Typology of red maradi dairy goat farms in the north east of Benin

MEHOU-LOKO Lucrèce Marie Reine, ASSOGBA Brice Gérard Comlan, AZALOU Maximilien, ALKOIRET TRAORE Ibrahim
Laboratoire d'Écologie, Santé et de Production Animales (LESPA), Faculté d'Agronomie, Université de Parakou, BP 123, Parakou, Bénin
*Corresponding author, *E-mail*: lucrecemehouloko@yahoo.fr

1   ABSTRACT

The characterization of livestock systems enables to identify the diversity of livestock farms in order to define development actions. The aim of this study is to characterize the different farming practices observed in the Red Maradi goat farms located in the North East of Benin. Data collection took place between August and December 2019, in 90 goat farms with at least one breeding nucleus of the Red Maradi breed. Using the Multiple Correspondence Factor Analysis (AFCM) and Ascending Hierarchical Classification (CAH) methods, a typology of Red Maradi goat farms in the region was developed. Thus, four types of breeding of Red Maradi goats were identified. Agro-pastoralists, traders (27.59%) and craftsmen (17.24%) mostly from the Bariba socio-cultural ethnic group (38.72%) characterize wandering peasant farms (type 1). They are responsible for herds of modest numbers (15 ± 8 heads) made up by purchase. The mode of rearing goat straying is practiced in 93.1% of these farms against 6.9% of semi-straying. The animals hardly have a sheepfold. The farms (type 2), semi-scavenging peasant herds, are mainly characterized by breeders and agro-breeders of the Fulani and Gando socio-cultural ethnic group (56%). They are responsible for small herds (16 ± 8 heads) and practice the seasonal straying of goats (88%). The animals are housed on these farms (58.07%) in a basic sheepfold and receive crop residues as a supplement. The breeders of type 3, semi-improved peasant breeding are from a very diverse socio-cultural ethnic group Dendi (23%), Yorouba (19%), Fon (11.5%), Bariba (12.5%) with a relatively higher level of education. Over 75% of type breeders have reached secondary level. They combine their main activity, public service, commerce and crafts, the breeding of goats with herds of relatively larger size (20 ± 15 heads). The animals are housed in more improved sheepfolds built in roughcast or hard earth and in 75% of these farms receive food and water in the pen. Type 4, semi-intensive dairy farming of Red Maradi goats, brings together farm farms producing and upgrading goat's milk. Fon (51.25%) and Bariba (48.75%) mostly own these farms. They are responsible for larger herds (57 ± 7 heads) so 35% is made up of the Red Maradi goat and the rest of the Saanen breed. The animals have a permanent sheepfold and, in addition to the basic ration consisting of fodder, a production supplement consisting of concentrate.

1   INTRODUCTION

In Benin, the livestock sector contributes at 7% to the GDP (MAEP, 2018) and occupies a prominent place in the socioeconomic and cultural life of the population. It contributes to the security of families, the capitalization of resources, the diversification of activities, economic and social integration, and plays an indirect economic role, in particular through the organic fertilization that it provides to the soils as well as through harnessed cultivation. The country's national herd was estimated in 2011 at 2,465,000 heads of small ruminants, including 825,000 heads of sheep, 1,640,000 heads of goats and 2,058,000 heads of cattle (DE, 2012). The production of goats in villages contributes significantly to the livelihoods, economic and social livelihoods of the majority of rural families and has resulted in a national consensus on the need to focus more on its long-term sustainability (Arodokoun *et al.,* 2001). Thus, the Support Program for the Rural Development Sector (PASDeR) through its intervention introduced in goat farms breeding nuclei of Red Maradi goats originating in the Maradi region in Niger given the proven performance of the breed in order to improve the productivity of these farms. In fact, in red goats, double, triple and quadruple litters of kids are frequent and increase with the number of births (UA, 2015). These animals have good dairy skills resulting in an accentuated development of the udders. The average annual milk production is 145 kg of milk during an average period of 210 days of lactation (Marichatou *et al.,* 2002); i.e. an average daily production of 0.6 l of milk for a period of 3 to 4 months. However, little information is available on the breeding practices and zootechnical performance of this goat. This study was initiated to characterize red Maradi dairy goat farms in the north east of Benin.

2   MATERIAL AND METHOD

2.1   Study environment: Data collection for this study was carried out simultaneously in three municipalities in the departments of Alibori and Borgou (Figure 1). In the department of Alibori, the three communes concerned were the communes of Malanville, Kandi and Gogounou. In the department of Borgou, these are the communes of Kalalé, N'Dali and Parakou. The department of Alibori is situated in northern Benin between 10 ° 49 '60' 'and 11.86 ° North latitude and 2 ° 25' 60 " and 3 ° 41 '40' 'East longitude. It has a surface area of 26,242 km² (23% of the national territory) and an approximate population of 521,093 inhabitants. The climate and vegetation are Sudano-Sahelian with a rainy season (May to September) and a dry season (November to April). Rainfall is between 700 and 1000 mm (Adam and Boko, 1993). The department of Borgou is located in the North-East of Benin between 8 ° 52 '60' 'and 10 ° 25' 60 " North latitude and 2 ° 36 '0' 'and 3 ° 41' 40 " East longitude. It covers an area of 25,856 km² including 13,962 km² of cultivable land, i.e. 54% of the total area of the department. The climate is Sudanese with an alternating rainy season (May to October) and a dry season (November to April) where the harmattan blows between December and February. The average rainfall is 1200 mm (Adam and Boko, 1993).
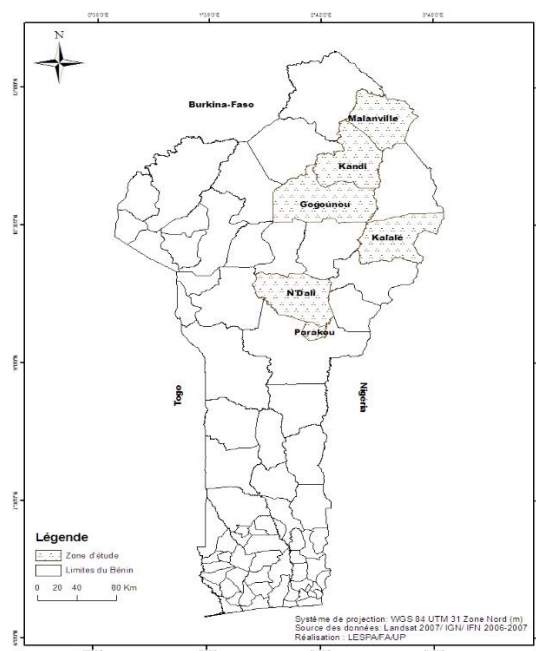
Figure 1: Map showing the study area

