

**Characteristics of traditional cattle farms in
Borgou District, Republic of Benin**

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Abbreviations and symbols

ANOPER: Association Nationale des Organisations Professionnelles d'Éleveurs de Ruminants

APIDev: Association pour la Promotion des Initiatives de Développement durable

CBPP: Contagious Bovine Pleuropneumoniae

CeCPA: Centre Communale pour la Promotion Agricole

CeRPA: Centre Regional de Promotion Agricole

ELISA: Enzyme Linked Immunosorbent Assay

F CFA: Franc de la Communauté Financière Africaine (Benin currency)

FMD: Foot and Mouth disease

GDP: Gross Domestic Product

Ha: hectares

HDI: Human Development Index

INSAE: Institut National de la Statistique et de l'analyse Economique

Kg: Kilogram

Km: Kilometers

NGO: Non-Governmental Organisation

OIE: Office International des Epizooties-World Organisation for Animal Health

PACE: Pan African Program for Control of Epizootics

PPP: Purchasing Power Parity

PPR: Peste des petit ruminants

PRA: Participatory Rural Appraisal

RESUREP: Reseau de Surveillance Epidemiologique du Benin or Benin Epidemio-Surveillance
Network

SNV: Netherlands Development Organisation

UCOPER: Union Communale des Organisations Professionnelles d'Eleveurs de Ruminants

UDOPER: Union Départemental des Organisations Professionnelles d'Eleveurs de Ruminants

%: Percentage

Introduction and literature review

Benin is a West African country with an agriculture based economy (CIA-World Fact Book 2009). Livestock production is a small sub-sector within agriculture providing 5.7% of the total gross domestic product (GDP) and 16.9% of agriculture GDP (Benin Livestock Department 2010). Livestock species are farm animals ranging from conventional species like cattle, sheep, goat, pig, poultry, horses, donkey and camels, to non-conventional species like rabbit, snail, quail, ostriches, ducks, guinea fowl, turkeys, bees and grass cutter. Livestock population estimates in 2009 include 1,954,000 bovines, 791,000 sheep, 1,570,000 goats, 354,000 pigs and 15,500,000 poultry (Benin Livestock Department 2010). The estimated populations of rabbit and grass cutter in 2005 were 225,000 and 75,000, respectively (Benin Livestock Department 2007). The geographical distribution of livestock species is uneven – the northern districts characterized by more grasslands are predominated by cattle, sheep and goat, while the humid southern districts are predominated by poultry and swine (Table 1).

The cattle is a source of food, manure, hides for leather industries, traction and power for transportation, and is part of many other socio-cultural services. The most consumed meat in Benin is beef, accounting for 56 % of meat supply in 2008 (Benin Livestock Department 2009). Dairy milk is the only type of milk produced. Benin crop farmers appear to know about the value of manure and its utilization as fertilizer (Bierschenk & Forster 2004; Ton & Haan 1990). In contrast with manure, the impact of draft animal in crop farming is more visible. Since the introduction of animal traction technique, crop fields have been expanded, and field yields (mainly cotton) have increased. As a result, more and more farmers are using draft animals,

accounting for almost 65 % of plowed fields in 2008 (Benin Livestock Department 2009). Cattle movements (either for trade or pasturing) and beef sales are activities that provide employment and cash flow to local and central government through taxes which contribute to economic growth (Kperou Gado 2006).

As a background, this study reviewed the major aspects of cattle farming in Benin.

1. Production systems

Livestock enterprises in Benin can be divided in two main groups: traditional and modern/commercial farms (Table 2). Despite results of a decade work of livestock projects suggesting new methods that can improve productivity, livestock production in Benin is still predominated by traditional husbandry practices (Aregheore 2009). Zebu Goudali, Zebu Bororo, Zebu White Fulani as well as Taurine cattle namely Lagune, Somba, N'dama and crossbreds generally called Borgou (Table 3) are breeds reported (Belemsaga *et al.* 2005).

