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Sustainability of small ruminant production on the Adja Plateau (South Benin)

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Abstract

Since 1986 the RAMR project (*Recherche Appliquée en Milieu Réel*) has conducted on-farm research on the Adja Plateau in Mono Province (South Benin). In this article, technical and socio-economic aspects of small ruminant production systems on the Adja Plateau are described. Monitoring of small ruminant flocks showed that about 25% of the small ruminants were sold annually. Export of nutrients as a result of the sale of animals (85 g N, 23 g P, 12 g K and 46 g Ca per hectare) was low compared with export through crop production. In-depth studies at village level showed that farmers mainly collected oil palm leaves, constituting 75% of the small ruminant rations, to feed their animals. Nutrients in collected oil palm leaves represented a substantial fraction (about 10%) of available nutrients in fields under oil palm. Proposals for future research on small ruminant production systems have to contribute to the sustainability of farming systems. Emphasis will be put on animal feeding and feed production integrating small ruminant and crop production.

Keywords: sustainability, small ruminant production, Benin

Introduction

Crop production based on soil mining, a general phenomenon in sub-Saharan West Africa, leads to a continuous decrease in soil fertility (e.g. Van der Pol, 1992) and consequently to environmental degradation. It may be questioned whether small ruminants, the most important animal production factor in humid West Africa, are also responsible for this process.

Since 1986 the RAMR project (*Recherche Appliquée en Milieu Réel*) has conducted research on farming systems in Mono Province (South Benin; Figure 1), initially in the fields of agronomy and socio-economics and since 1989 in animal production as well. The International Institute of Tropical Agriculture (IITA, Ibadan) and the Royal Tropical Institute (KIT, Amsterdam) provide technical support to the project, operating within the Directorate of Agricultural Research (DRA). Farming in Mono Province is characterized by fallow and permanent production systems on small family farms, mainly cropping maize, cotton and oil palm. The major agricultural con-

The Adja Plateau

The Adja Plateau (Figure 1) has long been inhabited and is therefore the most densely populated area of the Province (more than 250 inhabitants per km^2). Soils on the Plateau are classified as Nitisols (*terres de barre*; sandy to sandy-loam soils). On the Adja Plateau, situated in the humid zone of West Africa, annual rainfall amounts on average to 1100 mm in two rainy seasons from March until July and from September until November, with strong variations from one year to the next.

Rainfall permits two crops per year. Maize, cassava, cowpea and groundnut are the most important annual crops, always intercropped. Oil palm is the perennial crop. The densely planted oil palm trees, initially mixed with annual crops, cover the fields after 10-15 yr and are cut down at the end of the cycle (20-25 yr) to extract palmwine. This oil palm fallow system was identified as a productive local agroforestry system (Kang et al., 1991). Cotton, the major cash crop in Mono Province, is of minor importance on the Adja Plateau because of land scarcity. Food crops for home consumption have priority. An average household, consisting of eight members, has about 2 ha to cultivate.

In addition to crops, farmers (women and men) raise animals, e.g. goats, sheep, pigs and poultry. The number of cattle on the Adja Plateau is small. Diseases, like *peste des petits ruminants* (PPR) and Newcastle disease are major constraints on livestock production. Chickens are the most common animals, followed by small ruminants, raised by about 50% of the households. An average small ruminant flock consists of three to four head. Animals are raised to be sold on the local market. Two husbandry systems for small ruminants were identified on the Adja Plateau: (1) animals are permanently kept on free range and (2) small ruminants are confined during cropping seasons. Confinement is prescribed by law.

Small ruminant production in a free-roaming system

In Touléoudji, goats, kept permanently on free range, were much more important than sheep: the RAMR census conducted in 1989 counted 16 sheep among 189 small ruminants. Small ruminant keepers stated that free-roaming sheep were destroying crops. Sheep covered several km a day and crossed the dense bush (often oil palm fallow) surrounding the village. However, goats stayed in the village, searching for feed (herbaceous species, leaves of trees and crop residues) at the village border and along small roads not far from the village.

Goats in Touléoudji were rather productive (9.0 kg weaned kid at day 90 per reproductive doe per year) as a result of a balanced nutritional situation (Gbégo & Van den Broek, 1992). Fertility (1.3 births per year per reproductive doe) and prolificacy (1.8 kids per birth) were comparable to figures mentioned by ILCA (1983) and IEMVT (1990) referring to research in Ghana and Senegal, respectively.

Mortality was high during the year of monitoring, in particular as a result of an unidentified epidemic disease at the beginning of the rainy season with diarrhoea as its major symptom. Of the goats monitored, 27% died within 3 months. In general, more than 50% of the goat keepers observed diarrhoea in their herd (Koudandé, 1991). Goats kept on free range frequently also showed mange infections: 22% of the livestock keepers observed these infections.