2.2   Data collection method: The livestock productivity survey method by sample (MCD, 1989), developed by IEMVT and CIRAD, was used to carry out this study. It has been used to make the typology of cattle breeding systems in many tropical countries, notably in Guadeloupe (Salas *et al.,* 1986), in Mexico (Cervantes *et al.,* 1986), in Burkina-Faso (Bourzat, 1986), in Guinea (Lhotse *et al.,* 1993), in Réunion (Alary, 2001; Tache, 2001), in the Philippines (Duval, 2001), in Brazil (Làu *et al.,* 2001), in Morocco (Sraïri, 2004) and in Benin (Assogba *et al.,* 2017, Azalou *et al.,* 2017, Assani and Alkoiret., 2014, Alkoiret *et al.,* 2009). The herds surveyed were those having at least one breeding nucleus of goats of the Red Maradi breed head in their herd. Data were collected using an interview guide from August to December 2019 and the semi-structured interview technique was adopted. The questions concerned the farmer (location, socio-cultural group, age, level of education and literacy, family size, areas sown, labour used,), animals (numbers of goats, sheep, cattle and poultry, breeds and origin of animals) and breeding practices (breeding and reproduction method, animal habitat, milking of Red Maradi goat's milk, health monitoring and food and mineral supplementation). Individual interviews were used to collect information on the breeders and their animals, while group interviews with breeders in the same camp made it possible to learn about breeding practices. Analysis of survey data was performed using R 3.5.1 software in two stages.

- Multiple Correspondence Factorial Analysis (MCFA) was then performed on the data used for the typology. This made it possible to obtain a representation of the farms in the form of projections on planes defined by the first factorial axes (Escofier and Pages 1990).

- A Hierarchical Ascending Classification (HAC) was carried out from the coordinates of the farms on the main factorial axes and this made it possible to represent all the individuals in the form of a dendrogram. The different groups of the typology correspond to the main "branches" of the dendogram (Bourzat 1986). . From the analysis in the Hierarchical Ascending Classification (HAC), the different farms were then grouped according to their proximity to each other

3   RESULTS

3.1   Characteristic of the sample: The general characteristics of the Red Maradi goat breeders surveyed in the various communes of the departments of Alibori and Borgou in north-eastern Benin are shown in tables 1 and 2.

Table 1: Variables describing the Red Maradi goat breeders surveyed

Variable code and titles	Modalities	Meaning	Frequencies (%)
DEPAR = Department	1	Alibori	48
	2	Borgou	52
COM = Commune	1	Malanville	22
	2	Kandi	18
	3	Gogounou	9
	4	Kalalé	12
	5	N'Dali	27
	6	Parakou	15
SEX = Sex	1	Man	63
	2	Women	37
RELI = Religion	1	Muslim	77
	2	Christian	23
ETH = Ethnic	1	Fulani	19,1
	2	Gando	18
	3	Bariba	41
	4	Fon	6
	5	Haoussa	4,2
	6	Yorouba	4,5
	7	Dendi	7,2
SMAR = Marital status	1	Married	81
	2	Single	16
	3	Widower	3
EDUL = Educational level	1	Unschooled	46
	2	Primary	9
	3	Secondary	12
	4	University	11
	5	Literate	14
	6	Koranic teaching	7
CORB = Core business	1	Breeder	42
	2	Farmer	23
	3	Trader	15
	4	Official	11
	5	Artisan	8

Table 2: Variables describing the Red Maradi goat breeders surveyed

Variable code and titles	Modalities	Meaning	Frequencies (%)
AGE = Age	1	≤ 30 years	16.7
	2	30 – 50 years	66.66
	3	≥ 50 years	17.24
SHOU = Household size	1	≤ 10 heads	86.2
	3	≥ 10 heads	13.8
TACS = Total area of crops sown	1	≤ 5 ha	71.26
	2	≥ 5 ha	28.74
NUG = Number of goats	1	≤ 10 heads	32.18
	2	> 10 heads	67.82
NUS = Number of sheep	1	≤ 10 heads	80.45
	2	> 10 heads	19.45
NUC = Number of cattle	1	≤ 20 heads	43.56
	2	30 - 50 heads	30
	3	≥ 50 heads	26.44
NUP = Number of poultry	1	≤ 30 heads	72.41
	2	≥ 30 heads	27.59
NUPI = Number of pigs	1	≤ 10 heads	100
	2	> 10 heads	0
GBH = Goat breeds in the herd	1	Rous + Saanen	20.68
	2	Rous + Sahelian goat	49.42
	3	Rous + Guinean Dwarf Goat	29.9
MOA = Labour	1	Family	81.6
	2	Employee	18.4
MAA = Mode of animal acquisition	1	Purchase	90.8
	2	Heritage	1.2
	3	Confiage	5.7
	4	Don	2.3
AB = Animal behaviour	1	Straying	42.3
	2	Semi-divagation	31.4
	3	Sedentary	25.3
AHM = Animal health monitoring	1	No treatment	63.1
	2	Veterinary treatments	37.9
AS = Animal supplementation	1	No supplement	10.35
	2	Crop residues	71.26
	3	Agri-food residues	18.39
MG = Milking goats	1	No	81.6
	2	Yes	18.4
AH = Animal habitat	1	None	43.11
	2	Basic accommodation	36.31
	3	Housing	20.68