1-1. Traditional system

Traditional farms lack in basic facilities and are characterized by a low input-low output system. Cattle are kept in fenced or not, open air park at night. These farms represent 99% of cattle production (Hoste *et al.* 1992). Description of their productions systems follows the classification in pastoral and village-based systems proposed by Blench (1999). The pastoral system is divided into 3 types: exclusive pastoralists, transhumant pastoralists and agro-pastoralists. In such system, cattle herds move regularly from one area to another and play a core role in the owner's livelihood. In the village-based systems, cattle raising is generally a

secondary activity and herds' movement is limited to the village surrounds. According to Benin Livestock Department (2007), around 40% of herds are kept under pastoralist transhumant system, 48% under agropastoralism, 10% under various traditional village based system.

a) Pastoral systems

Exclusive pastoralists do not grow crops and rely on sales of dairy products and animals to purchase grain. In Benin, they are located mostly in Alibori district (semi-arid area). They own a herd ranging from 100 to 300 heads of Zebu (rarely Zebu x Borgou). Herds are regularly moved between areas according to the season in search of grazing land and water. This practice is dependent on the nutritional need and health of the livestock, and the social and economic needs of the pastoralists. In dry season, herds can be moved over 200-300 Km to even cross country borders (Hann *et al.* 1990). This movement is called transhumance, which can last up to 5-6 months depending on the duration of pasture scarcity.

Transhumant pastoralists have a permanent homestead. They are involved in crop activity primarily for their own use rather than for the market. When needed, they purchase grain and other basic products from incomes generated from dairy products. Household income is also derived from sale of surplus male, old cows, sheep or chicken. They live in areas wherein water and forage are scarce during dry season. Thus, they practice seasonal movements in which, part of the herd are sent to other areas with better pastures, while the other part of the herd (mainly lactating cows) remains at the home base. The distance of dry season transhumance (around 10-30 Km or 30-50 Km) is nearer than for exclusive pastoralist. At the end of the dry season, the herd and the accompanying family members return to the home base. Herd size range is between

40-100 heads, composed of Borgou, Zebu x Borgou, few Zebu and rarely Lagune cattle (GERAM-Conseils 2002).

Agro-pastoralists are semi-settled pastoralists who cultivate areas sufficient to fit their needs for cereal, and grow other staple food like tubers or commercial crops like cotton. They live in sub-humid areas which is ideal for integrated cattle farming and arable activities. Herd size range is 10-80 animals, mainly Lagune, Borgou, Somba, Zebu x Borgou and Zebu x Lagune (GERAM-Conseils 2002). Depending on the herd size and environmental conditions, herds stay all year round in the homestead or go for a long transhumance during the dry season. In some areas during rainy season, they also practice a “short transhumance” to avoid crops damages (Aregheore 2009).

b) Village based systems

Village-based cattle farming systems include traction animals, compound dairying, seasonal tethering, fattening, scavenging, peri-urban and “modern” cattle husbandry (Blench 1999). These systems are practiced in humid and subhumid areas. Herds rarely go for transhumance.

Crop farmers mainly use cattle as traction power, as manure source for fertilizing cotton and corn crops fields, and as an asset (Hann *et al.* 1990; Bierschenk & Foster, 2004). Traction oxen stay in the village the whole year. Sometimes during dry season, it can be sent away with pastoralists. Additionally, some farmers practice compound dairying by keeping lactating cows that are never moved out of the village. They are either stall fed or grazed close to the homestead, and are kept in an enclosed area at night (Djenontin 2010).

In the North West part of the country, crop farmers belonging to Somba ethnic group herd their cattle during cropping season. After harvesting, cattle are left to roam freely. At night, cattle

are kept in the first floor of the house. Generally, they own small herds (3-8 heads) (Hall *et al.* 1995).

Another production system is observed in the tsetse-infested flooded plain areas of the southern part of Benin. In such area, most of the animals belong to fishermen or crop farmers. During dry season, cattle graze freely in flooded plains. At times when water rises, cattle are gathered together and kept on rafts. Fodder is then collected from outside the flooded area and brought to the animals daily by boat. Sometimes, households who own 2-3 cattle tether their animals in the morning at the edge of the fields, and bring them back home at night (Aregheore 2009). When they can not herd their cattle by themselves, fishermen and crops farmers can combine their animals in one herd and share the cost of hiring herdsmen.

Fattening is practiced by many middlemen and crops farmers who raise cattle for selling. The animal are bought from transhumant, in villages or small cattle markets, kept for a while for fattening, and later sold at a higher price (Djenontin 2010).

1-2. Commercial system

Modern enterprises have more organized management schemes typical of intensive and semi-intensive farm systems. Modern farms of ruminants represent only 2% of herds in the country (Benin Livestock Department 2007). They are located in rural or peri-urban areas and owned by government and wealthy citizen. Herds which never go for transhumance are managed by hired herdsmen and are kept in barns or fenced night parks, with shelter for calves, drinking and feeding troughs. Benin government cattle farms are located in Kpinnou (South), Samiondji, M'Betecoucou (Center), and Okpara (North). Various activities among which artificial insemination and planning of breeding season are carried out for research on preservation and

improvement of local cattle breed (Adjou Moumouni, 2006). On the other hand, private farms are kept for meat purposes, milk production, or prestige.

