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Smallholder farmers practices of crops livestock integration in the district of Aguié (Niger): Agricultural production and livestock feed

Abdou Nourou [1,*], Kouré Abdoul Aziz [2], Ousseini Mahaman Malam Mouctari [3], Hamani Marichatou [3] and Verla Nsahlai Ignatius [4]

[1] *Department of Animal Production, National Institute for Agricultural Research, Niamey, Niger.*
[2] *Ministry of Livestock, Niamey, Niger.*
[3] *Department of Animal Production, Faculty of Agronomy, University Abdou Moumouni Niamey, Niger.*
[4] *Department of Animal and Poultry Science, University of KwaZulu-Natal Pietermaritzburg, South Africa.*

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Abstract

Crop production and livestock are main economic activities of most populations in Maradi region. The objective of this work is to study agricultural production and livestock feeding in terms of farming practices of crops livestock integration in 4 villages of Aguié.

The results of surveys randomly conducted on a sample of 78 farmers showed that farmers were categorized into two groups, which are farmers (67%) and agro-pastoralists (33%). However, the multivariate analysis of data highlighted existence of three categories of agro-pastoralist farmers, distinct in terms of their means of existence and levels of integration. It was counted 21% of population who have plows and seeders, while 51% have carts. According to distribution of oxen in farms, a proportion of 51% were small farms have no draft oxen, while 45% of farms have a draft oxen, 3 % of farms have a pair of oxen and 1 % of farms has five (5) draft oxen. Cereal production in Kg is 862 ± 419 for Small Farms (SF); 1008 ± 132.7 for Medium Farms (MF) and 5748 ± 4068 for Big Farms (BF). As for production (Kg) of legumes; SF produce on average 293 ±139.3, MF 452 ± 123.7 and the BF 991 ± 208.5. With regard to sales and self-consumption of cereals and legumes, BF carry out these practices in large quantities. In MF, for a millet production of 4,155.99 ± 613.49 kg, the millet stovers are 2,068.85 ± 305.39 kg. Cowpea production in BF is 359.08 ±135.25 kg for 65.64 ± 24.72 kg of cowpea haulms. The sorghum stovers for BF, MF and SF is respectively 566.2; 276.8 and 125.2 kg with land capital in Ha of 8.1 (BF), 3 (MF) and 1.8 (SF). Despite fodder available which is 2,227.5 kg for 0.58 TLU in the SF; 2,441.1 kg for 1.63 TLU at the MF level and 4,414.5 kg for 3.03 TLU, fodder balance is in deficit in all farms according to fodder requirement (Kg/270 days).

Key words: Integration; Agriculture; Livestock; Climate change; Aguié; Niger

1. Introduction

Located in the heart of Sahel, Niger is a continental country with an area of 1,267,000 km2, with nearly two-thirds (2/3) occupied by desert. The Nigerien Sahel appears as transition zone between the Sahara and Sudan [1]. It also presents itself as zone of convergence and contact, between pastoralists and farmers, in search of new and free land for pasture and clearing. Niger's economy is essentially based on agriculture and livestock. These sub-sectors occupy more than 80% of the population and contribute nearly 33% to added value of rural sector and 12% to national GDP [2]. Demographically, Niger ranked 18th among the most populous countries in Africa with a population of 25.25 million in 2022, and will rank 11th with 68.9 million in 2050 when we take into account its synthetic fertility rate which is 7.6. The

* Corresponding author: Abdou Nourou

problem of land use characterizes relationships of complementarity and/or competition depending on whether one is a farmer, agro-pastoralist or stockbreeder. Thus, we are even witnessing conflicts related to the use of resources and leading to brutal or progressive restrictions of pastoral space. This leads to increasing difficulties in the movement of groups of animals around the country [3]. It is in this way that the relations of economic complementarity must first be grasped at level of the basic family units, considering that agriculture and livestock breeding contribute together to ensure the reproduction of social, economic and cultural systems whose agricultural production is only one dimension. The herd accompanied group in peregrinations, and is used as a means of transporting loads [4]. Faced with these main constraints of variability and climate change with effects that are increasingly felt [5] on various sectors of socio-economic activity in Sahelian countries, it follows from consequences of irregular rainfall in time and space, recurrent droughts, decline in soil and livestock productivity in addition to constant reduction of cultivable areas and floods [6]. The association of agriculture and livestock is a practice common to all farms, it corresponds to a long-term strategy of diversification of activities and intensification of production, which the importance depends on the types of farms [7]. It is therefore important to have interest in current practices of integrating agriculture and livestock farming in order to encourage the optimization of an integrated farming model. The overall objective of this study is to analyze the management of livestock feed, the diversity of resources and productions in terms of agricultural-livestock integration practices and techniques.

