-pastures with only sheep grazing show a mean stocking density of 0.9 LU ha^{-1} a^{-1}. *Brachiaria decumbens*-pastures in Sucumbíos are nowadays undergrazed. In a sheep grazing experiment with short grazing cycles of four weeks (grazing rest of three weeks), a pasture yield of 11 tons DM ha^{-1} a^{-1} and 8 kg grain maize per 0.15 LU (1 adult sheep à 35 kg liveweight) and year, a mean stocking density of 3.6 LU ha^{-1} a^{-1} could be achieved. In such systems 400 kg ha^{-1} a^{-1} liveweight can be produced. *Brachiaria decumbens*

shows a good fodder value (crude protein content of 14 %) for sheep after three weeks grazing rest. This decreases while grazing rests are prolonged.

On a *Brachiaria decumbens* pasture with a yield of 6.5 ton DM ha^{-1} a^{-1}, rotational grazing (typical grazing cycle for cattle in the region with six weeks of grazing rest), a mean stocking density of 1.8 LU ha^{-1} a^{-1} without additional concentrate feeding was achieved. Liveweight production was 321 kg ha^{-1} a^{-1}. To compare the mean stocking densities of sheep and cattle, densities were corrected assuming that both pastures had the same yield and that the sheep did not have additional concentrate fodder. The mean stocking densities in Sucumbíos are shown in Table 1.

Grass cover under agro-silvo-pastoral systems (mostly coffee) is spontaneously and yields 1 to 2.8 tons DM ha^{-1} a^{-1}. Usually cattle are not kept on coffee plantations, because of possible damage on the roots by trampling; that is not the case with sheep. Out of 34 classified spontaneous plant species, 14 are not eaten by sheep. Depending on the vegetation type, between 2 % (*Panicum polygonatum*-vegetation type) and 81 % (*Axonopus compressus*-vegetation type) of the biomass is grazed by sheep. The sides coveres with spontaneously grazing vegetation are continuously grazed by sheep with a mean stocking density of 0.5 LU ha^{-1} a^{-1}, and 40 kg ha^{-1} a^{-1} liveweight production can be assumed.

Sheep browse some invading shrubs like *Vernonia spp*. (local: Chilca) and regrowth of *Psidium guajava* (local: Guayava). Under coffee and cocoa, this is an advantage to reduce clearance efforts. On the other hand, bark stripping on coffee and citrus trees can become a problem. This happens when fodder and minerals are scarce.

Table 1: Mean stocking rates (LU ha^{-1} a^{-1}) of pasture sites in Sucumbíos.

[Table 1]

4.2 Livestock reproduction and productivity

Hair sheep do not lamb seasonal. The lambing rate is 1.4 born lambs per birth, the fertility rate is 1.4 birth per year and the total productivity rate amounts to almost two lambs per ewe and year. 62% of the births were single lambs and 33% were twins. The breed Barbados Blackbelly has more twins and triplets than the Pelibuey-West African hair sheep. The average lambing interval lasts 214 days (N=84) and the age of first partition varies between 9 and 15 month.

Reproduction performance in different farming systems is shown in Table 2. The number of weaned lambs is superior in mixed grazing of sheep in coffee plantations and on artificial pastures (FS 4). Grazing only under coffee leads to inferior performance (FS 3) as well as rotational grazing on artificial pasture.

Table 2: Reproduction performance in different farming systems with hair sheep keeping[1]

[Table 2]

Both cattle and sheep can adapt to perhumid conditions as in Sucumbíos. Problems arise when livestock management is bad. Particularly new born and/or weak lambs suffer through inadequate management. Therefore, 50% lamb mortality may occur, but on the farms of the survey a lamb mortality rate of only 23% was observed due to better management conditions (Table 3). Infections are the major problems in livestock keeping. Umbilicus infection and weak lambs of Barbados Blackbelly multiple birth account for most mortality of lambs.

Additionally, lambs die through of accidents and can be killed by dogs or pigs. Hoof-rot of adult hair sheep can be a problem in these wet locations when management is not adequate.