2. Cattle management

2-1. Feeds sources

Grass lands cover around 93 % of the Republic of Benin (GLCCD 1998) and the climate favors the practice of grazing. In addition, the utilization of rangeland for pasture is free, as legislation allows herders to use all available lands for grazing. Yet in rural areas, it is the customary land tenure system which is applied. According to tradition, the land usage rights belongs to sedentary crop farmer communities (first established in most areas) who allow herders to feed their cattle on fallows, uncultivated lands, and crops residues (Ton & Hann 1995; Djenontin 2010). Therefore, the main feed sources available to animals are natural pasture, cut forage from forests, some additional fodder, and crop residues (Aregheore 2009).

Natural pasture is estimated at 6,000,000 ha, while improved pasture is only at 490.6 ha. Grazing duration ranges from 5-7 hours in rainy season, and 9-11 hours in dry season. The average distance between pasture and home base ranges from 1 to 3 Km in rainy season, and 5-10 Km during dry season (GERAM-Conseils 2002). Currently, grazing lands and their biomass are decreasing (Djenontin 2010) due to increase in cultivated lands, demography, climate change, environmental degradation, and overgrazing. The introduction of animal traction, motorized pumps, and use of fertilizers favored the extension of crops fields which resulted in reduction of grasslands, fallows and obstruction of cattle trails (Benin Livestock Department 2007; Djenontin 2010). Population growth stimulates development of villages and cities and increases land usage

for constructions. Also, cutting of wood for fire, bush fire, and herders' practices of browsing are contributing to the degradation of the soil, hindering quick regrowth of the biomass (Ton & Haan 1995; Djenontin 2010). In addition, every year in dry season herds of neighboring countries move to Benin for transhumance (Benin Livestock Department 2007) increasing the pressure on pastures. Browsing of *Khaya senegalensis*, *Azelia africana* and *Pterocarpus erinaceus* was an alternative cattle feed resource in dry season but nowadays these trees are used as lumber and cut by lumber jacks in common pasture areas as well as in protected forests.

Cultated fodders such as pasture grasses and legumes species (Aregheore 2009; Adamou-N'diaye 2002 *et al.*; Benin Livestock Department 2010) are used in "modern" cattle farming system. Some fodders have been experimented and promoted by many livestock development projects for wide adoption by traditional farmers but with low uptake rate. The Livestock Department reported in 2009 that cultivated fodder represented 213,325 ha, produced by 587 farmers in 8 of the 12 districts. However, since the end of projects in the center and northern districts, many cultivated forages have been abandoned (Benin Livestock Department 2009).

Crops residues play an important role in cattle feeding specially in area where pastures are scarce during dry season. These include leaves, straw of cereal mainly corn, sorghum, millet and rice (Djenontin *et al.* 2003), husks left in the field after harvest, and hulls, shells removed during processing of the crop at the mills. They are used in traditional farms and "modern" farms. Many traditional herders use crops residues directly on crop fields while others like private farms collect and store it (Djenontin 2010; Kperou Gado 2009). Due to lack of storage, cattle farmers exploit only 20% of the available crops residues (Benin Livestock Department 2009).

2-2. Diseases

Cattle diseases frequently reported to the disease surveillance systems of Benin Livestock Department are presented in Table 4. Foot and Mouth Disease (FMD) due to A, SAT1, SAT2, SAT3, O serotypes (OIE 2003), is enzootic, presenting seasonal epidemic surges. Morbidity rate reaching 80-100% and 80% mortality rate in calves of less than 3 months has been reported (Dehoux & Hounsou-Ve 1991). Bovine brucellosis is enzootic, with a reported sero-prevalence rate of 10.4% (Akapo *et al.* 1984). Recently, Koutinhoun *et al* (2003) reported a 15.21% sero-prevalence rate in traditional herds.

