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Coffee-Ensete-Livestock interaction for sustainable livelihood in the Sidama area of southern Ethiopia

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Abstract
The coffee growing areas of Sidama, the midlands, are one of the densely populated areas in Ethiopia, with a population density of 500 persons per arable land. Coffee serves as the major cash source to the farm household, which expends the cash to its different uses one of which is asset formation through the purchase of livestock. Livestock of different type are reared with small herd size in the area. The population pressure brought land to be the most limiting production constraint. Due to its limitation the available land is mainly allocated to the major staple food of the area, Ensete (*Ensete ventricosum*). This plant is everything to the farmer: food, feed, construction material etc. The food use of Ensete is very significant, because it supports large population size, however it is deficient in fat, protein and energy. Ensete covers the larger share of the feed use and it is a good feed sources because the feed part is rich in protein. This paper tried to address how the major enterprises of the system coffee, ensete and livestock can be intensified so as to ensure sustainable livelihood in the farming system.

1 Introduction

Rapid growth of the human and livestock populations in sub-Saharan Africa is creating unprecedented increases in food and feed demands. These population pressures on a fixed land bases are likely to promote severe competition for resources and drive agriculture progressively towards intensification (SMITH *et al.*, 1997). Being part of the sub-Sahara, Ethiopia in general and the Sidama midlands in particular share this episode.

The Sidama midland is one of the densely populated areas in Ethiopia, with a population density greater than 249 persons/km^2 and the density per arable area greater than 500 persons (WBISPP, 1997). Because of this the system is known for its permanent mixed cropping of the major crop enterprises, Ensete (*Ensete ventricosum /Welw./ Cheesman*) and coffee (*Coffea arabica* spp.) and other minor crops and livestock production on an average holding of 0.4ha. An overall trend shows that cultivation has been and is invading livestock grazing areas because as population increases, people prefer to cultivate crops rather than breed livestock (AYELE, 1975) as

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quoted by (GHIROTTI, 1995). However, even if they are small in population livestock play an important role in the system, because they have non replaceable role of nutrient recycling, and nutrition supply to the farm household.

Enset, being the staple diet, is the major component of the farming system due to its merit of sustaining large population with adequate quantity of food (SHIFERAW, 1996). However it lacks essential nutrients to fulfil the human diet, because of which malnourishment is observed in the area (GHIROTTI, 1995).

The need for the supplementation of essential nutrients can be fulfilled in one way or another. Animal products such as milk and meat will be important sources. However, the decrease in grazing land limits the possibility of increasing herd size for larger supply of animal products. Especially, the possibility of increasing protein and other sources from cattle is limited because of the requirement of large feed sources. Therefore, the potential role small ruminants, mainly goats, play for the sustainable intensification of the system is worth studying.

This paper addresses this issues with the following objectives:

1. to describe the interaction of crop and livestock in the farming system.
2. to identify the potential role of small ruminants, mainly goats, for sustainable intensification of the system.
3. to identify possible interventions to ensure sustainability of the system

2 Materials and Methods

2.1 Data collection

Data were collected mainly through:

1. Participatory Rural Appraisal (PRA) technique and
2. Review of secondary data

1. Participatory Rural Appraisal (PRA) - using the known methodologies of PRA; that is key informant survey and direct observations were done to collect data on.
   - food habits
   - common crops grown
   - livestock reared and
   - the interaction between crop and livestock
   - and other features of the farming system

The key informants (Development agents, and some innovative farmers, which were identified by the development agents) and other group of farmers were involved into discussions. An open ended question outline was used to collect basic data using probing technique.