High mortality may negatively influence offtake (19%). However, relatively substantial gross profit margins per goat keeper were attained in Touléoudji (2810 FCFA; 1 US $ = 270 FCFA; average annual income = 126000 FCFA) because of an increase in the number of animals raised during monitoring. In general, small ruminants may be exchanged for cash to solve problems of disease, lack of food and repayment of loans. Animals were also sold for management purposes: livestock keepers feared epidemic diseases and sold their animals before these fell ill and died.

Small ruminant production in a confined system

In Zouzouvou small ruminants were confined during cropping seasons from April until November. In fact goats were tied to a 'piquet' outdoors during the day and in the house at night. Sheep, representing about 20% of all small ruminants, generally stayed in enclosures during the day and indoors at night. During the months of confinement, small ruminant keepers fed their animals with forage collected in the fields. Most of the collected feed (75%) consisted of oil palm leaves. In 50% of the cases oil palm leaves were mixed with other, mostly woody species. Only one out of six daily rations did not contain any oil palm leaves at all.

Gbégo (1992) calculated that for rations consisting of 100% oil palm leaves, daily collections amounted to 10.4 kg per 100 kg live weight (LW). Dry matter intake was estimated at 2.3 kg per 100 kg LW (dry matter (DM) content of oil palm leaflets was 39%). Analyses of protein content in DM of oil palm leaflets showed figures between 11.5% and 16.4%, corresponding with analyses of the Oil Palm Research Station at Pobè, Republic of Benin (pers. comm.).

In this system goat productivity, expressed as weight of weaned kid at day 90 per reproductive doe per year, was significantly lower than in Touléoudji (free-roaming system). Flock monitoring revealed an average productivity of 5.3 kg weaned kid per reproductive doe per year (Gbégo & Van den Broek, 1992). Low productivity was due to low prolificacy (1.4 kids per birth) and low fertility (1.0 births per year per reproductive doe). Abortions among about 20% of the reproductive does explained the low fertility figure, related to a longer kidding interval in Zouzouvou (274 d) than in Touléoudji (230 d). Insufficient and unbalanced feed supplies are supposed to be the major causes of abortions.

Weight differences at 90 d (4.1 kg for Zouzouvou and 4.3 kg for Touléoudji) and at 12 months (11.1 kg and 11.3 kg respectively) were almost negligible between these villages. However, the mortality rate was substantially lower when goats were confined (29% against 50%) than in a free-range system. Apparently, livestock keepers paid more attention to confined animals, resulting in rapid disease treatment. Major causes of mortality in Zouzouvou included diarrhoea and lethal blows. The most common disease stated by 80% of the farmers was diarrhoea (Koudandé, 1991). About 20% also noted fever and numbness, symptoms of PPR, which also caused diarrhoea.

Table 1. Basic data on small ruminant production on the Adja Plateau.

Households on the Plateau		43412	Adapted from Van der Pol et al. (1993)
Cultivated land on the Plateau (ha)		89000	Adapted from Van der Pol et al. (1993)
Small ruminants per household[a]		2.56	RAMR (unpublished census)
Average flock weight (kg)		40.0	RAMR (flock monitoring)
Average weight of small ruminant (kg)		10.5	RAMR (flock monitoring)
In animal bodies:	N (%)	3.00	Landais et al. (1990)
	P (%)	0.83	
	K (%)	0.42	
	Ca (%)	1.64	

[a] Average number of small ruminants per household, including households which do not raise small ruminants (about 50% of households).

Goat keepers sold 28% of the goats and sacrificed 4% for ceremonies. Goat keepers in Zouzouvou obtained 3060 FCFA per year as gross profit margins on average.

Export of nutrients by small ruminant production: a discussion on sustainability aspects

Basic data for the calculation of export of nutrients by small ruminant production from the Adja Plateau are summarized in Table 1. The small ruminant population on the Adja Plateau was estimated from the average number of small ruminants per household in the villages studied (this average includes households which do not raise small ruminants). Based on figures computed from flock monitoring, other parameters were determined, such as total weight of the small ruminant population and weight export rate (Table 2).

Export of nutrients was calculated from the difference between sold and purchased animals. It is presented per average flock (3.8 head) and per hectare (Table 3). Annual export of nutrients by small ruminant production was small (less than 1%) compared with export by crop production. The latter includes uptake by crops, erosion, leaching and volatilization of N. Export of nutrients as a result of the sale of small ruminants is thus negligible in relation to nutrients exported by crop production. However, it should be noted that export of nutrients by small ruminant produc-

.Table 2. Estimated small ruminant production parameters for the Adja Plateau.

Total small ruminant population	111204
Total weight of population (t)	1172
Stocking rate per hectare (kg ha^{-1})	13.2
Weight export rate (%)	21
Weight export per flock (kg)	8.6
Annual export (t LW yr^{-1})[a]	251
Export per hectare (kg LW ha-1 yr^{-1})[a]	2.8

[a] LW, live weight.