2. Material and methods

2.1. Study zone

The department of Aguié has an area of 2800 km2 (Fig 1). It is one of eight departments of Maradi region and has two municipalities, including municipality of Aguié. It is bounded to the East by department of Gazaoua, to West by those of Guidan Roumdji and Madarounfa, to the North by that of Mayahi and to the South by Federal Republic of Nigeria over a length of about 50 km. This study was conducted at level of four intervention villages of Research Development project for Food Security and Climate Change (RED/SACC) in municipality of Aguié. The choice of sites in this rural commune as study area was motivated by fact of being one of intervention communes of RED/SACC Project, on one hand, and its relative ease of access compared to limit of means available on other hand. Thus, four villages namely Dan Saga, Debi, Maigaoudi and Guidan Dawaye (Table 1) out of five interventions of development research project for food security and climate change (RED/SACC) were selected for this study, fifth (city of Aguié) having been dismissed, given certain difficulties linked to its urban character, but also jointly capital of department and municipality of same name, which is not very favorable to this investigation.

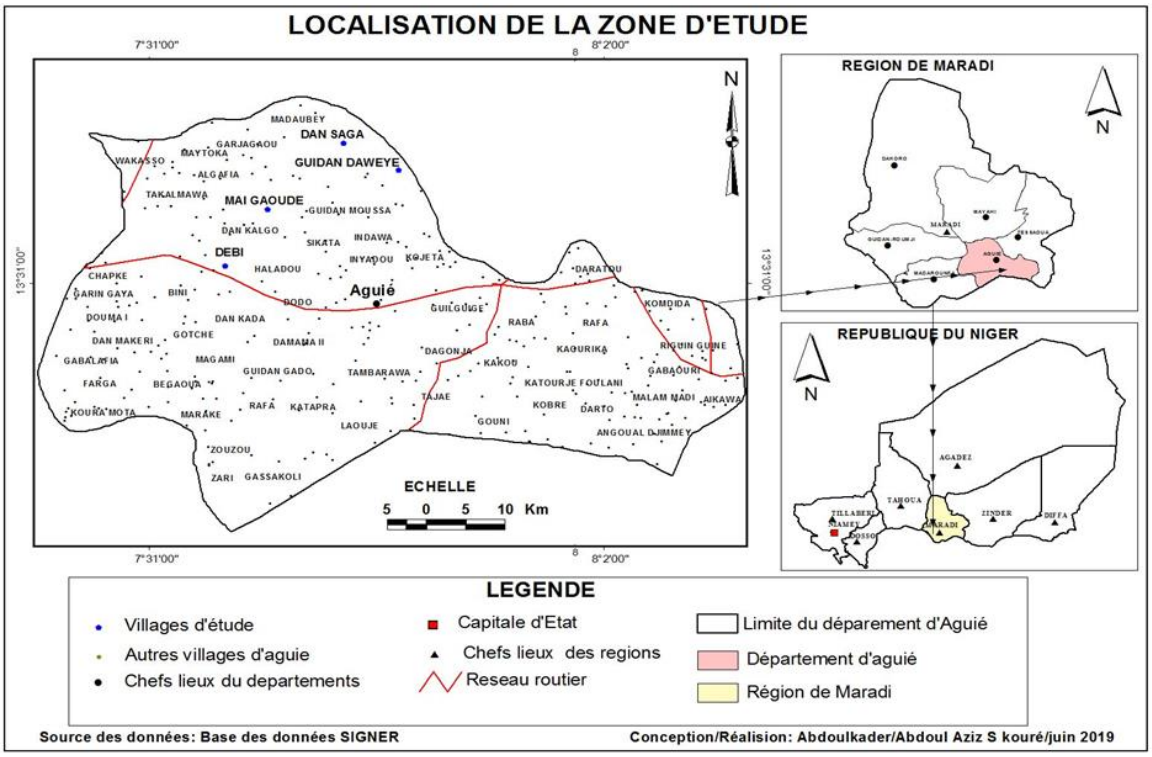

Figure 1 The Study area

Table 1 Geographical Coordinates of Villages Surveyed

Villages	Longitude	Latitude
Débi	7,6	13,54
G.Dawaye	7,88	13,66
Dan Saga	7,73	13,7
Maigaoudé	7,65	13,62

2.2. Collection of data

The purpose of holding a general assembly at each site was to present and explain the purpose of the survey and conditions for its execution; it also explained the choice of sampling method and its relevance, and the framework that served for administration and information of village questionnaire.