2. Review of secondary data- data that supplements the informal survey were collected from different sources.

2.2 Description of the study Area

The study area is the mid part of the Sidama zone of the southern Nations Nationalities and peoples Regional state (SNNPRS). The western part of the zone is the unproductive low lands, lying adjacent to the Rift valley, where the main human activity is pastoralism and the eastern part is the highlands, they have a potential for cereal production (GHIROTTI, 1995). These two extreme topographies sandwich the midland, which is the coffee-producing and more densely populated area. The population density is greater than 249 persons/km^2 and the density per arable area is greater than 500 persons/km^2 (WBISPP,1997) while the national average is 32 persons 1km^2 (GHIROTTI, 1995).

The area has a bimodal rainfall pattern with a prolonged wet season extending from March up to October; with an average annual rainfall of 1300 to 2000mm distributed over 8 to 9 months. The dominant soil types are Nitosol, Cambisol, and Lithosol. The natural vegetation consists of Cordia, Millettia, Croton, Ficus, Albizzia and Eucalyptus tree.

The most numerous ethnic group is the Sidama, they are cushitic-speaking people of southern Ethiopia, the lowland is dominated by the Guji-Oromo.

The area is well served with roads. The highway to Kenya passes through the survey area and there are enough feeder roads to the different service co-operatives.

3 Results and Discussion

3.1 Coffee in the system

Coffee (*C. arabica spp.*) is one of the dominant enterprises in the Sidama midlands. It is grown in combination with Ensete (*Ensete ventricosum*) as a garden crop or grown under the evergreen shade trees of *Milletia ferruginea*, *Albizzia* spp. and *Erythrina* spp. Most of the coffee farms are relatively better managed than in the south western region, that is here the fields are manured with farm yard manure.

Farmers in the area ranked coffee to be first in area coverage and all of the farmers in the area grow coffee (Table 1). All farmers grow coffee as the major cash source in the area. This result is in conformity with GHIROTTI (1995) who has reported 98% of the farmers in the area ranked coffee to be the major cash source.

Table 1: The major crops of the Sidama midlands

	Dale				A/wendo			
	Shole		Ferro-2		Bulessa		Homecho	
Crop	Ac rank	% of HH*	Ac rank	% of HH	Ac rank	% of HH	Ac rank	% HH
Coffee	1	100	2	100	1	100	1	100
Enset	2	100	1	100	2	100	2	100
Maize	3	100	3	100	3	100	3	100
Cabbage	4	100	4	100	8	100	4	100
Avocado	6	54	5	25	6	62	6	67
Banana	6	73	6	70	5	77	7	56
Sugar cane	5	73	8	15	4	31	5	11
Beans	8	36	7	100	7	46	8	22

* HH: household; percentage of households cultivating the crop
Source : Survey, 1997

As the major cash source, coffee is the major product of the farm household supplied to the market. Except the insignificant proportion of coffee consumed at home all of the production is supplied in the form of red cherry (for wet processing) and dry coffee (*Buni* or *Jenfel*)

The average production of fresh coffee in one year is between five and seven quintals per household. It depends on different factors such as the number of the trees kept, their age and condition and husbandry (GHIROTTI, 1995).

Coffee and livestock production largely contribute to family income (over 80%), the former as source of cash, the latter as asset (GHIROTTI, 1995).

3.2 Ensete in the system

Ensete looks like a large, thick, single-stemmed banana plant. Both ensete and banana have an underground corm, a bundle of leaf sheaths that form the pseudostem, and large leaves. Ensete, however, is usually larger than banana, with the largest plants up to one meter in diameter. The leaves are more erect than those of a banana plant.
Ensete belongs to the order *Scitamineae*, the family *Musaceae*, and the genus Ensete. Banana is in the same family as ensete, but in the genus *Musa*. So far it is known that two wild ensete species are found distributed over much of Asia, and four wild ensete species in sub-Saharan Africa and Madagascar. (BAKER and SIMMONDS, 1953; SIMMONDS, 1958) as quoted by Brandt *et. al*, (1997). *Ensete ventricosum*, the only known wild species in Ethiopia, is concentrated in the southern highlands, but also grows in the central and northern highlands around Lake Tana, the Semien Mountains, and as far north as Adigrat and into Southern Eritrea (BRANDT *et. al*, 1997). In spite of the extensive distribution of wild ensete, it is only in Ethiopia that the plant has been domesticated.

