

Full Length Research Paper

Characterization of pastoral herding in Kanem (Chad)

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The present survey was conducted to characterize herding practices and overall production performances of pastoral systems in the Kanem region, Chad. Overall, 69 livestock keepers were interviewed, among which 12 sedentary agro-breeders, 35 mobile agro-herders, and 22 nomadic herders. Species association is a main feature of the herd structure. Agro-herders make most often an association between cattle and small ruminants (47%). Among mobile agro-herders, the association between cattle and small ruminants is frequent (47%) whereas nomadic herders tend to show more diverse modalities of herd composition. Feed is mainly based on natural pastures. However, complementary feeding is provided, targeting the producing females and weaker stock during the maximal risk period. During the rainy and post-harvest season, milk yields are significantly higher among agro-herders than in other groups ($p < 0.05$). In camels, the season of the year and the herding system have no effect on milk production. Regarding reproduction parameters, the mean age at first calving is 4.7 ± 0.7 years in cows and 5.8 ± 0.6 years in she-camels. The calving interval is 1.9 ± 0.4 years in cows and 2.7 ± 0.4 years in she-camels. The fecundity rate is around 63% in cows and 44% in she-camels. Simple husbandry techniques might help increasing production levels to the benefit of the households, as complementary feeding, which is already provided in a targeted way. The systematic implementation of this complementation faces constraints of availability of these agricultural by-products on the local markets. As far as research is concerned, the study recommends the implementation of herds monitoring of the area in order to precise the livestock breeding practice as well as zootechnical parameters.

Key words: Agro-pastoral, cattle, camel, Chad, herding, Kanem, production performances.

INTRODUCTION

In Sahelian countries, livestock plays an important economic, social and cultural role. The share of the livestock sector in the gross domestic product varies from 5 to 10% according to the country and at local levels; it contributes to food security in rural and urban households (Wane et al., 2009). Pastoral herding appears as the main mode for a sustainable utilization of the sparse and

heterogeneous vegetation in the region. Furthermore, pastoral herding allows for a flexible and rapid adaptation to the wide seasonal variations in availability of water and plant resources (Gerber et al., 2012). Presently, pastoralism faces important ecological and socio-economic changes that include climate change, population growth, urbanization, market development,

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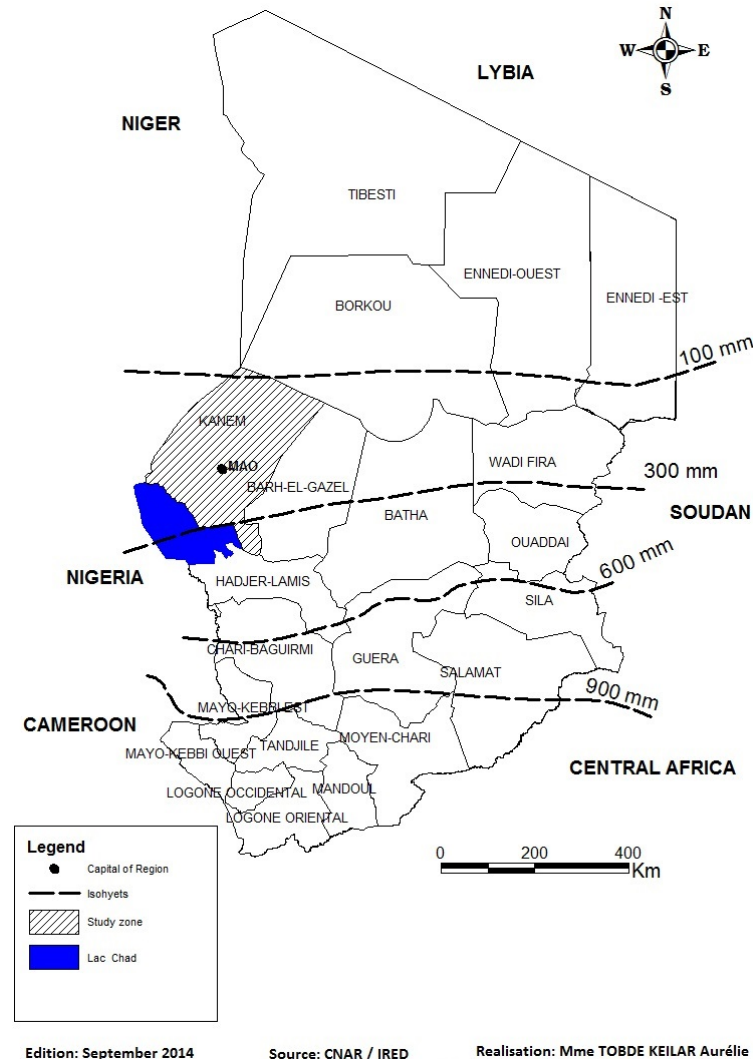


Figure 1. Study zone.

evolution of the demand for animal products, administrative decentralization and the withdrawal of the State from economic operations (Magrin et al., 2011).