Table 3: Mortality rates on the farms of the survey 1997

[Table 3]

Rabies exists in the region (bats are the vectors). A difficult ecto-parasite is *Dermatobia hominis* (local: tupe). Concerning rabies and *Dermatobia hominis*, cattle seemed more affected than sheep. *Babesiosis* and *Anaplasmosis* have not been found, whereas *Trypanosomiasis* has been detected in blood samples of sheep and cattle. The infected animals did not show sickness caused by these blood parasites. A wide range of different endo-parasites could be found. The farmers treat cattle regularly, but sheep are neglected.

The daily liveweight gain of the lambs is about 100 g d^{-1} between birth and 270 days (Figure 3). Lambs gain more weight on artificial pasture than under coffee with local vegetation (FS 3). Data on reproduction performance and daily liveweight gain should indicate rough trends and are not based on a statistically proved sample. The results on sheep production correspond with the data in literature for the temperate tropics (FITZHUGH & BRADFORD 1983), and the little data for the humid tropics in South America (INIAP 1993, CALLE 1994) for Barbados Blackbelly and Pelibuey-West African.

[Figure 3]

Figure 3: Liveweight gain of lambs in different farming systems

Cattle have an average calving interval of 15 months, the first birth being at 28.5 months. Calving rate reached 69 % and mortality rate until weaning 14%. The daily liveweight gain of calves between birth and 12 months was 420 g to 536 g per day. The results correspond with data for dual purpose cattle in the humid tropics of South America (PLASSE et al. 1998, VERA & SERÉ 1989)

4.3 Socio-economic aspects

Animal husbandry fulfils several functions in the farming systems of Sucumbíos. Cattle keeping has mainly an economic function, hair sheep keeping serves economic and subsistence purpose as well as on-farm links´ function. The dung of sheep (not of cattle) is used as fertilizer, and grazing in the coffee plantations reduces clearance efforts (Table 4).

Table 4: Functions of cattle and sheep in the animal holder households in order of importance

[Table 4]

The work in animal husbandry is carried out by the whole family. The amount of labour needed for cattle and sheep on the farms chosen was 3,5 hours d^{-1}. About 3 hours are needed for cattle including milking and just 0,5 hours for sheep. The men do 46% of the work in cattle and 42% in sheep keeping, the women 30% in cattle and 25% in sheep keeping, and children 16% and 31% respectively. In an on-farm level more labour per livestock unit is needed for sheep (0,30 h/ d^{-1}) than for cattle (0,18 h/ d^{-1}). Direct comparison of different farming systems with cattle and sheep keeping shows these results, too (Table 5).

Table 5: Labour requirements (hours) per livestock unit in cattle and hair sheep keeping

[Table 5]

The most important criterion in economic analysis are the returns on capital, because livestock represents some kind of investment. In farming systems 2 - 4 sheep keeping accompanies the main activity coffee or cattle production. Table 6 shows the partial budget for sheep keeping in these farming systems. The turnover depends on the number of produced lambs per ewe and year. Turnover, proportional and semi-fixed costs determine the marginal income of hair sheep keeping. Shrub browsing and grazing in the coffee plantations reduced clearance costs in this cash crop production (FS 3 and FS 4). Hair sheep keeping is profitable, even if costs for stables and fencing are considered. The agro-silvo-pastoral farming systems 3 and 4 are more profitable than the silvo-pastoral system (FS 2).

Table 6: Partial budget and factor utility in hair sheep keeping for different farming systems (in 1.000 Sucre per ewe and year) [1]

[Table 6]

In farming system 1 sheep are grazing in a rotational system on artificial pasture at different stocking rates (0.6 - 3.6 LU ha^{-1} a^{-1}). Sheep keeping is the main purpose, and therefore this system could offer an alternative for cattle production on artificial pasture. In cattle production dual purpose cows for milk and beef (calf and bull fatting) production are used. Farming system 2 represents a mixture of cattle and sheep grazing at a stocking rate of 1.1 LU ha^{-1} a^{-1}. To compare the different silvo-pastoral farming systems, the internal rate of return for investment is calculated for different stocking rates over 15 years (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The proportional costs are mainly influenced by the costs of pasture clearance. With increasing stocking rates, the costs for clearing per livestock unit decrease.