Data collection was carried out in two stages. The first stage for information and sensitization at the level of each site on the objective of the study, the choice of respondents and scheduling appointments for data collection. The second stage consisted of actual collection of data. Two types of survey questionnaires previously developed, tested and amended were administered in field (i.e., a village questionnaire administered in village assembly and a farm questionnaire administered individually to heads of farms).

The other tools used for data collection are knight chart and kraft papers for participatory diagnostic and analysis work (VEN diagram, resource maps; analysis of constraints for different areas, a camera for taking view and a GPS for georeferencing. The logistics having made it possible to accomplish this work, which for the most part took place in the field (collection of primary data). A "Hilux 4X4" vehicle was mobilized to facilitate movement of investigators who are part livestock technical service agents with a certain knowledge of area coupled with their experience in collecting socio-economic data from the rural households. It was systematic and at intervals at level of each village. The objective was initially to survey one hundred (100) farms in total, with twenty (20) per village. However, village of Aguié has been finally ruled out, 80 farms were targeted and 78 were finally affected by this survey. Thus, we have a representative sample of 9.1% of households in four villages (i.e. 78 out of 857 households).

The choice of sample was random and consisted from a practical point of view of:

- Numbering, from 1 to N, of all units included in sampling frame (where N is size of total population in each village);
- Determination of the sampling interval (k) by dividing number of units included in population by size of desired sample (here 20 per village);
- Randomly drawing of a number between 1 and k by an assistant at a village assembly. This number was chosen randomly and is considered the first included number in the sample;
- The selection of each (kth) unit in a regular and progressive way after the first number on the nominative list available from village that represents our sampling base.

2.3. Statistical analyzes

The data collected was previously entered, organized and checked in an Excel spreadsheet for statistical processing. Pivot tables and charts were produced for a first assessment. A second analysis by generalized mixed model in GenStat 9th edition was carried out. Categories were included as fixed effects and producers were considered as a random effect. The Student Newman-Keuls test was used to compare means with significant differences

3. Results

3.1. Agricultural production and livestock feed

3.1.1. Agricultural production equipment

Of entire population surveyed, 21% of population have plows and seeders, while 51% have carts (Table 2).

Table 2 Agricultural production equipment

	Percentage of plows (%)	Percentage of seeders (%)	Percentage of carts (%)
Dan Saga	5	20	50
Debi	6	6	44
G. Dawaye	15	10	45
Maigaoudé	55	45	65
Total général	21	21	51

3.1.2. Distribution of draft oxen

When further investigations are carried out (Figure 2), we find that 51% of farms, generally a large proportion of constituents of small farm have no draft oxen, while 45% have one draft oxen, 3 % of farms hold a pair of oxen and 1 % of farms has five (5) draft oxen.

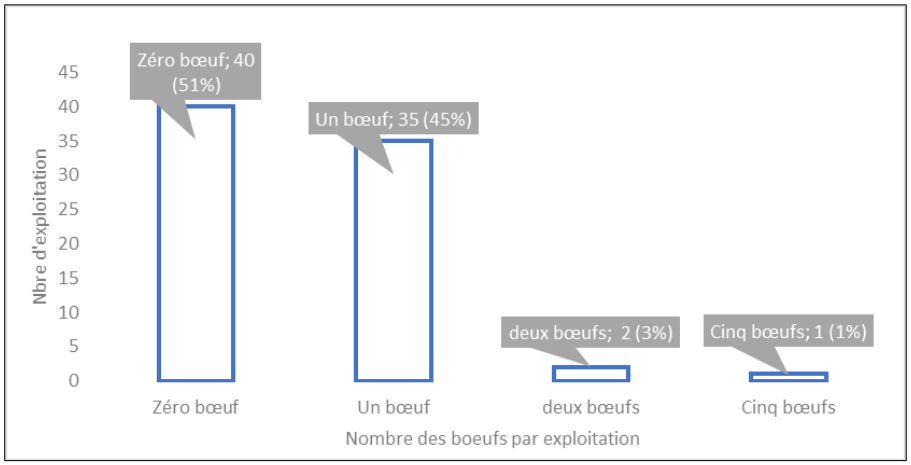

Figure 2 Graph of distribution of oxen on farms

3.1.3. Production and operations management

The comparison of the averages (Table 3), on agricultural productions were different between the three categories of farms, this allowed us to appreciate different destinations of these productions. Cereal production, estimated per kilogram concerns millet and sorghum. As for legumes, it is cowpea cultivation that concerns majority of producers and then groundnut cultivation.