Parasitic infections like trypanosomiasis, tick-borne diseases and gastro-intestinal parasitism are highly prevalent. Agents of Trypanosomiasis in Benin are the following (in order of importance): *Trypanosoma vivax*, *T. congolense* and *T. brucei* (Doko *et al.* 1991, 2010; Youssao *et al.* 2001). Vectors are *Glossina tachinoides*, *G. palpalis gambiensis* and *G. morsitans submorsitans* (Dehoux & Hounsou-Ve 1993). The estimated national prevalence level for this disease is 31.6 % in 2007 (Livestock Department of Benin, 2008a). The prevalence of ticks in traditional herds vary according to the rainfalls and the more frequent are *Amblyomma variegatum* and *Boophilus geigy* (Farougou *et al.* 2006). As a result of tick prevalence, ticks borne diseases are common among cattle. Peripheral blood smears stained with giemsa, revealed a national average prevalence of 14.40%, 31.11%, 15.55%, and 57.77% for *Babesia bigemina*, *Babesia bovis*, *Anaplasma marginale* and *Theileria mutans* respectively. However, prevalence level depend on the area and the age of cattle (Pangui & Salifou 1992). Moreover, examination of blood smears in Northern Benin herds showed prevalence rates of 57%, 46.5%, 39.5%, 28.5% for *B. bigemina*, *T. mutans*, *A. marginale* and *A. Centrale*, respectively (Farougou *et al.* 2007).

The prevalence of *Fasciola gigantica* eggs in fecal samples ranged from 0.41 to 13.1% depending on the region and the period of sampling (Assogba & Youssao 2001, 2002).

Traditional cattle herds are particularly susceptible to diseases due to their farming practices, and location in rural areas which is far from drugs and vaccine distribution routes. In addition, the difficulties in controlling national borders and the presence of numerous transhumant herds coming from diverse areas, concourt to the dissemination of diseases. Consequently, traditional farms present higher fatalities and diseases cases. For example abortion rates in Borgou cattle traditional herd is estimated at 4 ± 10.6 % (Dehoux & Hounsou-Ve 1993) and fertility rate in brucellosis infected herds is only 35 % (Dehoux & Verlhust 1994). Calves are the most affected group with a mortality rate of 23 % in pastoral herds (Dehoux & Hounsou-Ve 1993) and 33% in village-based herds managed by Somba crops farmers (Hall *et al.* 1995). The calves' health care seems to be a particular problem in pastoral herds, with 55% of death occurring during the first weeks of life, and 30 % at 6th month during weaning (Dehoux & Hounsou-Ve 1993).

3 Stakeholders

3-1. Cattle farmers

In Benin cattle husbandry is mainly done by Fulani and Gando ethnic groups, owing more than 95% of herds. Historically, Fulani tribe farmers are mainly involved cattle production, while Gando tribe farmers are mainly on crop production with minor cattle production (Dehoux & Hounsou-Ve 1993; Bierschenk & Forster 2004; Benin Livestock Department 2007; Aregheore 2009). Fulani look after their own animals or are hired to look after animals which belong to other people (Aregheore 2009).

3-2. Benin government veterinary services

In Benin, livestock production and animal health matters are managed by three ministries (1) Ministry of Agriculture, Livestock and Fisheries, (2) Ministry of Development, Economy and Finance and (3) Ministry of Higher Level and Technical Educations. The Ministry of Agriculture, Livestock and Fisheries is the center of government policy and actions for livestock development. The Ministry of Development, Economy and Finance works with the former by managing the funding for livestock development projects, ensuring salaries, monitoring and evaluation of projects and enforcing taxes exemptions. The Ministry of Higher level and Technical Educations is responsible for the training of professionals in charge of the livestock sector. There is no Veterinary School in Benin, all Veterinary Surgeon of Benin are graduates from other countries.

a) Structure of livestock and veterinary services

In the Ministry of Agriculture, Livestock and Fisheries, two departments are in charge of managing matters related to livestock: the Livestock Department and the “Centre Regional de Promotion Agricole” or Regional Centre for Agriculture Promotion in English (CeRPA). While, Livestock Department is completely devoted to livestock (Figure 1), CeRPA play a role of ministry branches at the regional level (Figure 2). CeRPA have also branches at the division level which are called “Centre Communale pour la Promotion Agricole”, or Communal / Division Level Center for Agriculture Promotion in English (CeCPA) responsible of applying government agriculture policies in each commune or division (Figure 3). In 2009, they were 432 government staffs involved in livestock health or animal production activities (Table 5).

Livestock Department roles are (1) Identification of technical and economic measures for the development of animal production (2) Monitoring of livestock development measures and (3)

Diseases control. CeRPAs' roles are (1) Definition of rural development policies (2) Technical support of farmers and farmers' organizations (3) Definition and application of natural resources management policies and (4) Coordination of activities of rural development NGOs. At subdivision level, eight CeCPA staffs are in charge of supporting farmers in (1) Crop production, (2) Crops quality control, (3) Agricultural enterprise management, (4) Natural resources management, (5) Animal production (6) Animal origin product inspection (7) Crops products inspection and (8) Fisheries products inspection. In villages, polyvalent extension workers are directly in contact with farmers and are under the responsibility of the CeCPA's director.