3.2.2 Ensete as a source of food

One of the four major agricultural systems in Ethiopia is the ensete-based cultivation. Within which four major ensete sub-systems can be recognised, based upon environmental, agronomic, and cultural criteria, as well as the extent to which people depend upon the plant as a staple crop (WESTPHAL, 1975). The Sidama area is one of the ensete based sub-system.

Ensete plays a central role in the life of Sidama people. It provides the main staple food which is potentially available through out the year (Table 2).

Table 2: Food calendar of the farming system

Crops	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Main starch:												
Ensete	XXX	XXX	XXX	XXX	XXX	XXX	XX	XXX	XXX	XXX	XXX	XXX
Sub starch:												
Maize								XX	XX	XX		
Relish												
Cabbage						XX	XX					
Meat	XX	XX									XX	XX

Source: Survey, 1997

The pseudostem and corms of ensete are cut and the pulp may be cooked while fresh or after fermented in pits. The main product, is a fermented starch of the pseudostem and the corm. The period of fermentation fluctuates between a few weeks and one or more years. Although slightly fermented starch is suitable for consumption, the longer the product has fermented, the more it is appreciated. The two main ensete products utilised as food are locally known as *kocho* (*wassa*) and *bulla*.

According to some works (KELBESSA *et. al*, 1993; BRANDT *et. al*, 1997; DERJE, 1996) the nutritive value of kocho is low with respect to the major nutrients. Human food from mature ensete plant, comes primarily from the corm and an extracted pulp from the pseudostem leaf sheaths. Together the corm and leaf sheaths have 0.037 kg of protein per kg of dry matter. The remainder of the plant, which is mostly leaves, is about 26 percent of the plant, and contains 0.160 kg of protein per kg of dry matter.

The comparison of ensete and other staple foods shows ensete to be lower in (Table 3) its contents of energy, protein and fat.

Table 3: The nutrition status of *kocho* and some staples

	Nutrient content				Annual nutrient yield	
Product	Energy kcal/kg	Protein kg/kg of food	Carbohydrate kg/kg of food	Fat kg/kg of food	Energy kcal/ha	Protein kg/ha
Kocho	3800	0.026 *	0.96	<0.01	19.0	130 *
Maize	4100	0.108	0.83	0.05	16.2	
Sweet potato	4000	0.052	0.93	0.01		
Av. of maize & sweet potato	4050	0.080	0.88	0.03		320
Dry bean	3900	0.230	0.72	0.01	6.2	368

* An average of three reports which indicated different values
Source: Extracted from (BRANDT, STEVEN A. *et.al*, 1997).

Therefore, the low-protein portion of an ensete plant is eaten by humans and the high-protein portion is either recycled to the soil, used as a wrapping material, or fed to animals. Thus, the entire cycling of protein through other components of the system, particularly animals, has a greater impact on human nutrition and human carrying capacity than in cereal-based systems, in which the high-protein portion is eaten by humans (BRANDT *et. al*, 1997).

3.2.3 Ensete as a feed source

Enset leaves are the major source of feed to the livestock in the area. Due to the encroaching of crop land at the expense of the grazing lands the system is dependent on cut-and carry system for its livestock feed (Table 4).

During the dry season the domestic livestock are substantially dependent on parts of the enset not normally eaten by humans, in particular the leaf and the petiole, and the upper parts of the leaf sheaths and the core (the soft inner part of the central shoot) composing the Pseudostem which are discarded during harvesting (DEREJE, 1996, WBISPP, 1997). In this system crop residues, mainly that of enset, is used for livestock feed than as a source of fuel (Table 5).