More than 50% of the whole sheep production on the surveyed farms (N=33) was used for selling, one third for home consumption and 16% to increase the sheep flock. The farmers´ own production of meat in small (consumable) portions is an important purpose for hair sheep keeping. Small numbers of animals are sufficient to fulfil this purpose. In the sampled farms the sheep used for home consumption could contribute an average of 400 g of meat per family and week over the whole year. Sheep keeping in general could increase the self-provision with meat. The average flock size of 11 sheep per farm contributes only about 2% to the total farm income (average figures). It is easy to increase this number, as all farms dispose of free resources in fodder and family labour available.

4.4 Ecological aspects of sheep and cattle keeping

The vegetation composition on pasture is determined by the selection of the grazing animals, the stocking density, the grazing system and the grazing persistence of the individual plant species. Permanent pasture is the most easy way to keep animals, but it causes fodder plant species to disappear with time, especially the ones that are not tolerant to grazing. To avoid such unwanted alterations, rotational grazing is recommended. In periods without grazing the vegetation can recover.

On a one-year grazing trial on a *Brachiaria decumbens*-pasture with mean stocking density of 3.6 LU ha^{-1} a^{-1} sheep with a grazing rest of only three weeks and a grazing period of one week per rotation, the vegetation composition changes positively towards an encroachment of the cultivated grass *Brachiaria decumbens* and a reduction of *Cyperaceae*. *Brachiaria* species

show rapid regrowth and good persistence under frequent defoliation (FISHER & KERRIDGE 1996). A one-year grazing trial with cattle at a mean stocking density of 1.8 LU ha^{-1} a^{-1} showed no significant changes on the vegetation composition, thus assuming a sustainable carrying capacity.

In agro-silvo-pastoral systems the spontaneous ground vegetation is extremely heterogeneous, thus making rotational grazing more difficult. A grazing trial showed that with a mean stocking density of 1.1 LU sheep ha^{-1} a^{-1} the vegetation composition changes significantly towards less preferred species (less preferred *Panicum stoloniferum* is encroaching, preferred *Dicotyledoneae* are decreasing and preferred and persistent *Axonopus compressus* is stable). Such a mean stocking density is too high for spontaneous ground vegetation (s. Table 1). It is recommended to carry out manual clearance every six months in order to minimise the competition advantage of not preferred vegetation towards preferred vegetation. Positive effects of rotational grazing with adjusted stocking densities can be assumed to avoid heavy vegetation changes.

Animal grazing influences strongly the movement of nutrients through the soil-plant-animal system. About 60 to 99 % of the ingested nutrients return to the pasture in form of dung and urine provocating a nutrient concentration on the patches of excreta and a translocation of nutrients towards the stock camps (animal housing) (HAYNES & WILLIAMS 1993). The latter is more marked on sheep grazing than on cattle grazing. On a sheep pasture a nutrient gradient between the area of grazing and the stock camps could be proved. It would be ecologically wise to reincorporate the excretions into the pastures that accumulate in the sheep housing. Soil erosion is no problem in the region. Because of the short period of the survey, tendencies towards a more severe trampling effect on soil by cattle than by sheep could merely be seen.

5 Conclusions

It can be concluded that hair sheep keeping is possible in climates like the rainforest of Ecuador. Productivity and health of the animals show acceptable levels with basic management. People accept hair sheep. Meat of lamb and mutton are also well accepted. Nevertheless, sheep keeping will not substitute cattle keeping which has a higher status, but could supplement cattle keeping without negative ecological impacts.

The ecological effects depend on the management and the frame conditions. The most valuable ecological impact is that hair sheep keeping increases farm income without further deforestation. The sheep use otherwised unused resources of fodder and family labour. Sheep are less expensive than cattle, and for poor farmers it is easier to start animal husbandry with hair sheep than with cattle.

The integration into permanent crop plantations represents the most profitable and ecologically acceptable keeping system. On artificial pastures keeping of some sheep in addition to the cattle stock increases intensity of land-use. Sheep have a different fodder spectrum than cattle.