In Chad, the Kanem region is a typical Sahelian agro-ecological context, of which pastoral herding is the main economic activity. Climatic changes have resulted in a higher frequency of severe annual rainfall deficits, leading the region to suffer from chronic food insecurity. Pastoral systems should hold in this context a key-role in the socio-economic development of the region, being the basis of the livelihoods of households and providing the meat needed on the national and sub-regional markets. To enable this development, investments and support will be necessary, needing in turn a thorough understanding of the constraints and opportunities of the system. Therefore, the present survey was conducted to characterize the herders' practices and production performances of pastoral systems in the Kanem region. It

identifies future research area in order to deepen the thought on the performances of nomadic livestock breeding in Kanem.

MATERIALS AND METHODS

Study zone

The Kanem region (Figure 1) lie between the latitude 14° and 17° north. The climate is sahelo-saharian, that is, subdesertic in its northern part and Sahelian in its southern part. Annual rainfall vary from 100 to 200 mm, concentrated on one season, from July to October. The mean monthly temperatures are lowest in January, with 23°C, and peak in May at 45°C. The landscape is dominated by sand dunes and interspersed basins with temporary rivers, called Ouadis. Dune vegetation is sparse, of the pseudo-steppic type, with few trees (*Balanites aegyptiaca*, *Acacia raddiana*, *Acacia albida*, *Ziziphus mauritiana*, etc.) and annual grasses (*Panicum turgidum*, *Aristida mutabilis*, *Cenchrus biflorus*, *Aristida mutabilis*, *Eragrotis tremula*, etc.). In the north, the vegetation becomes

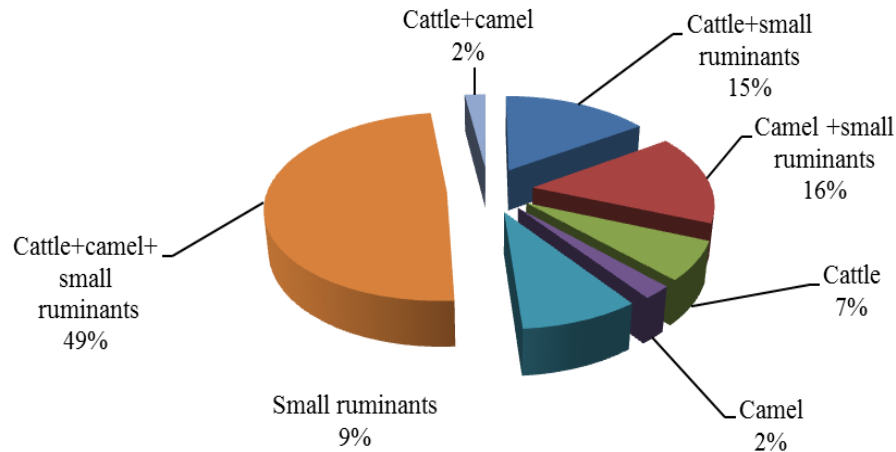


Figure 2. Distribution of species composition of herds in the Kanem Region (Chad).

sub-desertic with very sparse shrubby vegetation (*Leptadenia pyrotechnica*, *Calotropis procera*). In inter-dunar basins, vegetation is denser, mainly composed of above-mentioned tree species. Due to its aridity, the zone is weakly populated, with 2.4 inhabitants per km². Agricultural activities are marginal and consist of two crop types: Rainfed crops on the dunes, e.g. *Pennisetum glaucum* and *Vigna unguiculata*, and off-season crops in the Ouadi, e.g. maize, vegetables, cassava.

Sampling and survey methods

The study sites were villages in the case of sedentary agro-breeders and transhumant agro-herders, and camps in the case of nomadic herders. Preliminary interviews with administrative leaders and local livestock services allowed for the localization of targets groups. Village or camp chiefs were contacted telephonically for appointments.