Table 4: Feed calendar of the system

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. Common grazing									XX	XX	XX	XX
2. Cut crop												
- Banana leaf	XX	XX										
- Enset leaf and other parts	XX	XX	XX	XX	XX				XX	XX	XX	XX
- Maize stalk							XX	XX				
3. Cut grass					XX	XX	XX					

Source: Survey, 1997

Table 5: End uses of crop residue in the system

Wereda	% of crop residue used for livestock feed	fuel
Aleta wendo	> 80	< 20
Dara	> 80	< 20
Dale	> 80	< 20

Source: WBISPP, 1997

Reports by (DEREJE, 1996; BRANDT *et al.*, 1997) show that the protein content and the total amount of protein is greater in the portion not eaten by humans. The recycling of all these products have important consequences for the human carrying capacity of the system. By comparison, the stems and any remaining leaves of cereals and other tuber crops that are left for animal feed are usually of low protein value and in some cases are unacceptable as animal feeds. According to (DEREJE, 1996) the chemical composition and the rumen degradability suggests that the ensete have a potential to be uses as feed for animals to an increasing extent.

3.2.4 Ensete for environmental protection

In the farming system there is a mixed intercropping of ensete, coffee, maize and other crops. In this mix ensete perennial canopy of leaves and the abundant accumulation of litter reduces soil erosion and organic matter decomposition to a minimum.

Enset is also likely to affect the macro-environments of an area in a positive manner. It has been commonly observed that species like ensete, with deep roots and leaf canopies of long duration, improve the hydrological dynamics of an area (BRANDT *et. al.*, 1997). As the proportion of these species increases with respect to annual species, water infiltration increases and surface runoff decreases, resulting in more water in the soil

and aquifers. The result is increased water availability and greater volume and duration of discharge to springs, decreasing the effective length of the dry season. (BRANDT *et. al.*, 1997).

3.3 Livestock in the system

The increasing human population, which is claiming every arable and grazing land of the area is negatively affecting the livestock production in the system. Farmers keep very few animals because of shortage of grazing land. The reduction of common grazing lands has forced farmers to tether feed their animals in their front yards. The major livestock reared are Cows, Donkeys, Sheep's and Goats (Table 6). They are mainly used for milk and meat production and as a means of saving. The cash obtained from the sale of coffee is saved on livestock, which serve as a major asset to the farm household.

An overall ranking indicate that cows stand first in population followed by heifers and goats. This result is in conformity with (GHIROTTI, 1995), who ranked cattle and goat as first and second in population respectively.

3.3.1 Livestock as assets

The term at which coffee is traded does not help the farmers to save cash. That is, had it been through co-operatives, which register and account every delivery of the farmer for future withdrawal of cash, the cash obtained through the sale of coffee would serve evenly within a year. However, this is not the case, so farmers purchase livestock from the cash left after spending on the basic necessities. In most of the cases farmers by bulls and after fattening for some months they sale them. Therefore, bulls account the major share in serving as asset followed by sheep. Other livestock, such as cows, goats, oxen, heifers and chicken also serve the asset accumulation purpose (Table 6). This result is in conformity with GHIROTTI (1995) who reported that after a farmer has sold his coffee harvest, bought items they need and saved something for future expenses, he may decide any money left to buy an animal according to the amount still available. A poor family may buy a chicken or small ruminant, preferably female.

3.3.2 Livestock as manure sources

The very fact that the farming in the area is based on garden cropping implies the important role farm yard manners could play in the area. There is a long tradition of using farm yard manure for crop production, though its use is limited through years due to the decrease in livestock number.

Ensete fields are positively affected by the long term application of manure. The manure modifies soil and the soil is likely to be more fertile and have better physical characteristics, such as water holding capacity (BRANDT *et. al*, 1997). In this area livestock dung is mainly used for farm yard manure and less than 20 % of it is used as a source of fuel.