3.2 The breeder: The geographical distribution of goat farms, Red Maradi surveyed in the two departments comprising the study area was almost uniform. The department of Alibori concentrates 48% of the farms surveyed against 52% for the department of Borgou. These farms are more concentrated in the communes of Malanville and N'Dali, which together account for 49% of the total workforce. The breeders surveyed were mainly from the Bariba socio-cultural group (41%) followed by the Fulani (19.1%), Gando (18%), the Dendi (7.2%), Fon (6%), Hausa (4, 2%) and Yoruba (4.5%). These breeders are predominantly of the Muslim religion (77%). They are relatively young and their average age was 40.39 ± 10.85 years with 22 years for the youngest farm manager and 65 years for the oldest. there was an average of about 9 people per household .The smallest household had 3 people and the largest had 20 The majority of these farms are owned by men (63%) with a relatively high proportion of women, i.e. more than a third of the farms (37%). These breeders have a very low level of education. The majority of these breeders, or 68% of our interviewees, did not attend school and did not receive any training in breeding techniques. However, we note among them some educated breeders (32%) with a predominance of those with primary and secondary levels (21%). The literacy rate was 14% and 7% of these herders received Koranic education. The vast majority of the farmers surveyed associate agriculture with animal husbandry (65%). However, there are traders (15%), civil servants (11%) and craftsmen (8%) in their ranks. The average cultivated area sown was 2.06 ± 1.78 ha with a minimum of 0.75 ha and a maximum of 8 ha, with the main crop for the breeders who are in the communes of Malanville and Kandi are cereals (maize and Sorghum) and then cotton and maize for those of other communes (Gogounou, Kalalé and N'Dali). The women cultivate small areas (0.79 ± 1.31 ha) and as crops, they produce soybeans, maize, cowpeas and okra. The family workforce is in high demand. It is used by 81.6% of breeders. The rest or 18.6% of the respondents have a skilled workforce whose work is remunerated by a salary. The production objectives are diverse but all oriented towards the market. 81.6% of the breeders surveyed produce goats for slaughter and are therefore in the meat sector, while 18.6% of breeders, in addition to slaughter animals, exploit the milk produced by the Red Maradi goat farms and are therefore in the milk and meat sector. The goat's milk processed by the latter is transformed into various products including cheese and yogurt.

3.2.1 Animals: The average number of goats in the farms surveyed is 15.75 ± 12.22 heads with a minimum of 2 heads and a maximum of 65 heads. The surveys focused on 1,670 head of goats, of which 18% are dairy goats of the Red Maradi breed, 8% of dairy goats of the Saanen breed and the remainder consisting of goats of local breed, the Guinean dwarf goat (32%) or the local Sahelian goat (24%). Some herds use Red Maradi progenitors who have produced crossbreed products, the number of which (8%) confirms that the phenomenon of "crossbreeding" is still in its infancy in goat farms located in the North East of Benin. The farms that exploit goat milk have associated the Red Maradi dairy goat with the exotic European breed Saanen. The survey showed that the constitution of the herds is done either by purchase, inheritance, fostering or of which, with a dominance of the constitution of the herd by purchase (90.8%)The proportion of fostering is very low and concerns only 5.7% of the farms surveyed. Certain traders who are often too mobile often entrust animals. The proportion of animals entrusted to the herds is also very small and represents 4.25 ± 1.49%. The majority of breeders (77%) associate the breeding of goats with that of Sheep. However, just over half of the breeders (52%) associate the breeding of goats with that of cattle. This practice is observed especially among Fulani herders, Gando and Bariba farmers with draft oxen. Small poultry farming is present in all farms and

pig farming is only found among farmers producing goat milk. The average numbers of cattle, sheep, poultry and pigs were respectively 10.98 ± 17.79; 6.63 ± 8.6; 18.66 ± 20.47 and 1.43 ± 4.5 heads. The dominant breeds are: the Borgou cattle breed, the Djallonké sheep, the local Fulani hen with yellow legs in places and the semi wild guinea fowl.

3.2.2 Breeding practices: The vast majority of the Red Maradi dairy goat breeders surveyed practice stray breeding (74.7%). In these farms, the animals are left to themselves and graze for the longest time around the agglomerations. This practice is observed in most of the farms owned by Fulani herders, Gando and Bariba agro-pastoralists. Sedentary breeding is nevertheless practiced in 24.3% of the farms surveyed. These are the farms owned by dairy farms producing goat's milk and the farms of certain officials, traders and craftsmen. The criteria for choosing the method of farming are cultural, economic and social. Thus, Fulani breeders as well as Gando agro-pastoralists who practice grazing animals prefer to abandon goats whose care is difficult in the camps so that they are satisfied with the pasture located around towns and kitchen scraps thrown here and there. Civil servants, traders as well as craftsmen, whose criteria are much more economical, often instruct their children, who are responsible for looking for fodder for animals usually housed in summary stables. Sedentary breeding with an intensification of production is observed in dairy farms whose production objective is milk production. On these farms, the animals benefit daily from a basic ration consisting of fodder and a food supplement consisting of crop residues and concentrates to optimize milk production. The habitat of animals is diverse. Thus, 43.11% of the farmers surveyed do not have a stable for goats. The animals from these farms are housed in the open air on the camp's yard or on livestock night parks located around the houses. However, summary sheepfolds can be observed in some farms (36.31%) in which the animals are housed in shelters made of precarious materials. These are straw huts made of wood, the top of

which is covered with sorghum thatch or straw to serve both as a shelter for animals and at the same time as a drying area for residues brought back to the camp or sheepfolds built in earth with a straw or tin roof. In other farms (20.68%), the animals have benefited from modern permanent sheepfolds. Most of them are dairy farms and a few government officials. Almost all farms are fed by natural grazing supplemented with crop residues. Add to that food concentrates and Mineral salt lick blocks on dairy farms. The harvest residues exploited consisted mainly of corn and sorghum stalks, peanut and cowpea tops, soybean, cowpea and peanut leaves, cassava and yam peels. The concentrates used on the farms consisted of corn bran, sorghum, okra (bran obtained after extraction of soy milk) and cottonseed meal. The animals are watered in most farms (74.72%) by water from rivers and reservoirs. Only 25.28% of herders have a borehole or well for watering animals. The behaviour of animals is diverse and depends in some cases on the seasons. Stray breeding dominates and is practiced in 74.7% of the farms surveyed against 25.3% for sedentary farms. However, the straying behaviour of animals has two variations. There is strict stray breeding in all seasons, which is observed throughout the year, and stray driving with animals being fenced in during the rainy season. The method of farming in straying in all seasons is observed in farms located near urban centres where the fields are far away. In stray farms with animals being fenced in the rainy season, goats are strayed during the dry season and fenced in the rainy season in order to protect the crops; their food is provided in this case by fodder that brings them the children instructed for this purpose by the breeder. Watering is also provided animals. All breeders use natural service in the majority of cases at random. Nevertheless, nearly 3/4 of breeders regularly renew their male progenitor in order to avoid the phenomenon of consanguinity. The criteria for choosing the parents were state of health, age, size, breed, purses, and build. Control of broodstock is much more remarkable on dairy