At the village or camp level, a focus group was held with all livestock keepers to present the research team, composed of three persons, and to explain the goals of the study. The interviewed livestock keepers were chosen on a voluntary basis, while maintaining the balance between the three main breeding systems: The sedentary agro-livestock system, the transhumant agro-herding system, and nomadic herding. Overall, 69 livestock keepers were interviewed, among which 12 sedentary agro-breeders, 35 transhumant agro-herders, and 22 nomadic herders. The questionnaire was applied through face-to-face interviews with the households' chief who is in charge of the herd management. The questions tackled the following topics: (i) Herd's structure (number, species, sex and age distribution); (ii) The feeding practices in the different seasons; (iii) Production and reproduction performances (estimated average daily milk quantity per animal in the different species, age at first parturition, intervals between parturitions, fecundity, off-take rate of the herd). The herders' wives were more particularly involved about questions on milk production.

Data analysis

All statistical analyses were performed with the SPSS+ software. Analysis of variance was used to compare between livestock systems. To test the effect of season, the year was divided in four seasons, according to the local traditional classification: (i) *Darat*: Harvest season (September to October); (ii) *Chité*: Dry and colder

season (November-February); (iii) *Sef*: Dry and hot season (February to April); (iv) *Rouchach*: First rainfalls (May to June); (v) *Kharif*: Rainy season (July to October). The rate of herd off-take is the number of animals exploited (culling, sale, gift) divided by the mean herd size. The fertility rate was calculated by dividing the 12 months of the year by the interval between calving.

RESULTS

Herd structure and composition

The species association of animals in a same herd is a common practice. The dominant modality is the association of cattle, camels and small ruminants (Figure 2). The association camels and small ruminants (16%) or cattle and small ruminants (15%) are the second modality. Herds exclusively composed of cattle, small ruminants or camels amount together to 20% of the total sample. The presence of cattle and camels in the same herd is rare (Figure 2).

The association between cattle and small ruminants is the only modality practiced by sedentary agro-breeders and is also practiced by 52% of transhumant agro-herders (Table 1). The species composition of herds is more variable among nomadic herders, with two main modalities (36% each), that is, herds exclusively composed of small ruminants and their association with camels. Exclusive camel herds are only found in nomadic systems.

Nomadic herders keep zebu cattle whereas the transhumant and sedentary breeds hybrids resulted from the cross between zebu and Kouri taurin.

Feeding

Rangelands

In the North part of Kanem, animals (cattle and small

Table 1. Distribution of species composition according to the breeding system (%) in the Kanem Region (Chad).

Association type	Transhumant agro-herders	Nomadic herders	Sedentary agro-breeders
Cattle + small ruminants	52	21	100
Camel + small ruminants	11	36	0
Cattle + small ruminants + camel	30	0	
Cattle	7	0	0
Camel	0	7	0
Small ruminants	0	36	0
Total	100	100	100

Table 2. Different pastures used by livestock.

Pastures	Season				
	First rainfalls	Rainy	Post-harvest	Colder	Hot
Pastures of the dunes and trays (grasses and woody plants)	Cattle zebus, camels, small ruminants	Cattle zebus, camels, small ruminants	Cattle zebus, camels, small ruminants	Cattle zebus, camels, small ruminants	Cattle zebus, camels, small ruminants
Fields (crop residues)			Cattle zebus, small ruminants	Cattle zebus, small ruminants	Cattle zebus, small ruminants
Polders of Chad Lake				Taurine Kouri and hybrids, camels, small ruminants	Taurine Kouri and hybrids, camels, small ruminants
Islandes of Chad Lake				Taurines Kouri	Taurines Kouri
Woody plants	Camel	Camel	Camel	Camel	Camel

ruminants) of the nomadic herders are free all the year. They value all the year the grassy and woody pastures of the dunes and trays (Table 2). The different kinds of grasses are: *Panicum turgidum*, *Aristada mutabilis* and *C. biflorus*. As for the shrub, it essentially consisted of *L. pyrotechnica* and *C. procera*. After the harvest, they go in the fields for eating the crop residues. The seasonal trips are scarce because the number of cattle and small ruminants is down. The pasture in the free space such as leaves, flowers and fruits of shrubs constitute the feeding of the camels. During the dry period, the herds of camels move more to the east in the area of rig-rig where the pastures are abundant. They use year-round the herbaceous pasture and woody plants of dunes and traps.