The information system of Benin veterinary services aims at gathering data necessary for (1) Disease surveillance and control of epizooty, (2) Assessment of the quality of animal source food (3) Assessment of livestock industries productivity, (4) Assessment of economic importance of livestock production and (5) Assessment of food security and poverty levels. The information flow is presented in Figure 4.

b) Veterinary services activities

Disease control activities are done through annual vaccination campaigns, disease surveillance, border veterinary control points and laboratory analysis. Activities are shared between the Livestock Department and CeRPA. Vaccinations provided to farmers are against Bovine Pasteurellosis, CBPP, Anthrax, Black Leg, Peste des petit ruminants (PPR), Newcastle disease, and Avian pox. Cattle herd vaccination coverage rate is relatively low. In 2009, 42.8%, 40.03%, 0.2% and 1.5% were reported as vaccination rates for Pasteurellosis, Contagious Bovine Pleuropneumoniae (CBPP), Anthrax and Black leg, respectively (Benin Livestock Department 2010).

Livestock Department Animal Health office has created an epidemiological surveillance agency, called “Reseau de Surveillance Epidemiologique du Benin” in English Benin Epidemio-Surveillance Network (RESUREP) (Benin Livestock Department 2007). The RESUREP ensures early detection and control of disease outbreaks all over the country. It favors information exchange between veterinary laboratories, farmers, veterinary services and private veterinary clinics for better surveillance of diseases. On the other hand the planning, coordination and synthesis of regional veterinary laboratories activities is devoted to the African Union program called “Programme panafricain pour le controle des epizooties in English Pan African Program for Control of Epizootics (PACE).

From 1994, government officialy retired from providing veterinary services to livestock owners. Privatization and liberalization of veterinary services occurred and government nowadays is only in charge of vaccines importation (Lekeux 2006). Currently, 70% of veterinary services to farmers are done by private actors represented by Veterinary surgeon and Husbandry techniques engineer graduates (Noudeke 2007) and para-veterinarians. Most of private practices are located in the south whereas majority of the cattle herds are located in the Northern part (Table 5).

The control of animal food and feeds is done by Livestock Department Animal Food and Feeds Inspection office and the Control and Regulation office of CeRPA. Concerning slaughter houses, there is only one official ”Abattoire”, the other are 55 slaughtering spots. Moreover, there is no public slaughter house for poultry in Benin. Most frequent cattle carcasses retirement reasons are Tuberculosis, and putrefaction (Benin Livestock Department 2010).

Extension services are under the responsibility of CeRPA. In collaboration with NGO, and farmers associations they organize training of farmers, in husbandry techniques, management of enterprises and marketing of agricultural product (Benin Livestock Department 2007).

3-3. Non Profit organizations

a) International cooperation agencies

In Benin, the Netherland development organization (SNV), a non-profit, international development organisation in coordination with a farmer association called “Union Communale des Organisations Professionnelles d’Eleveurs de Ruminants” (UCOPER), support the improvement of farming systems. Their activities include support in creation of farmer association networks, training in communication, management and leadership skills, access to veterinary services, water and forages sources and improvement of farm products marketing systems.

b) Non-Governmental Organizations (NGO)

Several NGO are active in rural areas, however very few are devoted to cattle farmers and APIDev NGO is one of them. APIDev stands for “Association pour la Promotion des Initiatives de Développement durable” in English “Sustainable Development Initiatives Promotion Association“. Their activities include training in gardening, husbandry, animal health care, feeding techniques, water management and marketing of farm products.

c) Farmers’ association

The “Union Departemental des Organisations Professionnelles d’Eleveurs de Ruminants” (UDOPER) is the main association of ruminants keepers. The association is a cooperative with a

pyramidal structure and has branches at each administrative level. At the division level it is called “Union Communale des Organisations Professionnelles d’Eleveurs de Ruminants” (UCOPER), UDOPER at District level, and ANOPER at national level. Currently, 24 of the 77 divisions of Benin have an UCOPER. UDOPER works directly with ruminant farmers and serve as intermediate between farmers and other institutions. Its activities aim to (1) Improve herders ‘livelihood (2) Support for the improvement of animal health (3) Improvement of ruminants marketing system and management of cattle markets (4) Ensure the regular animal supply of ruminants markets (5) Train members about associative life and (6) Provide moral and social support to farmers as well as help in avoiding and solving herders-crop farmers conflicts.