farms, unlike other farms, given the mode of straying observed in these farms. However, to acquire a parent, 85% of the surveyed breeders buy it and 15% borrow it. Broodstock exchange practices are very rare. The practice of castration of kids is observed in all farms. This practice concerns much more goats than sheep in mixed farms and concerns kids intended for slaughter. Animal health monitoring is practically only observed on dairy farms where animals are vaccinated against contagious pleuropneumonia, dewormed and treated in cases of disease. In the vast majority of farms (62.1%), the animals do not receive any veterinary treatment. This testifies to the adaptability of the animal to its environment.

3.2.3 Development of the typology: Multiple correspondence factor analysis (MFA) was carried out on 106 goat breeders with the Red Maradi breed in the communes of Malanville, Kandi, and Gogounou in the department of Alibori and in the communes of Kalalé, N'Dali and Parakou in the department of Borgou. The study of the correlations between the various variables considered enabled to retain a set of 23 active variables giving 74 modalities, which are presented in Tables 1, and 2. The analysis of the coordinates of the main projection axes of the AFCM is summarized in Table 3 and the cumulative contribution to the total inertia of the first 3 factor axes selected was approximately 58% (Table 3).

Table 3: Definition of factor axes

Factorial axes	Negative	Positive
1	Low numbers of goats, pigs and poultry	Large numbers of goats, pigs and poultry
	Animal habitat in rough materials	Hard animal habitat
	Wandering breeding mode	Sedentary breeding method
	No veterinary treatment	Veterinary treatment
	Red goat associated with the local Sahelian goat or the Guinean dwarf	Red goat associated with the exotic Saanen breed
	Use of crop residues as a supplement	Use of crop residues and agro-food residues as a supplement
	Does not exploit goat milk	Exploit goat milk
	High cultivated area	Small cultivated area
	Meat production	Meat and milk production
2	No schooling and no training	Schooled, literate and trained
	Large household size	Small household size
	Agro-pastoralists	Farmer breeders
	Cattle and sheep numbers raised	Low numbers of cattle and sheep
	Family labour	Hired labour
3	Rather old breeders	Rather young breeders
	Mainly Muslim breeders	Mainly Christian breeders
	Do not renew their breeding	Renew breeding stock

Table 5: Cumulative contribution to the total inertia of the factor axes

Factorial axes	% inertia	% Cumulated
1	45.44	45.44
2	7.12	52.56
3	5.4	57.96

3.2.4 Definition of groups: To define the types of goat farming, Multiple Correspondence Factorial Analysis (MCA) and Hierarchical Ascending Classification (HAC) were performed with the dataset of farms. It enabled to differentiate 4 breeding groups of Red Maradi goats in the North East regions of Benin. The best graphical projection of the surveyed farms in the different axis systems is provided by the projection in a plane defined by the factorial axes 1 and 2 (Figure 2).
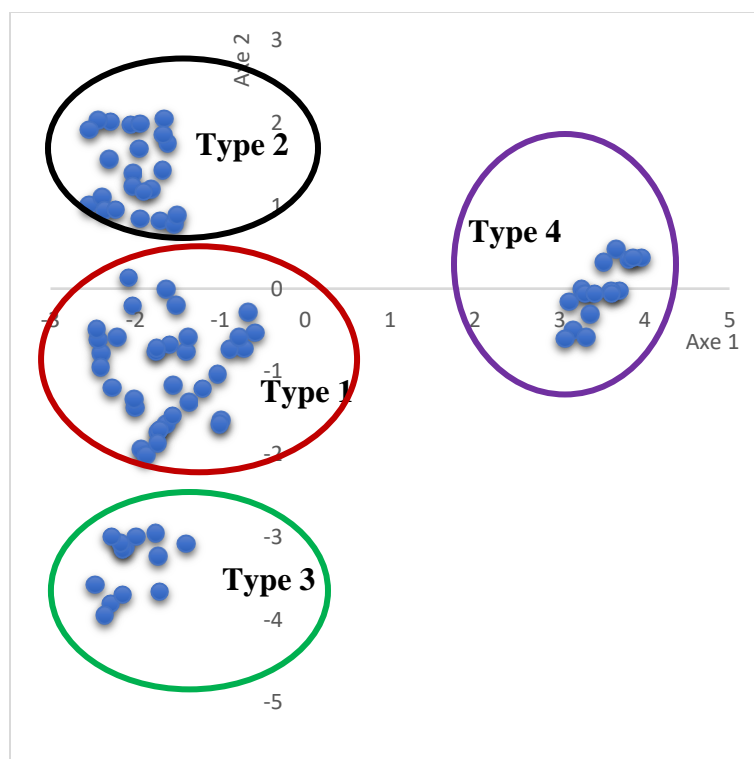

Figure 2: Projection of Red Maradi goat farms surveyed on factor axes 1 and 2
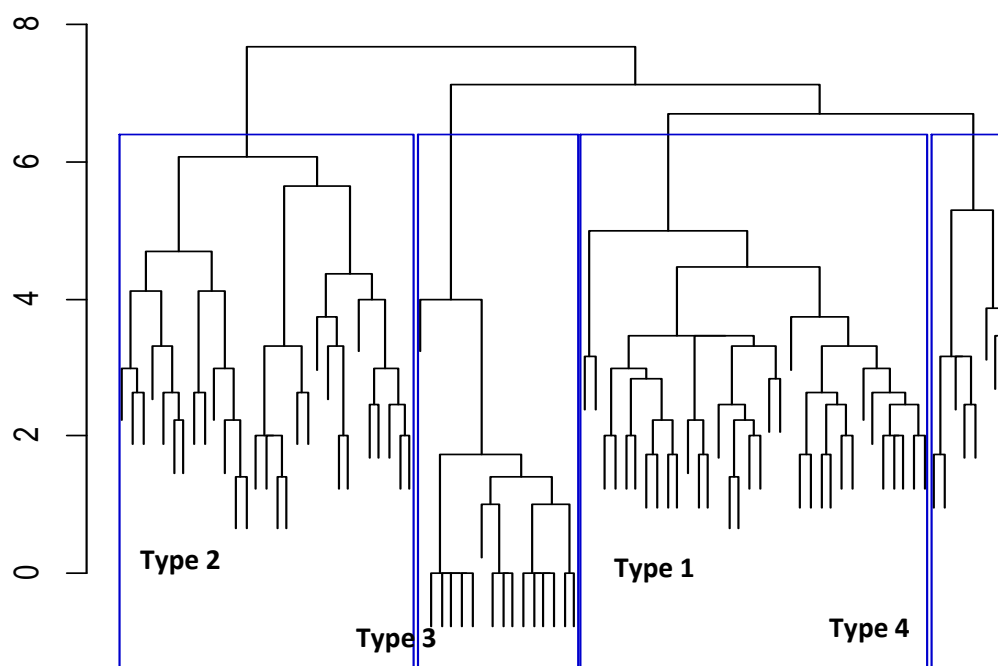
Figure 3: Dendrogram showing the distribution of breeders in groups