Improvements in hair sheep keeping in the region should focus on animal health, management, housing, fencing and breeding. Extension efforts should consider grazing in agro-silvo-pastoral systems. It is necesary, therefore to investigate rotational grazing in these farming systems. Mixed grazing on artificial pasture with cattle and sheep is viable and could be improved, but investigation is needed, too.

To improve the fodder supply for sheep in agro-silvo-pastoral systems, sowing of adapted legumes (e. g. *Arachis pintoi,* compare PIZARRO & RINCÓN 1995) and proliferating grazing-resistant spontaneous fodder plants (e. g. *Axonopus compressus*) would be useful. It would also counteract bark stripping on permanent crops, which may occur due to fodder scarcity.

To counteract the translocation of soil nutrients towards sheep housing and maintain/improve soil-fertility, sowing of legumes (*Inga spp.*, *Centrosema spp.*, *Codarioclyx gyroides*; compare INIAP 1997) and trees would be advisable.

The infrastructure is less developed for hair sheep keeping. The marketing of hair sheep is currently small compared to cattle, but the meat of lamb and mutton is being accepted by consumers. The exploring of local demand could help to improve the attitude to hair sheep. Market structures for sheep and mutton are a condition for further expansion of sheep keeping in the region. With increasing numbers of stock, a market could develop based on the structure of the cattle and beef market. The demand of farmers for breeding ewes is high. The local stock however can not meet this demand but in Columbia large flocks exists (1.5 million ewes). The hair sheep association ACOAS, founded in 1997, could be the target group and work as multiplicators.

Ecologically sound agro-silvo-pastoral systems with hair sheep keeping could potentially be installed in 52.000 ha coffee plantations (INEC 1996) in the Amazone provinces of Sucumbíos and Napo. But other perennial crops like cocoa, oil palm and rubber could also be used for the integration of hair sheep (SANCHEZ 1995).

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Figure 1: Map of Sucumbíos/Ecuador

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Figure 2: Climate of Sucumbíos

Table 1: Mean stocking rates (LU ha^{-1} a^{-1}) of pasture sites in Sucumbíos.

pasture site	Continuos grazing LU cattle	Continuos grazing LU sheep	rotational grazing LU cattle	rotational grazing LU sheep	Sum LU
Brachiaria decumbens	-	0.9	-	-	0.9
	-	-	-	(2.7)[1]	2.7
	-	-	0.6 (2.4)[1]	-	0.6 (2.4)
	-	0.5 (0.7)[2]	0.6 (0.8)[2]	-	1.1 (1.5)
Permanent crop with Spontaneous cover	-	0.5	-	-	0.5
			(0.8)[1]	-	(0.8)

Note: [1]Determined on grazing experiments. [2]Estimated on grazing experiments and experience values in Sucumbíos. The numbers outside the brackets refer to the typical mean stocking densities in Sucumbíos, the ones inside stand for possible mean stocking densities.

Table 2: Reproduction performance in different farming systems with hair sheep keeping[1]