In developing countries like Benin, it is difficult to assess the real economic impact of livestock because of the multiple roles played by animals in the farm owners’ livelihood. The poor people keep livestock for varied reasons including food consumption, social status, source of income, manure and traction, as well as financial collaterals (Randolph *et al* 2007). The 2008 annual estimates of consumption level per person for meat, and milk in Benin were 6.53 kg and 11.88 kg respectively. This is considered low by Food and Agriculture Organization (FAO) norms for sub-Saharan African country (Benin Livestock Department 2009). Also, the population growth rate of 2.97% per year clearly shows an increasing demand for animal protein. Cattle as main meat consumed are in the frontline of food supply. Unfortunately main producers which are the traditional farms can not meet this growing demand. Compared to modern herd farming, they show high mortality rate, high prevalence of diseases and limited feeds and water sources. These factors impede cattle productivity, and threaten the quantity and quality of beef and milk supply in the country. The GDP adjusted for purchasing power parity (PPP) per capita and the human development index (HDI) estimates are US\$ 1.440 (International Monetary Fund)

and 0.492 (161st from 173 countries in 2007), respectively. These indexes have ranked Benin as a low revenue country. Importing food supply will certainly increase poverty and reduce food accessibility. The export of livestock and its derivatives makes a significant contribution to the national economy even though it is not reflected in the GDP and other statistics (Moritz 2008). The necessity of improving traditional cattle farming systems tantamounts to food security, poverty alleviation, economic, social and sanitary concerns.

Cattle industry has gone through a number of changes in the recent years including attempts to introduce “new” or “improved” breeds, creation of state farms, projects to improve livestock health, and privatization of the veterinary services. The failure of attempts to introduce new breeds encouraged the research on local livestock characteristics and their roles in traditional farming systems, as well as their socio cultural importance for local communities (Rege 1999). Consequently, a shift of development actions towards improvement of traditional cattle farming practices was carried out. Yet, projects to improve growth, milk production, and to reduce animal health problems in traditional herds did not have the expected impact. At the end of the project funding, programs or facilities (e.g. water points, dipping tank, vaccination park) were not sustained by the recipient farmers. Based on these facts, the main challenge is to develop strategies for efficient and sustainable livestock development actions.

Nowadays, traditional farmers’ knowledge in diseases and their control, animal husbandry, animal nutrition and genetics are widely acknowledged (Catley *et al.* 2002a, 2006; Mochabo *et al.*, 2005, 2006; Ayantunde *et al.* 2000, 2007; de Jode *et al.* 1992; Jabbar & Diedhiou 2003). The value and use of such knowledge in livestock development and detection of useful research topics are now promoted (Khohler-Rollefson 1993). New approaches taking into account pastoral communities’ existing knowledge should be the center of development efforts.

A “down–top approach” is necessary for identification of farmers` needs and adequate support. Therefore, for the improvement of the traditional system in Benin, there is a need to understand cattle farmer`s practices to identify their problems, priorities and solutions that could be applied based on local resource endowments. This study aims to: 1) identify farmers` socio economic characteristics; 2) describe farming systems; 3) give an update description of livestock management practices; and 4) identify farmers` perception of diseases presence and forage availability across seasons. A better understanding on the characteristics of traditional farming system will certainly contribute in identifying future research topics and deciding on ideal development actions which consider the farmers` situations. Moreover, it can help in assessing the scope of trainings needed based on farmers` knowledge, and in improving information exchange between farmers and veterinarians for better disease control and management. Thus, this work can be a step towards the improvement of traditional cattle farming productivity, and the increase of the animal protein supply in Benin, which is one of the current challenges of the Government.

Methods

1. Study area

1-1 Characteristics of Borgou district

Borgou district is located in the lower part of North East Benin. It shares an international border with Nigeria (Figure 5). The 25,856 Km² coverage area is divided into 8 divisions or “communes”, namely Kalale, Sinende, Bembereke, Nikki, N’Dali, Perere, Parakou and Tchaourou. Each commune is further subdivided into “arrondissement” which is composed of several “quartiers” in the city or villages in the country side. The estimated population in 2009 was 909,004 habitants with a density of 35 habitants/Km² (INSAE 2008). The climate is tropical sub humid with a mono-modal rainfall pattern. Two seasons are identified: the rainy season (May to October), and the dry season (November to April). The average rainfall and temperature are 1,200 mm and 26-27°C, respectively. The district covers two agro-ecological zones (Aregheore 2009), but all study sites were located in the agro-ecological zone 3. The estimated cattle population in 2008 was 572,200 heads, which represents 30% of the national herd.