The analysis of the distribution of the different operating groups on the AHC and AFCM graphs made it possible to identify the characteristics of each group. The frequencies of the different modalities of the variables used to characterize the different groups of Maradi Rousse goat farms in our typology are given in Tables 4 and 5. The general characteristics are as follows:

Type 1 *(29 farms or 32%):* **wandering peasant farming:** Red Maradi dairy goat farms of this type are present in all the municipalities but in higher proportion in the municipalities of the Alibori department. This department alone accounts for 58.62% of these farms against 41.32% for the department of Borgou. The communes of Malanville and Kandi located in the department of Alibori account for nearly half of this type of breeding (48.28%), followed by the commune of N'Dali in the department of Borgou. These breeders belong to various socio-cultural groups. The Bariba come first with 38.72% of the herders surveyed, followed by the Fulani (17.24%), the Gando (16.89%), the Dendi (15%) and a minority of Hausa herders (8.7 %) and Yorouba (3.45%). Almost one third of the

farms in this group are owned by women. The breeders of this type are predominantly Muslims (86.20%), relatively young (40.25 ± 11.82 years), their level of education and literacy is relatively acceptable. 20.69% of these breeders have secondary level and 10.34% university level. Those at the primary level represent only 3.45% and the rest of these herders have either been literate (44.83%) or have benefited from Koranic education (20.69%). The mean size of their families is small (8 ± 4 people). Breeders of this type belong to various socio-professional groups with a strong predominance of breeders (31.03%), followed by traders (27.59%), farmers (20.69%), craftsmen (17.24 %) and a minority of civil servants (3.44%). They are also engaged in agriculture, sowing relatively small areas (4.76 ± 1.06 ha) mainly for food crops. They use family labour more. Goat herds are modest in size (15.96 ± 8.32 head) and are mostly made up by purchase (82.76%). This group comprises 13.80% of herds made up solely by inheritance. The average numbers of cattle, sheep and poultry were 14 ± 12.6 ± 7 and 16 ± 18 heads, respectively. The Red Maradi goat is most often associated with the local Sahelian goat. The

proportion of Red Maradi goats represents on average 25% of the herd's size. In this type of breeding, the breeding of goats straying in all seasons is much more practiced (93.1%). The farms in straying with fencing of animals in the rainy season are only 6.9% and the latter educate their children who are responsible for looking for fodder for the animals. This practice is much more noticeable among civil servants and some traders and craftsmen. Most of the breeders in this group use crop residues as a feed supplement to animals. Only 44% of these farms have basic sheepfolds built with precarious materials. These are small ruminant pens whose fence is made of sorghum thatch and which houses a sort of straw hut whose roof is either sorghum thatch or straw and at the same time serves as a drying area for residues of harvest constituted in food reserve. The animals are in this case housed together with the sheep and poultry. Animal health monitoring is weak and only 24.13% of these breeders call on veterinary services in the event of disease or for the vaccination of their herd against ovine Rinderpest.

Type 2 *(25 farms or 28%):* **Semi-wandering peasant farming:** Herds of this type are located in all the communes of the department of Alibori and only in the communes of Kalalé and Parakou for the department of Borgou. They are more concentrated in the communes of Gogounou (36%) and Kalalé (28%). The majority of the farms of this type are owned by women (60%). The herders in this group are mostly from the Bariba (44%), Fulani (28%) and Gando (28%) socio-cultural groups. They are all illiterate, out of school and untrained. They are relatively young breeders (40.35 ± 10.77 years), but all married. Their household size is modest and includes on average (9 ± 2 persons). They

are mostly breeders (56%), farmers (24%) and traders (20%). The predominance of women means that the average areas of sown crops were modest 1.07 ± 1.19 ha with a maximum of 5 ha and a minimum of 0.5 ha. The breeders in this group mainly use family labour to maintain the animals and carry out fieldwork. They do not exploit the milk of the Red Maradi goats, which they introduce in their Guinean dwarf goat farm to improve fertility and growth. The proportion of Red Maradi in these farms is on average 27.56%. Animals, especially reformed males and females, are sold in the majority of these farms to solve emergency family problems, including schooling for children, health or the purchase of agricultural inputs. Goat herds have a relatively low average number (16 ± 8 heads) and were formed by purchase (92%). The average numbers of cattle, sheep, and poultry are relatively lower in this group and were 12 ± 15, 6 ± 7 and 12 ± 35 heads, respectively. All farmers in this group have poultry. However, a little over half of these breeders do not own cattle (51.42%) and 28.57% do not own sheep. Almost 58.07% of these herds have an improved traditional sheepfold made of earth with a straw roof for the goats and 4% have a semi modern sheepfold made of earth with cement plastering and a tin roof. The goats are led in straying throughout the dry season and placed in enclosures during the rainy season. In addition to the natural pasture located around the houses, they receive a supplement consisting of crop residues and kitchen scraps. Health monitoring of goats is still very weak and barely 12% of breeders in this group call on veterinarians in the event of any illnesses. The animals are practically not dewormed. Riding is natural and is carried out by one or two breeders, the rest of the kids being castrated.