Unlike the North, in the southern part of Kanem, each morning, the herds of the transhumant agro-herders and agro-breeders are led to the pasture under the watch of a young shepherd. And then, cattle, small ruminants and camels are led near the Chad lake where the green grasses are abundant. The herders of taurine Kouri lead theirs in the Islands to breed the green grasses, particularly sedges and *Acacia* sp. In the rainy season, cattle move more in the northern of the Chad Lake where they take advantage of the breed pastures of the dunes

and traps as well as cattle of nomadic herders.

Complementary feeding practice

Complementary feeding is only practiced during the dry and hot season (*Sef*) and during the period just preceding rainfalls (*Rouchach*), when the shortage in fodder is the most limited. During the dry and cool season (*Chité*), dry season fodder and cereals straws are harvested and stocked by the 3/4 of sedentary agro-breeders to serve as complementary feed (Table 3). This practice is less frequent among transhumant agro-herders (19%) and is almost absent among nomadic herders (1%).

Agro-industrial by-products may also be used, particularly groundnut oilcake, being used by 75% of sedentary agro-breeders, 93% of transhumant agro-herders and 71% of nomadic herders. Other by-products used, include cereals brans, by 25% of agro-breeders, 81% of transhumant agro-herders and 43% of nomadic herders. Cereal grains may also be distributed in extreme cases, when other complements are not available on the market. In all cases, complementation is selective, targeting lactating and gestating females, weak animals or young stock. Salt complementation is a common

Table 3. Use of dietary supplements by type of farming (%).

Supplements	Sedentary agro-breeders	Transhumants agro-breeders	Nomadic herders
Cereals straw	75	26	1
Cereal brans	25	81	43
Groundnut oilcake	75	93	71
Salt complementation	100	100	71
Cereals grains	25	44	36

Table 4. Mean milk yield variation per cow according to the season and the herding system (liter/day) in Kanem Region (Chad).

Herding system	Season				
	<i>Kharif</i>	<i>Darat</i>	<i>Chité</i>	<i>Sef</i>	<i>Rouchach</i>
Sedentary agro-breeders	3.24 ^a ±1.6	2.01 ^a ±1.0	1.15±0.8	0.60 ^a ±0.3	1.2±0.5
Transhumant agro-herders	1.94 ^b ±1.5	1.51 ^b ±1.0	1.02±0.8	0.25 ^b ±0.4	1.1±0.5
Nomadic herders	2.71 ^c ±0.8	1.60 ^c ±0.7	1.01±0.5	0.83 ^a ±0.4	1.2±0.6
Total	2.60±0.8	1.54±0.7	1.10±0.5	0.83±0.4	1.1±0.6

* Different superscripts (a, b, c) on a same column indicate statistically significant differences ($p < 0.05$).

practice of all livestock keepers), either in the form of sodium chloride (60% of cases, mainly sedentary agro-breeders and transhumant agro-herders in the South of Kanem) or in the form of sodium carbonate (40% of cases, mainly among nomadic herders from the North Kanem).

Milk production

The daily milk yields per cow are presented in Table 4 for the three different systems. During the rainy and post-harvest seasons, milk production is significantly higher in sedentary agro-breeder system ($p < 0.05$). During the dry and hot season, the dry and cool season and at the beginning of the rainy season, daily yields are generally low, under 1.5 L, for all three systems. During the dry season, the mobile agro-herders report significantly lower yields than in the two other systems ($p < 0.05$).

In camels, except for agro-breeders who only own some males for transport, the breeding system (nomadic or transhumant) has no statistical effect on the reported milk yield for all seasons (Table 5). On the contrary, the season itself shows a significant effect on the reported milk yield, being lowest at the end of the dry and hot season ($p < 0.05$).

Reproduction performances

Age at first calving

The mean age at first calving is 4.7 years old in cows and 5.8 years old in she-camels. This age does not vary significantly between breeding systems ($p > 0.05$) (Table 6).

Calving interval

The mean calving interval is 1.9 years in cows and 2.7 years in she-camels. In both cases, this interval was not influenced by the breeding system (Table 7).

Fecundity

Mean fecundity, that is, the number of offspring per year and per animal is 0.63 in cows and 0.44 in she-camels.