Table 3 Comparison of production averages and their integrations

Categories	Small farms	Medium Farms	Big Farms	lsd	P<0.05
Cereal production	862a ± 419	1008a ± 132.7	5748b ± 4068	859,8	0,002
Sale of cereals	69 ± 46.6	136 ± 54	3520 ± 168.7	7715,9	0,51
Cereal self-consumption	793 ± 168.7	873 ± 118.2	2227 ± 207.5	7565,5	0,314
Legume production	293a ±139.3	452a ± 123.7	991b ± 208.5	475,5	0,008
Sale of pulses	237 ± 140	391± 123	616 ± 136	373,4	0,122
Legume self-consumption	56a ± 11	61a ± 20.6	375b ± 153	286,6	0,035

The comparisons of means highlighted statistical differences among three variables, cereal production (P<0.01), production of legumes (P<0.01) and self-consumption of legumes (P<0.05) between the big farms and other two.

3.1.4. Livestock feed source

Animal feed in the study area is based on agricultural residues (millet and/or sorghum stovers, cowpea and/or groundnut haulms) and supply of natural rangelands (bush straw and pods of woody plants collected and/or standing). The fodder collected is stored in order to offer to the animals in times of shortage feeds). For some farmers, these stocks represent a security reserve and for others it is a goodwill, which they turn into an income-generating activity (IGA).

The comparison of means on agriculture productions showed statistically significant differences (P<0.01) among big, medium and small farms for the following variables: production of sorghum (P<0.01); Production of sorghum residues; both Production of millet and sorghum brans (Table 4).

Table 4 Comparison of agriculture productions and crop residues

Productions	**Small farms**	**Medium Farms**	**Big Farms**	**lsd**	**P <0.05**
Millet production	4 045.12 ± 739.67	4 155.99± 613.49	7 461.94 ± 2261.07		0.101
Sorghum production	251.41a ± 144.21	556.13a 184.82	1 137.36b± 253.93	536.90	0.004
Cowpea production	90.13 ± 25.77	76.98 ±14.21	359.08 ±135.25		0.055
Peanut production	372.55 ± 98.69	445.00± 123.32	394.89 ± 111.35		0.888
Production of millet residues	2 013.66 ± 368.21	2 068.85± 305.39	3 714.55± 1 125.56		0.101
Production of sorghum residues	125.15a ± 71.79	276.84a ±92.01	566.18b± 126.41	267.30	0.004
Cowpea haulm production	16.48 ± 4.71	14.07±2.60	65.64 ± 24.72		0.055
Peanut haulm production	72,19 ± 20.35	81.35 ± 22.54	68.10 ±18.04		0.888
Millet bran	223.43a ± 40.86	229.56ab ± 33.89	412.17b ±124.89	190.40	0.001
Sorghum bran	13.89a ±7.97	30.72a ± 1021	62.82b ± 14.03	29.65	0.004

± Standard error; Means assigned the same letter in the same row are not significantly different

For cereals (millet and sorghum), the production of cereal grains per kilogram is multiplied by the following coefficient: 0.4978; And, for legumes (cowpeas and groundnuts) by: 0.1828

Estimation of load capacities by operating category

Table 5 Fodder balance by farm category

	Small Frams	**Medium Farms**	**Big Farms**
Workforce (TLU)	0.58	1.63	3.03
Available fodder (Kg)	2 227.5	2 441.1	4 414.5
Fodder requirement (Kg/270days)	978.75	2750.625	5113.125
Balance = Fodder available (Kg) Fodder - need (Kg/270days)	1 248,8	- 309,5	- 698,6

The available fodder and the average livestock capital (in TLU) are calculated, respectively on the basis of agricultural production and the numbers of animal species reared within each category of farm. Knowing also that a TLU needs 6.25kg of DM/Day, the fodder needs and the average balances are estimated by type of farm (Table 5).

4. Discussion

The presence of animals in the concessions of farmers, the latter continue to stick the identity of exclusive farmers, considering these animals, just as savings or simply the lever of a survival strategy. Thus, there are a few small ruminants and/or poultry on almost all farms. This finding is different among breeders whose cultivated area is so small that most often production does not meet the food needs of households; cereal availability is below the FAO standard (200 kg/person/year). They then sell animals to guarantee their food needs [7].