Table 5: Frequency (%) of the different modalities describing the Red Maradi goat breeders surveyed according to the groups of the typology

Variables	Modalities	Meaning	Group 1 (27%)	Group 2 (33%)	Group 3 (23%)	Group 4 (17%)
COM = Commune	1	Malanville	27.59	32	25	0
	2	Kandi	20.69	16	25	0
	3	Gogounou	10.34	12	37.5	0
	4	Kalalé	13.8	28	0	0
	5	N'Dali	17.24	0	0	100
	6	Parakou	10.34	12	12.5	0
SEXE = Sex	1	Man	65.52	40	62.5	100
	2	Women	34.48	60	37.5	0
RELI = Religion	1	Muslim	86.2	80	75	68.75
	2	Christian	13.8	20	25	31.25
ETH = Ethnic	1	Peul	17.24	28	10.5	0
	2	Gando	16.89	28	11	0
	3	Bariba	38.72	44	12.5	48.75
	4	Fon	0	0	11.5	51.25
	5	Haoussa	8.7	0	12.5	0
	6	Yorouba	5.45	0	19	0
	7	Dendi	13	0	23	0
SMAR = Marital status	1	Married	75.86	96	87.5	62.5
	2	Single	17.24	4	12.5	37.5
	3	Widower	6.9	0	0	0
EDUL = Educational level	1	Unschooled	0	0	0	0
	2	Primary	3.45	100	62.5	0
	3	Secondary	20.69	0	25	0
	4	University	10.34	0	12.5	97.7
	5	Literate	20.69	0	0	6.25
	6	Koranic teaching	44.83	0	0	0
CORB = Core business	1	Breeder	31.04	56	0	93.37
	2	Farmer	20.69	24	0	0
	3	Trader	27.59	20	37.5	6.25
	4	Official	3.44	0	50	0
	5	Artisan	17.24	0	12.5	0
AGE = Age	1	≤ 30 years	27.59	20	37.5	0
	2	30 – 50 years	65.51	52	62.5	100
	3	≥ 50 years	6.9	28	0	0

Table 6: Frequency (%) of the different modalities describing the Red Maradi goat farms surveyed according to the groups of the typology

Variables	Modalities	Signification	Group 1 (27%)	Group 2 (33%)	Group 3 (23%)	Group 4 (17%)
SHOU = Household size	1	≤ 10 heads	93.1	72	75	100
	3	≥ 10 heads	6.9	28	25	0
TACS = Total area of crops sown	1	≤ 5 ha	83.2	71.5	100	100
	2	≥ 5 ha	16.8	28.5	0	0
NUS = Number of sheep	1	≤ 10 heads	20.69	24	0	0
	2	> 10 heads	79.31	76	100	100
NUG = Number of goats	1	≤ 10 heads	72.41	84	75	100
	2	> 10 heads	27.59	16	25	
NUC = Number of cattle	1	≤ 20 heads	79.31	50	61	100
	2	30 – 50 heads	20.69	36	39	0
	3	≥ 50 heads	0	14	0	0
NUP = Number of poultry	1	≤ 30 heads	93.1	88	62.5	0
	2	≥ 30 heads	6.9	12	37.5	100
NUPI = Number of pigs	1	≤ 10 heads	100	100	100	0
	2	> 10 heads	0	0	0	100
GBH = Goat breeds in the herd	1	Rous + Saanen	65.52	60	75	100
	2	Rous + Sahelian goat	34.48	40	25	0
	3	Rous + Guinean Dwarf Goat	0	0	0	0
MOA = Labour	1	Family	100	100	100	0
	2	Employee	0	0	0	100
MAA = MAA = Mode of animal acquisition	1	Purchase	82.76	92	100	100
	2	Heritage	13.8	4	0	0
	3	fostering	3.44	0	0	0
	4	Don	0	4	0	0
AB = Animal behaviour	1	Straying	93.1	12	0	0
	2	Semi-divagation	6.9	88	25	0
	3	Sedentary	0	0	75	100
AHM = Animal health monitoring	1	No treatment	75.87	88	75	0
	2	Veterinary treatments	24.13	12	25	100
AS = Animal supplementation	1	No supplement	17.24	12	25	0
	2	Crop residues	82.76	88	75	0
	3	Agri-food residues	0	0	0	100
MG = Milking goats	1	No	100	100	100	0
	2	Yes	0	0	0	100

	1	None	56	37.93	25	0
AH = Animal habitat	2	Basic accommodation	44	58.07	25	0
	3	Housing	0	4	50	100

Type 3 *(24 farms or 23%):* **Semi-improved peasant farming:** The farms of this group are located in all the municipalities of the study area with a high concentration in the municipality of Gogounou. The Bariba constitute almost two thirds of the herders in this group and the others are socio-cultural groups Fulani (3%), Gando (5%), Fon (12.5% and Dendi (12.5%). is a group made up mainly of civil servants (50%), traders (37.5%) and craftsmen (12.5%). They are all educated with nearly 75% having at least the secondary level. The breeding of goats is a secondary activity for them. They are relatively young (37.14 ± 7.66 years). The average size of their families was 6 ± 4 people. Some also associate agriculture with very low average sown areas (1.05 ± 1.39 ha) and this shows that the breeders in this group are also farmers. They use more family labour to ensure the management of animals and hired labour to carry out fieldwork. The milk of the Red Maradi goats present in their breeding is not exploited and the reformed male and female animals are sold for the butcher's shop. The average number of goat herds was slightly higher 20 ± 15 head. Some of these breeders also have cattle (54.16%) and sheep (62.5%), the average numbers of which were lower, 5 ± 7 heads for cattle and 9 ± 1 heads for sheep. The cattle are entrusted to the Fulani and Gando breeders while the sheep are kept in the houses together with the goats and poultry (13 ± 32 heads). None of them practice pig farming. The goat herds of these farms are herds made up mainly of the local Sahelian goat associated with the Red goat of Maradi. The proportion of the Red Maradi breed in these farms was on average 33%. The majority of the farms in this group have a sheepfold (75%), of which nearly 50% are made of cement plastered earth with a tin roof. However, the practice of seasonal straying of goats was observed in 62.5%

of these farms. The animals are freed in this case each morning to benefit from the pasture located around the houses and locked in the evenings in the sheepfold. However, in 37.5% of breeders in this group, the animals are fed at the sheepfold throughout the year. All farms in this group supplement their animals with crop residues, corn bran and dried okra, which is a by-product of processing soybeans into cheese. All the breeders in this group deworm their animals, but only 25% of them have requested veterinary services for health monitoring of their herd.