1-2 Study population

Sedentary livestock farmers having at least one cow and living in the Borgou district were identified as respondents. Six subdivisions from 3 divisions were selected according to accessibility and advice of local veterinary assistants and NGOs (Figure 5). In each subdivision, respondents were chosen based on their willingness to take part in the study.

2. Data collection

A structured questionnaire was used during individual interview of cattle farmers (Annex 1). It consisted of 62 questions divided into 5 sections: demographics, permanent settlement indicators, agricultural activities, herd management practices, herd productivity and access to extension services. Seasonal calendar method was used to collect information about rainfall, pasture availability, important cattle diseases, ticks and biting flies population variations over 1 year period.

3. Analytical methods

Data were stored in Excel™ 2007 (Microsoft Corporation) and analyzed using EPI INFO™ software (CDC, Atlanta, version 3.5.1). Mean values for cattle herd size, small ruminants and poultry flocks were compared using their confidence interval chart. Seasonal calendars were analyzed using the Kendall's coefficient of concordance (W) (Catley *et al.* 2002b).

Results

A cross sectional study was carried out from 9th May 2011 to 18th June 2011. Number of farmers interviewed at Nikki centre, Tasso, Sekere, Sikki, Bouka and Dunkassa were 14, 37, 32, 19, 27 and 21, respectively.

1) **Socio-economic characteristics of cattle farmers**

Fulani farmers showed highest percentage of population in Sikki, Sekere, Bouka and Nikki centre, while Gando farmers has the highest percentage in Dunkassa (Figure 6). Except for Dunkassa where farmers prefer crop farming, livestock production was the main occupation in most areas. Family herds were mainly reported in Dunkassa. Individually owned herds were common in the other 5 subdivisions (Table 6). In Nikki centre, Tasso and Dunkassa, more than half of the farmers were not born in the current living place. In Dunkassa, majority of farmers who settled in the area for less than 20 years ago cultivated lands (less than 5 ha) which were not their own. In the remaining study areas, majority of farmers who settled for more than 20 years ago were landowners. In Sikki, Sekere and Bouka, majority of farmers exploited less than 5 ha for crop farming, while in Nikki centre and Tasso, majority of farmers exploited more than 5 ha (Table 7).

2) **Farming system characteristics**

Corn, sorghum and yam were produced by more than 93% of the respondents. In areas such as Nikki centre, Tasso and Dunkassa, corn was cultivated for consumption and selling purposes,

while in Sekere, Sikki and Bouka, it is for self consumption. Sekere, Sikki and Bouka farmers were not involved in cotton production (Figure 7). Using cattle as ploughing power was observed to be highest in Dunkassa (90%) and Tasso (57%), less frequent in Sinende and Nikki centre and inexistent in Bouka. In all study areas, farmers had poultry and small ruminants aside from cattle. Mean small ruminants flock sizes were similar between subdivisions (Figure 8). For poultry, Tasso and Dunkassa farmers had higher number, than those in Bouka (Figure 9).

3) Cattle management and health

More than 80% of farmers in all the areas had mainly Borgou cattle in their herd. However, except for Sikki, mixed herds of Zebu-Borgou were observed in all areas but with higher frequency in Bouka (29%). Herds made exclusively of Zebu were observed in Sinende and Tasso, and represented less than 11% of the herds. Sinende farmers had more cattle, while Bouka farmers have less than other areas (Figure 10). At the moment of the study, farmers in Bouka (52%) and Nikki centre (50%) reported that part of their herd was at another location whereas in the other study areas, majority of herds were in one single location.

More than 65% of farmers did not purchase any cattle. However, 62% of farmers in Dunkassa purchased at least one cattle during the previous year. Reasons to purchase cattle were principally to improve the herd and to replace sold animals. In all the study areas except for Nikki centre, almost all farmers sold at least one cattle during previous year. Sale of cattle is due to need of cash especially in Dunkassa or cultural reasons such as baptism and marriage in the rest of the study areas. Accordingly, in all of the study areas, farmers rarely consume their own cattle.

In all the study areas except for Sinende, forage production was rare. Feeding relied mainly on natural pastures during rainy season. In contrast, the use of crop residues beside grass and tree browsing was strongly reported during dry season. While farmers in Kalale and Nikki considered that pastures were close to the homestead (less than 5 Km), the majority in Sinende considered it far (more than 5 Km). Practice of feed storage such as corn, sorghum stalks, groundnuts and beans leaves was common among farmers of Tasso (57%), Nikki centre (43%), Sekere (34%) and Sikki (32%). Transhumance was common in Sekere, Sikki and Bouka, less frequent in Nikki centre and Tasso, and never done in Dunkassa (Table 8). Dry season transhumance generally occurred from December to May or June, wherein majority of herders in Nikki centre, Sekere and Sikki stay within the division while those in Tasso and Bouka move to other divisions of Borgou district. Rainy season transhumance was observed only in Sinende, and was generally practiced within the same division by more than 90% of farmers from September or August to December.