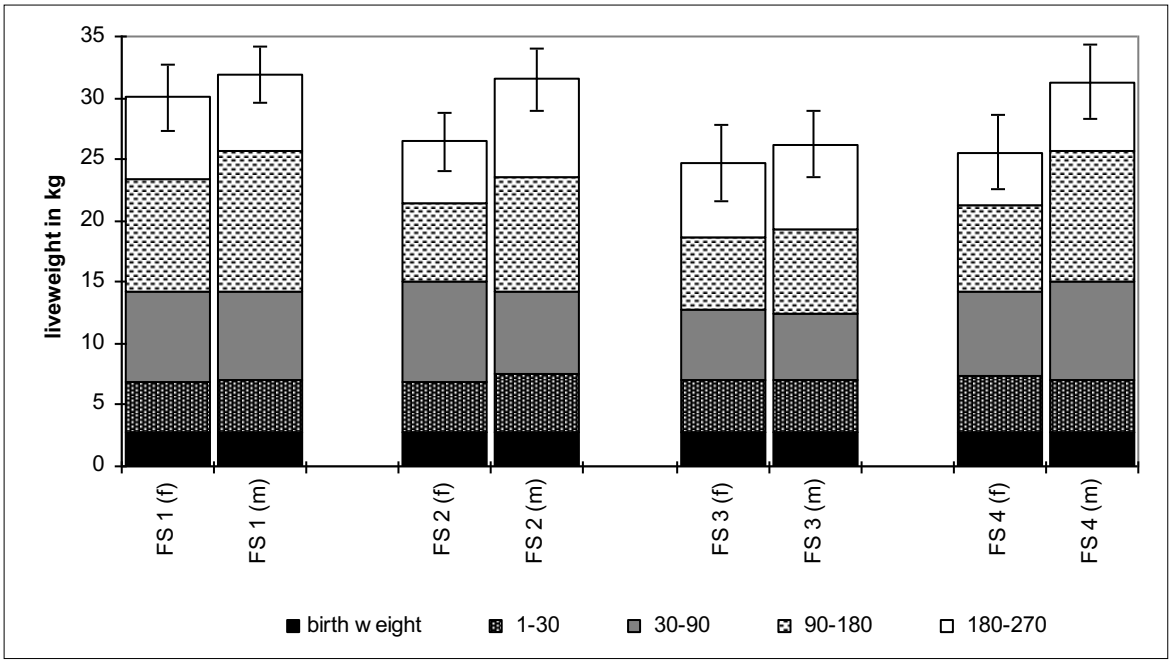
Farming system	1	2	3	4	
No. of births	28	30	15	38	111
Borne lambs/ewe/year	1.79	1.83	1.60	2.34	1.96
Mortality till weaning [2]	27.40	23.30	17.20	24.70	22.70
Weaned lambs/ewe/year [3]	1.31	1.38	1.32	1.73	1.51

[1] for definitions of farming systems see chapter on methods. [2] calculated on base of sample with 284 lambs in total. [3] calculated on base of number of born lambs and rate of mortality in 1.

Table 3: Mortality rates on the farms of the survey 1997

	Hair sheep	Cattle
Young stock (N)	23% (284)	14% (138)
Adults (N)	3% (182)	2% (284)

N=animals in the sample



f = female; m = male; FS 1 and FS 2 silvo-pastoral (artificial pastures), FS 3 and 4: agro-silvo-pastoral (in coffee plantation)

Figure 3: Liveweight gain of lambs in different farming systems

Table 4: Functions of cattle and sheep in the animal holder households in order of importance

Cattle keeping	hair sheep keeping
1. income	1. income
2. savings	2. subsistence on meat
3. risk reduction	3. on-farm links (dung and clearance)
4. status	4. savings
5. subsistence on milk	5. risk reduction

Table 5: Labour requirements (hours) per livestock unit in cattle and hair sheep keeping

Animal husbandry system	Hours per LU a^{-1}
Cattle keeping:	
Dual purpose (milk and beef) [1]	45
Hair sheep keeping:	
as in FS 1[2]	60 - 77
as in FS 2 -4[3]	80

[1]Herd size: 10 dual purpose cow, followers, calves, young bulls for fatting and bull. [2]Flock size: 17,5 ewes, followers, lambs and ram. [3]Flock size: 8 ewes, followers, lambs and ram.

Table 6: Partial budget and factor utility in hair sheep keeping for different farming systems (in 1.000 Sucre per ewe and year) [1]

	Silvo-pastoral	Agro-silvo-pastoral	
Farming system	FS 2	FS 3	FS 4
Ewes per ha	2	2	2
Labour hours per ewe[2]	19.5	19.5	19.5
Turnover per ewe	155	189	210
Proportional costs per ewe[2]	44	46	46
Investment cost per ewe[3]	46	46	46
Marginal income per ewe	65	97	118
Marginal income per ha	130	194	236
Marginal income per hour[4]	3.3	5.0	6.0

[1] component of sheep keeping without cost for familiy labour and land (1997: 1 DM=2.300 Sucres). [2]without pasture clearence. [3] useful life: housing 7.5, posts for fencing 15, fencing 10 years. [4]wages are 2.000 to 4.000 Sucres/h in the region.