Type 4 *(18 farms or 17%):* **Semi-intensive dairy farming:** The farms of this group are all located in the commune of N'Dali in the department of Borgou. These are farm farms owned by relatively young agricultural entrepreneurs (37.14 ± 7.66 years). They are from the Bariba (48.75%) and Fon (51.25%) socio-cultural group and have a higher level of education. Most of them have a university degree (97.7%) and have been trained in breeding techniques. The average size of their family, smaller compared to other groups, was 5 ± 2 people. Most of these farmers integrate crop production into their production system through the establishment of plots. The area of these fodder plots was on average 1.52 ± 0.46 ha with a minimum of 1 ha and a maximum of 2 ha. The forage grasses produced were *Panicum maximum*, Panicum C1 and Glycidia. Others associate it with Moringa in the form of a hedge. All these farms practice the milking of goats and the milk is transformed into cheese and yoghurt that they sell in the city centre in the commune of Parakou, a commune bordering that of N'Dali and which serves as chef- place of the department of Borgou. The animals are sold in nucleus of breeding stock and only reformed animals are sold for slaughter. The average number of herds from these farms was larger compared to farms from other 54 ± 7 head

groups, made up mainly by purchase. The herds are made up entirely of dairy goats. However, most of these farms associate the Red Maradi dairy goat, which is a tropical breed originating from the Maradi region in Niger, with the European dairy goat Saanen imported from Belgium. In these farms, the Red Maradi goat represents 35% of the total number of herds, the Saanen 33% and the mixed products 32%. The average number of Redheads per herd was 24 ± 3 heads. All of these farms are pig and poultry farms; sheep and cattle. The average numbers of the latter were respectively 11 ± 5 heads for pigs, 2 ± 3 heads for sheep, 4 ± 3 heads for cattle, 104 ± 51 heads for poultry. The sedentary farming method with intensified production has been adopted by the farms in this group. In this type

of breeding, the animals receive a basic ration consisting of fodder of Panicum C1, Glycidia, Moringa leaves and a production supplement consisting of concentrate consisting of cottonseed cake, corn bran, powder of Néré (*Parkia biglobosa*) and animal feed produced by the Société des Huiles du Bénin (SHB). The animals are housed in permanent sheepfolds and their watering is provided by the borehole of the farm. The animals also receive supplementation consisting of cooking salt and lick stone. Animal health monitoring is provided by the municipality's veterinary service. All animals are systematically vaccinated each year against contagious small ruminant pleuropneumonia. They are all dewormed and benefit from veterinary care in the event of illness.

4   DISCUSSION

At the end of our study, it emerges that the breeding of Red Maradi goats is practiced by a diversity of people belonging to various socio-cultural groups, with a dominance of Bariba, followed by Fulanis, Gando, Dendi, Fon, Hausa and Yorouba. Contrary to this diversity observed in the ranks of breeders who practice Red Maradi goat breeding, it should be noted that cattle breeding remains the prerogative of the Fulanis and to this extent the Gando (Youssao *et al.,* 2013; Assani *et al.,* 2014; Alkoiret *et al.,* 2009). The work carried out by Somda *et al.* (2004) in Guinea-Bissau also confirmed the importance of Fulanis in cattle breeding with a proportion of 96.2% of breeders. Among the goat breeders in Maradi, there are women who own flocks. More than a third of these herds are owned by women. . In the taurine lagoon farms of the Ouémé river valley in southern Benin, Assogba et al, (2017) reported a proportion of 6.25% of female lagoon cattle breeders. The proportion of women reported by our study was relatively higher than that reported by Charles Guingouain (2017) in the technico-economic diagnosis carried out in small ruminant farms in rural areas in the Kara and Savanes regions in Togo with a proportion of 18% of women against 82% of male breeders. The presence of women in the breeding of small

ruminants and more particularly in that of goats was also reported by Morand-Fehr *et al.* (2004) for whom these farms in arid regions are owned by the most vulnerable populations in especially women. a large proportion of the breeders surveyed, more than 3/4 are of the Muslim religion. The same observations were made in cattle farms in these regions by Assani *et al.* (2014) Youssa *et al.* (2013) and Alkoiret *et al.* (2009) respectively. The level of education of Red Maradi goat breeders was low with less than a third (1/3) of these breeders having access to schooling with 12% having access to secondary education and 11% to university education. These results are similar to those reported by Charles Guingouain (2017) in small ruminant farms in the Kara and Savanes regions in Togo with a proportion of herders with access to secondary and university education that is relatively higher in our study. The farmers surveyed have a diversified activity. Among them, we note the breeders who associate farming with livestock, traders, officials and craftsmen who associate the breeding of small ruminants with their main activity. The same observations were reported by Assogba et al, (2017), Youssao et al, (2013), Assani et al, (2014) and Alokoiret et al, (2009) who observed the

combination of agriculture and livestock in cattle farms. . For Youssao *et al.*(2013) trade, civil service and crafts were also activities carried out by cattle breeders in the Sudanese zone of Benin. This diversity of the activities of goat breeders testifies that the breeding of Red Maradi goats is rarely the only means of subsistence of the households of these breeders and constitutes a means of saving and multiplying income for traders, officials and craftsmen. For Wilson, (1988); Nwafor, (2004a); Ajala *et al.* (2008), the surplus from the resale of crops and part of the wages are saved in the form of goats to deal with possible unforeseen events, in particular poor harvests. This important role to play at the microeconomic level has also been pointed out by Ikwuegbu *et al.* (1996) and Missohou *et al.* (2004) who observe that goat farming constitutes a source of income for households, in particular for women, through the sale of live animals, milk and dairy products. The herds were formed in a large majority of farms by purchase (90.8%). Fostering is rarely practiced and was only observed in 5.7% of the farms surveyed. This result is in disagreement with that of Ajala *et al.* (2008) who observed that fostering represents 32–36% of goat acquisition methods in Nigeria. Red Maradi goat breeding is associated in almost all farms with the breeding of other goat breeds, in particular the Sahelian goat, the Guinean Dwarf (type 1, 2 and 3 breeding) and the exotic Saanen dairy breed (type 4 breeding). The introduction of the Red Maradi goat in type 1, 2 and 3 farms was mainly motivated by its relatively acceptable size and prolificacy, while it was preferred in type 4 farms because of its milkability. , evaluated between 140 and 150 kg of milk during 200 to 220 lactation days (Robinet, 1967); i.e. a daily production of 0.6 l of milk for two periods of 3 to 4 months.