Table 3. Annual export of nutrients from the Adja Plateau by small ruminant production (estimated per hectare cultivated land and per average flock of 3.8 head) and compared with export by crop production.

Export of nutrients	Small ruminant production		Crop production
	per flock ($kg\ yr^{-1}$)	per hectare ($kg\ ha^{-1}\ yr^{-1}$)	per hectare[a] ($kg\ ha^{-1}\ yr^{-1}$)
N	0.257	0.085	70
P	0.071	0.023	8
K	0.036	0.012	40
Ca	0.140	0.046	36

a Van der Pol et al. (1993).

Table 4. Export of nutrients from field under oil palm fallow to feed confined small ruminants with oil palm leaves.

Oil palm fallow on the Adja Plateau (ha)	22250
Total weight of small ruminant population (t)	1172
DMa feed offered (% of LW d^{-1})	5.3

Material	Feed offered to confined small ruminants ($kg\ ha^{-1}\ yr^{-1}$)	Present in oil palm leaves[b] $kg\ ha^{-1}$)
DM	512	8000
N	4.6[c]	71
P	0.6[c]	7
K	4.5[c]	49

[a] DM, dry matter.
[b] Estimated from data of Tinker & Smilde (1963).
[c] N, P and K contents were 1.84%, 0.13% and 0.79% for oil palm leaflets and 0.35%, 0.12% and 0.93% for rachis respectively (Tinker & Smilde, 1963).

tion only pertains to the export of live weight from the Plateau and does not include losses incurred during the production process.

While small ruminant production did not lead to nutrient depletion at regional level (Table 3), it was not the same at village level, particularly in the system using confinement. Small ruminant keepers in this system mainly collected oil palm leaves (75% of all forage) to feed their animals. Based on this ration and taking into account that small ruminants were confined for 8 months a year, export of nutrients from fields under oil palm was calculated (Table 4). Considerable quantities of biomass were transported to the villages annually, representing about 10% of the nutrients stored in the oil palms. Here, the export of nutrients only has been mentioned. Van der Pol et al. (1993) calculated nutrient balances for different crops. They reported a slightly negative N balance for fields under oil palm, although oil palms had among others a soil-fertility- regenerating function in the cropping system. Thus, if nutrients used from fields under oil palm are not replaced by others, such as fertilizers, sustainability of crop production will be negatively affected by small ruminant production.

Van der Pol et al. (1993) also concluded that restitution of crop residues constituted the most important source of nutrients for cultivated fields. Use of manure, however, will not substantially contribute to improved soil fertility in cropped fields because of the small quantities produced by small flocks (about 300 kg manure per small ruminant keeper annually). It also implies the problem of manure transport (over 1 to 5 km) from the village to distant fields, as reported from other parts of West Africa (e.g. Landais et al., 1990). An exception has to be made for fields near the village. Feed residues and manure were thrown into these fields, where farmers cropped vegetables (tomatoes, okra and pepper). Raising small ruminants thus contributed substantially to the transport of nutrients from the fields under oil palm to the fields surrounding the villages.

Improvement of sustainability: a provisional conclusion

Proposals for future research on small ruminant production systems have to contribute to sustainability of farming systems. In the case of the Adja Plateau, nutrient balances for cropped fields have to be in equilibrium and small ruminant reproduction figures should be improved. Emphasis will be put on animal feeding and feed production for confined animals. Alley cropping (hedgerow intercropping with *Leucaena and Gliricidia*) and the use of mineral licks will improve the nutritional status of small ruminants, having a direct effect on reproduction by larger litter size and shorter kidding interval through fewer abortions. In the past, on-station experience was gained with alley cropping, but little is known about the use of this method by farmers. The RAMR project is currently testing alley cropping with farmers on the Adja Plateau (Koudokpon et al., 1992). First results of on-farm feeding trials, using *Leucaena and Gliricidia*, will also become available shortly. The use of mineral licks will be tested in 1993.

Advantages of alley cropping on the Adja Plateau are expected from the multipurpose effect of this technology on crop production (as a result of improved soil fertility) and small ruminant production. On-station tests with *Panicum maximum* on depleted soils have also been conducted to improve soil fertility. Small ruminants may take advantage of the biomass produced. This innovation should be compared with other innovations improving fertility on depleted soils, which are actually tested by the RAMR project, e.g. the use of the legumes *Acacia auriculiformis and Mucuna pruriens*. However, to sustain crop production in the future supply of inorganic fertilizer in combimation with legumes or grasses is also required.

Manure produced in small enclosures, in which pigs and sheep are confined, may be used more efficiently. Intensive vegetable cropping in these enclosures, after removing the animals, would improve exploitation of fertilized soils. This rotation system with animals (small ruminants or pigs) and intensive vegetable cropping is a promising innovation of the farming system.

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