Herd off-take

In the Kanem region, this rate of herd off-take varies according to the breeding system and the animal species (Table 8).

Nomadic herders display the highest off-take rate among the three systems for cattle and sheep. The sedentary agro-breeders exploit fewer cattle than in other systems. The off-take rates in camels by nomadic herders and transhumant agro-breeders are similar. The small ruminants show the highest off-take rate in all breeding systems.

DISCUSSION

Herd structure and composition

Livestock keeping in the Sahelian context presents high risks due to the extreme environmental variability, both inter- and intra-annually. The particular vulnerability of the system appears at the end of the dry season, especially

Table 5. Mean milk yield variation per she-camel according to the season and the herding system (liter/day) in Kanem Region (Chad).

Herding system	Season				
	<i>Kharif</i>	<i>Darat</i>	<i>Chité</i>	<i>Sef</i>	<i>Rouchach</i>
Transhumant agro-herder	3.09±1.6	3.04±1.3	2.00±1.1	2.01±0.8	1.60±0.5
Nomadic herders	3.29±1.7	3.09±1.1	2.03±0.6	2.01±0.5	1.60±0.4
Total	3.12±1.6	3.04±1.3	2.01±1.1	2.01±0.8	1.60±0.5

Table 6. Mean age at first calving in cows and she-camels per breeding system in Kanem Region (Chad).

Herding system	Cow	She-camel
Transhumant agro-herders	4.7±0.6	5.9±0.6
Nomadic herders	5.0±1.0	5.7±0.6
Sedentary agro-breeder	4.6±0.7	-
Total	4.7±0.7	5.8±0.6

Table 7. Mean calving interval in cows and she-camels per breeding system in Kanem Region (Chad).

Herding system	Cow	She-camel
Transhumant agro-herders	1.9±0.4	2.7±0.5
Nomadic herders	2.0±0.0	2.6±0.4
Sedentary agro-breeder	1.9±0.2	-
Total	1.9±0.4	2.7±0.4

in unusually dry years (Thébaud, 2002). To mitigate the effects of such droughts, herders developed strategies, among which the diversification of species (Faye, 1992; Bourgeot, 2009). Hence, cattle are usually associated to small ruminants or even to camels. This diversification of animal assets appears as a major characteristic of the herds in Kanem. This strategy allows taking advantage of each species (reproductive performance, resistance to drought and diseases, production of meat, milk and manure and lowers the risk of losing the whole herd upon drought or epizootics. Species association also bring benefits regarding the diverse economic and socio-cultural roles of each species: Goats and camels produce milk all year round, sheep are sold to cope with regular or exceptional financial needs and are also sacrificed for religious events (Maiga, 1995). An additional advantage is that these different species graze different vegetal strata; camels and goats graze shrubby and tree strata whereas cattle and sheep graze the herbaceous layer (César and Zoumana, 1999). This diversification is a widespread strategy across the Sahel.

Rangelands

In Sahelian zone, natural pastures constitute the main part of ruminants feeding. However, their productivity

varies widely in time and space. Hence, if during the rainy season, the pastures are rich in annual grasses such as *Aristida funiculata* and *A. mutabilis* and may cover the animal needs for maintenance and production. During the dry season, this fodder becomes dry, sparser and of poor nutritional quality (Boudet et al., 1967). This seasonal disequilibrium in nutritional resources on rangelands affects animals, resulting in weight loss, an overall weakness and drop in milk yield (Thébaud, 1990). To face this shortage, livestock keepers in the study zone distribute complements to their animals, as crop residues, by-products or even cereals. This distribution is restricted in terms of time, targeting the critical periods, and in terms of animals such as sick animals and lactating females. Nevertheless, the implementation at a wider scale and on a longer period of this practice faces constraints due to the poor accessibility of these products.

Milk production

Milk plays an important role in the nutrition and economies of pastoral societies. Herders breed cattle and camel first for their milk and then for the sale of their offspring. Besides home consumption, the sale of transformed milk products (e.g. ghee) brings key income for the households (Kerven, 1987). In Kanem, this study confirms the wide seasonal variability of milk production. The highest yields are found in the rainy season (*Kharif*) and stay high in the post-harvest season, when animals have access to crop residues. The dry and hot season (*Sef*) is the harsher season and the time preceding the first rainfalls (*Rouchach*) is each year critical for herd survival, due to severe shortage in water and fodder. During this period, cow milk yield is lowest in the transhumant system but slightly higher and similar in the nomadic and sedentary systems. This result might indicate that the nomadic pastoralism is an efficient way of using the sparse vegetation and seasonal shortage (Colin de Verdière, 1995). Sedentary farms display similarly good yields in this period due to their complementary feeding practice and the presence in their herds of the Kuri breed that is known as a good milk breed. The breeding systems did not show an impact on camel production. This might be due to the fact that the nutrition of camels is based all year round on the tree fodder, mainly *Leptadenia pyrotechnia*.