In the context of vulnerability, the breeding of huts or barns is a basis guaranteeing the resilience of poor families. The statistical analysis which made it possible to compare the following variables: draft cattle, goats, poultry and the production of organic manure, did not even reveal statistical differences between the two types of farms (farmers and agro-breeders) when investigation. In northern Côte d'Ivoire, practices for integrating agriculture and livestock farming are developing: an average of 2 draft oxen per farm, storage of crop residues, spreading of OF, saving on the vine with the cattle etc.), but remains less sustained than those of southern Mali and western Burkina Faso [8].

Thus, like all economic activities, livestock farming occupies all strata of rural communities. Almost all domestic animal species are bred, some protecting the others, thus forming a food security device. Animals are raised only to satisfy all types of common needs in the life of rural societies. We talk about social roles, economic roles, religious roles, etc. Nevertheless, many points need to be improved in order to optimize the contribution of this sub-sector to farm food security. Unable to invent land with a wave of a magic wand, the fundamental basis of agriculture, nor easily obtain a herd of cows, the breeding of short-cycle animals must be understood and assumed as the lever of development at the base. "Everyone can afford two hens and a rooster and this breeding nucleus does not require a grazing area or large investments". However, efforts will have to be made to improve breeding conditions in terms of health, food and reproduction management. Consideration should be given to diversifying and enhancing resources. Other studies have shown that Peanut haulms, rice straws, maize stalks are used as feed for draft animals, dairy cows and weak animals during the dry season such as in southern Mali and west of Burkina Faso [9].

According to the results of certain researchers, among the adaptation strategies developed on food resources such as the development of fodder crops, the development of water points, the use of agro-industrial by-products, reforestation, the delimitation of spaces, the installation of the anti-erosion device, the deepening of ponds and the sinking of wells, only the collection and storage of fodder constitutes the most appropriate strategy [10]. However, other studies have shown Deepening allows breeders and market gardeners to increase the water storage capacity of ponds and lowlands in order to meet the water needs of herds and crops in the dry season [11] [12] [13] [14].

Thus, it is necessary to intensify the popularization of essential modules such as strategic supplementation, herd management, the prophylaxis program and basic animal health.

Animal traction, by virtue of its decisive effect on labor productivity, was adopted by the peasants. Production conditions did not encourage farmers to develop fodder and organic manure production practices. But times have changed and with the increase in the price of inputs and the reduction of grazing areas, the integration of agriculture and livestock is changing positively [15]. The virtues of the crop-livestock association on farm productivity and maintenance

The cereal production of large farms is worth nearly 6 times that of medium-sized farms and 7 times that of small farms on average. As for legumes, the production of large farms is twice that of medium-sized farms and three times that of small ones.

In relation to the exploitation and management of production, small farms consume 92% of their cereals and sell only 8%, while in medium-sized farms, the share of self-consumption amounts to 87% of the total production and 13% is assigned to sales. As for large farms, they allocate 39% to self-consumption to sell up to 61%.

It should be noted that the share allocated by large farms to self-consumption is almost three times that of small farms and more than double that of medium-sized farms. When we consider the average cereal availability for the coverage of needs according to the FAO standard which is (200Kg/person/year), report [7], the food security of small farms will only be covered for 5 months only, while medium-sized farms will insure theirs for 6 months and large farms for 9

months. This is what justifies the use of the sale of small ruminants, a large part of the production of legumes, poultry and the development of other rural survival strategies such as exodus and other small businesses.

For the production of legumes, small farms consume only 19% to sell 81%, while medium farms consume 13% to sell 87%. As for large farms, they sell 62% to keep 38% for household consumption. Here, we note that the share of self-consumption of legumes for large farms is 7 times that of small farms and 6 times for medium-sized farms. The income of these farms comes mainly from agricultural and/or animal production.

Regarding the management of agricultural residues, small farms have a surplus of 1248.8 kg, while medium and large farms are respectively in deficit of 309.5 kg and 698.6 kg. On a global level, the deficits observed could be covered by the surpluses achieved in small farms with a surplus of 240.6 kg. This would represent an income-generating activity for them. Nevertheless, the storage conditions and the inadequacy of the hay distribution techniques contribute to exposing the animals more to a feed shortage each year.

5. Conclusion

The study on livestock feeding, the diversity of resources and productions in terms of agriculture-livestock integration practices and techniques revealed that the population surveyed has plows, seeders and carts as agricultural production equipment. The agricultural productions between the three categories of farms are cereal productions, cowpea and groundnuts. The animal feeds were crop residues such as millet or sorghum stovers, cowpea and groundnut haulms which are the main factors of livestock crops integration. Medium and big farms have less fodder available compared to fodder needs, for this reason, strategy of improving feeding animal and fodder production is needed in order to fill the gap of shortage fodder.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest has been reported.

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