Table 6: Types of livestock, average size and purpose of rearing in the farming system

	Dale wereda						A/wendo wereda					
Livestock	Ferro-2 Kebele			Whicho Kebele			Homecho Kebele			Bulessa Kebele		
	Rank based on size	Purpose of rearing	% of HHs owning the livestock	Rank based on size	Purpose of rearing	% of HHs owning the livestock	Rank based on size	Purpose of rearing	% of HHs owning the livestock	Rank based on size	Purpose of rearing	% of HHs owning the livestock
Cow	1	M_1, M_2	80 (3)	1	M_1, O	90 (2)	1	M_1, M_2, C	90 NE	1	M_1, M_2	90 (1)
Sheep	3	H, M_2	50 (2)	5	O, C	60 (1)	7	M_2, C	20 NE	5	C	10 (1)
Goat	4	M_1, H_1, M_2	50 (1)	4	M_1, M_2, H	20 (1)	2	M_1, M_2, C	70 NE	4	M_1, M_2	20 (1)
Donkey	2	D	100 (1)	3	D, C	70 (1)	6	D	20 NE	6	D	10 (1)
Horse	5	T, D	30 (1)	-	-	- -	8	T	10 NE	-	-	- -
Ox	7	D, C	40 (1)	-	-	- -	-	-	- NE	-	-	- -
Bull	6	C, O	100 (1)	6	D, M_2, C	20 (1)	4	M_2, C, O	80 NE	2	C, O	10 (1)
Chicken	-	M_2,O	100 (4)	-	O, C	100 (2)	-	-	100 NE	-	-	0 -
Heifers	-	-	- -	2	O	50 (2)	3	M_1	50 NE	3	C, O	80 (1)

Source: Survey, 1997

Note: Purpose of rearing: M_1 - Milk, M_2 - Meat, H - Hide, T - Transportation, D - Drought power, C - Cash source (Asset) and O - Other

The significant increases in human population and decreases in animals and manure may cause reduction in crop yields and soil fertility, thereby reducing the long-term sustainability of the ensete system. However, still with the decrease in manure availability ensete gets preferential treatment in manure application, though other crops also benefit as parts of a mixed crop system.

3.3.3 Livestock as food sources

The fact that the staple food, ensete, is deficient with respect to the major nutrients necessitates alternative sources. To this end livestock play an important role. In all of the areas surveyed cows and goats serve as meat and milk sources. While sheep, bull and chicken serve in 50% of the cases as meat sources. In the rainy season one cow gives about 1.5 litre per day; a good producer can give 2.5 litre per day. Ten days of an average production gives enough to make one kg. of butter (GHIROTTI, 1995). However, this service is limited due to the decrease in livestock population and as a result malnourishment indicators are seen in the area where 36% of children presenting chronic malnutrition and 41% wasting (GHIROTTI, 1995; TESFAYE *et.al.*, 1995).

The cycle of increasing impoverishment of the livestock component in this mixed crop/livestock system is a serious cause of concern, because the multiple purpose of livestock cannot be replaced by fertilizer or any other manmade inputs (BRANDT *et al.*, 1997)

3.3.4 The potential of small ruminants (goats) for sustainable intensification

Goats are one of the major livestock component of the Sidama midland, they give multiple benefits to the household.

The overall trend in the system shows that farmers give high priority to the crop production than livestock production (AYELEW, 1975) as sites by (GHIROTTI, 1997). If this happens the size of livestock herds that are kept by the household decreases and threatens the alternative nutritional sources and manure that are supplied by livestock. The poor nutritive value of ensete, the staple food, coupled with this decreasing animal sources will endanger the sustainability of livelihood in the area. Therefore, some sustainable intensification should be sought so as to sustain the system. To this end small ruminants, mainly goats, can play a crucial role.