Table 8. Mean rate of herd off-take (%) per species and per breeding system in Kanem Region (Chad).

Herding system	Cattle	Sheep	Goat	Camel
Transhumant agro-herders	12.1	30.7	25.2	11.3
Nomadic herders	14.5	36.3	28.3	10.3
Sedentary agro-breeder	8.2	22.0	30.5	-
Total	11.8	32.0	26.8	10.5

Reproduction performances

The mean age of 4.7 years at first calving in cows is similar to those reported in by Wagenaar et al. (1988), Faye (1992), Colin de Verdière (1995) and Achard and Chanono (1997), who obtained ages comprised between 4 and 4.5 years old. The calving interval about 22 months is also higher than that reported by the same authors (16 to 18 months).

The studies on production parameters in camels in Africa are sparse. However, the mean age at first calving (5.8 years) and the calving interval (2.7 years) obtained in this study are similar to those reported by Vias et al. (2006) in Niger, that is, respectively 5.5 and 2.4 years. An age at first calving between 5 and 6 years is reported in different ecological zones of Ansongo region, Mali (Traoré et al., 2014).

A fecundity rate of 63% is obtained in cows and 44% in she-camels. These values are difficult to ascertain and difficult to compare between authors because of the diverse methods used. Ranges of values may nevertheless be proposed. Indeed, regarding cows, Sedes (1976) observes a fecundity rate between 53.8 and 63.5% in Arab zebu in Chad. Similarly, Achard and Chanono (1997) report a fecundity rate of 73 to 86% for the Azawak zebu in Niger. Regarding camels in pastoral systems, Mukasa-Mugerwa (1981) reported them to be lower than 50%.

The reproduction performances of zebu cattle and camels in the study zone are modest. These performances are constrained by the environment, indicating the poor availability and quality of fodder. Indeed, while local breeds might present genetically lower performances due to their adaptation to scarcity, several studies showed that the genetic potential of indigenous breeds might be better exploited by the adoption of simple husbandry techniques, relating to feeding and health follow-up, resulting in higher weight gains and milk yields (Achard and Chanono, 1997; Missohou et al., 1997; N'Djoya and Loko, 1997).

Off-take rates were highest in small ruminants, since these species are easier sold on Sahelian markets. Their sale aims at fulfilling medium financial needs of the household. They may be sacrificed for home consumption, more often than on religious occasions or to welcome important guests. Cattle and camels are sold to meet important expenses (maize stocks for agro-breeders and agro-herders, wedding, fines, etc.). The

high off-take rate reported by nomadic herders for cattle relates to the volatility of food prices, as cereals, forcing them regularly to sell animals to buy food. This rate was more moderate in agro-breeders who produce part of their food and generate monetary incomes through other activities (e.g. the trade of sodium carbonate).

Conclusion

This study highlights the strategies in different breeding systems in the Kanem Region, Chad. In many of them, species diversification is a key feature of their risk management. This practice allows taking advantage of the particular benefits of each species. However, there is a strong influence of the environment in particular food resources, including forage on livestock productivity and on reproductive parameters. Systems strongly rely on highly variable environmental resources, impacting their production level. The main product of livestock is found to be milk, although animals are also sold or even home-consumed for meat. Milk yields are low for a large period of the year. Despite their poor quantitative performances, indigenous cattle and camels are found to be highly adapted to their environment and its variability, showing the crucial ability to survive and breed in harsh conditions. Simple husbandry techniques might help increasing production levels to the benefit of the households, as complementary feeding, which is already practiced in a targeted way. The more systematic implementation of this complementation nevertheless faces important constraints of availability of these agricultural by-products on the local markets. As far as research is concerned, the study recommends the implementation of herds monitoring of the area in order to precise the livestock breeding practice as well as zootechnical parameters.

Conflict of Interest

The authors have not declared any conflict of interest.

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