It is not uncommon to see them coexist on certain farms with cattle, sheep and poultry (type 1, 2 and 3 breeding). The behaviour of animals depends on the number of heads, the production objective, the proximity of crops and the seasons. Thus, the breeding practices observed

in the Red Maradi goat farms in the North East region of Benin at the end of our study were very diverse. This is the straying of goats (**wandering peasant *farming***) observed in type 1 farms. In these farms, animals left wandering around graze around towns and have virtually no housing. Seasonal straying (**Semi-wandering peasant *farming***) is observed much more in type 2 farms. In this group, goats stray in the dry season and are put in enclosures in makeshift sheepfolds during the rainy season so as not to destroy the animals crops established near urban areas. The same practices were reported by Charles Guingouain (2017) in small ruminant farmers in the Kara and Savanes regions in Togo. Similar observations have been reported by Johann Dubois and J. Hardouin (1987) in small ruminant farming in Cameroon. In this study, they observe that the rearing method of small ruminants is similar to the sedentary, guarded or wandering agro-pastoral type. In type 3 farms (**semi-improved farmer breeding**), there is an improvement in animal housing with a relatively high tendency towards sedentarization throughout the year. Almost 40% of farms provide food for animals housed in sheepfolds made of earth rendered with cement. In type 4 farms (**semi-intensive dairy *farming***) whose production objective is much more oriented towards the market, there is a marked improvement in the housing and feeding of the animals. The goats are housed in permanent sheepfolds and the entire diet consisting of fodder as a basic ration and concentrate of production is brought to them. Charles Guingouain (2017) observed in small ruminant farms in the Kara and Savanes regions of Togo a semi-intensive system in which small ruminant breeders practice guarding small ruminants throughout the year bringing food and water to the sheepfold.

The breeding practices observed in the Red Maradi goat farms in the northeastern regions of Benin allow us to distinguish four types of Red Maradi goat farming in the region. Type 1 farming: **Wandering farmer farming** is characterized by total straying and practically in

all seasons of the animals that exploit the natural pasture and receive cooking scraps and crop residues as a food supplement. The animals spontaneously gather around the houses in the evenings. Type 2: **Semi-wandering peasant farming** is characterized by improved animal housing through the construction of summary sheepfolds covered with straw or sorghum thatch and sometimes even earthen sheepfolds covered with sheet metal, and guarding of animals in the rainy season. In type 3 farms: **Semi-improved peasant farming**, there is a marked improvement in the habitat of the animals and a remarkable tendency to settle the animals. The sheepfolds are mostly earth or cement with tin roofs. The animals in addition to their leftover food supplement are also given corn bran and dried Okara. Type 4: **Semi-intensive dairy farming** is characterized by improved feeding, housing and milk production for goats. Farms of this type have a more improved sheepfold and in addition to the basic ration, the animals receive a production supplement consisting of concentrate for the production of milk. In farms of this type, the milk of the Red Maradi goats is milked and transformed into cheese and yogurt. Farms of this type are located on the outskirts of the town of Parakou, capital of the department of Borgou. The different types of breeding reported by our study are similar to those noted by Assogba *et al.* (2017) in their study on the typology of Lagune breed taurine breeding installed in the Ouémé river valley in southern Benin. In fact, four types of breeding have been observed among Lagunaire cattle breeders in the region. This is the stray breeding of Lagune cattle (type 1) practiced on the island of Sô-Ava, sedentary breeding (type 2) with exploitation of natural pasture by animals attached to stakes, semi sedentary (type 3) with seasonal mobility and

sedentary ranching (type 4) practiced on the farm of Samiondji which is a state farm intended for the conservation of the Lagune breed. The typology carried out by Chentouf *et al.,* In (2004) in goat farms in the Chefchaouen region in northern Morocco reveals the presence of two types of goat farming in this region. These are rearing for meat production based only on forest resources (Type 1) and goat rearing for meat and milk production based on forest resources and farm resources. In Lebanon, Srour *et al.* (2006) characterized the rearing of goats and sheep into five types. Enclosed breeding, sedentary breeding, vertical transhumant breeding, horizontal transhumant then semi-nomadic breeding. The studies carried out in our study area by a number of authors and relating to the typology of cattle breeding systems have also revealed a diversity in breeding practices. Thus Assani *et al.,* (2014) in their typology carried out on the breeding systems of cattle of the Goudali breed in the communes of Malanville and Karimama have distinguished three types of breeding, large transhumant breeding, semi-transhumant breeding. and the small agro-breeding of cattle Goudali. In the commune of Gogounou, Alkoiret *et al.* (2009) noted the presence of three types of breeding in the Borgou cattle farms in the region. These are transhumant (type 1) semi-transhumant (type 2) and sedentary (type 3) breeding with a strong integration of agriculture. Azalou et al, (2017), in their study of transhumant livestock in the commune of Djidja, distinguished three types of livestock. . These are cross-border transhumant livestock (type 1), inter-municipal transhumant (type 2) and semi-sedentary transhumant livestock (type 3). However, compared to cattle rearing, goat mobility is very low and is limited to the perimeters of built-up areas.

5   CONCLUSION

This first step in the study of Red Maradi goat rearing systems introduced in goat farms in North East Benin aims to characterize the diversity of these farms. It enabled to develop

the typology of these farms and to classify them into four types of farming. Wandering peasant farming, Semi-wandering peasant farming, Semi-improved peasant farming and Semi-intensive

dairy farming. These different types of breeding are distinguished by the management practices, the composition of the herd, and the mode of housing, the production objective and the mode of exploitation of Red Maradi goats. The production objective of semi-intensive dairy farms is much more oriented towards the market

with the exploitation of goat milk. However, for other farms, it is a question of destocking during the lean season or in case of urgent expenditure. We can already see that the promotion of dairy farms of Red Maradi goat is possible in the North East region of Benin.

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