Adaptability and attractive properties of goats:

The traditional system has a well established goat rearing culture, about 40% of the households are owners of one goat on average. Though the population pressure has negative effect for livestock rearing goats have some attractive qualities which make them fit to such systems. Some of their qualities are:

1. Being a ruminant, the goat is able to make relatively good use of poor quality feed. Goats are the least selective concerning the kinds of plants which they eat, smelly and/or bitter grasses and herbs are also eaten. Under difficult circumstances, a goat will even eat bark and exposed roots. Because of these differences in grazing

behaviour, the goat will be able to maintain itself reasonably in bad times. The condition of the goat at the end of a dry season is usually better than that of a sheep or cow (JANSEN *et al.* 1996).
2. A goat is a quick maturing animal with a high fertility (JANSEN *et al.*, 1996).
3. In addition, since a goat is a small animal it is easier to keep more animals and small children can rear them.

Having these attractive characters, goats can serve different purposes in the system.

Goats as sources of milk and meat:
Those farmers who own goats in the area take advantage of milk, meat, hides and cash sources from goats. (GHIROTTI, 1995) reported that 2/3 of the owners milk their goats, which are local breeds, obtaining around 100 ml per day for 2-3 months. Goat milk serves as one of the meanness for compensating the malnourishment in the system. Goat milk has acceptable features, as having higher protein content than human milk in relation to total calories. The proteins also differ in proportion and kind, but the total amino-acid profile is closely similar in goat and human milk (DEVENDRA AND MARCA BURNS, 1983). Total fat content is not greatly different, between goats and humans, and goat milk is adequate for infants in essential fatty acids. In regard to minerals, goat milk is an excellent source of calcium and phosphorus, (DEVENDRA AND MARCA BURNS, 1983).

Goats as manure sources
Goat manure is as a good fertilizer as the other farm yard manures (JANSEN *et. al.*, 1996)
Possible Interventions:
1. All the herds in the area are local breeds except some female cattle, (CSA, 1995) therefore introduction of dual purpose goats that can serve both the meat and milk requirement is important.
2. Goats are considered to have degradation effect on the environment bringing high soil erosion however, cultures of tether and stall feeding followed for the other cattle should also be continued for goats.
3. Multipurpose trees, which can serve as shade, fencing and feed source should be encouraged.
4. Emphasis should be given to see how the manure from goat manure can be used efficiently for manure of ensete, coffee and other fields.
5. Extension should focus on the processing of goat milk, and sanitary precautions necessary.

4 Conclusion
The fact that the survey area is known for its high population rate requires a sustainable intensification of the system so as to ensure a sustainable livelihood to the community, Ensete, the major starch staple will remain in the system for long due to its merit of sustaining large population with adequate quantity of food and a very good source of feed to the available livestock herd. However, the lack of some necessary nutrients

from ensete food necessitates the supplementation with other sources of protein and other essential nutrients.

- The need for the supplementation of protein can either be addressed through leguminous crops or animal sources.
- The culture of producing leguminous crops such as haricot beans in the area is a good indication of the possibility of supplementing protein.
- However, plant sources remain to be poor protein sources as compared to animal sources. Therefore, animal products such as milk and meat will have important roles.
- There is an overall trend of decrease in livestock number in the area, mainly because of increase in human population, which claimed every grazing and marginal area for cereal productions. This decrease in livestock resulted in low supply of animal feed sources and manure for the farm household.

Even in the future this limitation will remain demanding a possible solution. The production of small ruminants, such as sheep and goat, which have some attractive features that make them fit into this system is of due importance. Especially, goats, require less space than cattle and larger herd can be kept. In addition, the indigenous knowledge of using goat milk for human consumption is an important intervention point for improving the households' malnourishment. To this end, the introduction of dual purpose goat breeds, which can supply both milk and meat is possible through credit shames taking into account the cash source from coffee as a repayment mechanism.

Environmental hazard usually associated with goat production can be managed by continuing the stall and tether feeding culture followed for cattle. In addition, some agroforestry products can sever multiple purposes as shade for coffee, fencing material and feed source. This will enable the intensive utilization of the limited land resource.

Therefore, sustainable intensification of enset-coffee-livestock will ensure a sustainable livelihood in the one of the highly populated areas of Ethiopia, the Sidama midland.

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