Majority of farmers in Dunkassa, Bouka, and Nikki centre watered their herds at natural water sources (rivers or dams), while only half of the farmers in Sekere and Tasso did such practice. In Sikki, 61% relied on boreholes/watershed. In most of the study areas, farmers watered their herd 2 times daily when the water source was near to their home (less than 5 Km). However in Dunkassa, the water point was located far (more than 5 Km); thus, they watered their herd only once a day.

The presence of diseases was strongly reported in all the study areas except for Nikki centre where farmers' opinion was divided. Vaccination against Pasteurellosis and CBPP had been reported by all the farmers. Deworming of the entire herd and sick animals is a frequent practice. In Sekere, Sikki and Bouka, it is practiced when it is needed, while in Tasso, it is done

only when it is affordable. In Dunkassa, calves are dewormed 2 to 3 times a year. Similar behaviour to deworming was observed for tick and fleas' prevention, except for Dunkassa where the entire herd was similarly treated. The use of veterinary drugs and traditional methods is frequent in all the studies areas for deworming. On the other hand, tick and flea prevention relies mainly on the use of traditional methods. However, farmers in Dunkassa and a high percentage of them in Nikki centre and Tasso only rely on veterinary drugs. In areas like Dunkassa, Tasso and Nikki center, the herd's health care relied on the veterinary assistant. Contrary in Sinende and Bouka, farmers were also involved beside the veterinary assistant,

Except for Tasso, most of farmers indicated that they belong to some herder organization. Farmers from Nikki and Sinende acquire knowledge on cattle management through experience. In contrast, farmers from Kalale relied on extension services and veterinary drugs salesman. Moreover, while Bouka, Sekere and Sikki farmers attended training sessions on cattle management, few in Nikki centre and Tasso did, and nobody in Dunkassa ever attended the training.

For herd reproduction more than 60% of the farmers relied on their own bull. In Bouka, 34% of herders used their own bull while 28% of them used the neighbouring herd's bull. Sires were used for more than 2 years. Majority of farmers used Borgou cattle in almost all of the study areas. However, in Bouka, Zebu sires were used by 21% of farmers (Table 9). Majority of farmers in Dunkassa (76%), Sekere (72%) and Sikki (58%) reported that abortion or stillbirth occurred in their herd during the previous year while almost half of farmers from Bouka, Tasso, and less in Nikki center did.

All the farmers let calves suckle until natural weaning. Milk production is mainly consumed while the surplus is sold. Majority of farmers milked their cow once per day in Dunkassa and Nikki centre, while those in Sinende and Bouka milk their cow 2 or 1-2 times depending on the season. More than 80% of farmers in Sinende, and Bouka started milking cows just after calving. While in Nikki centre and Tasso, they generally let the calf suckle for one week or more before milking. In Dunkassa, majority of farmers (65%) waited for 2 weeks after calving before milking (Table 9).

4) Seasonal calendar

A summary of the 3 seasonal calendars is presented in Figure 11. All the informants groups perfectly agreed ($W = 1, p < 0.05$) on rainfall distribution. The scoring of herders conformed to the data obtained at weather stations (Table 10). Pasture availability distribution showed also significant and good agreement ($W = 0.91, p < 0.05$), and was correlated with rainfall pattern. There was no agreement ($p > 0.05$) between informants for diseases incidence across the seasons. However, for *Heree* (Pasterellosis) all informant group ($W = 0.69$) tend to locate the peak during *Seeto*. Except for *Maaso* (Trypanosomosis) and *Boola* (Skin disease) which were more frequent during *Yanne*, farmers considered *Seeto* and *N'dungu*, seasons of rains as the period when diseases and vectors are highest. *Coneje* (Brucellosis) incidence was equally distributed across the seasons.

Discussion

Primary data were collected in Fulfulde (Fulani language) and Bariba through an interviewer administered questionnaire and PRA methods. A translator/guide speaking Fulfulde, Bariba and French was employed during the study. Before the study, the investigator and the translator/guide were introduced to cattle farmer communities by collaborating local institutions. Prior to the study period, the objectives of the research were explained and appropriate days/hours for interactions were decided with community leaders. The investigator stayed 7 days in each surveyed division to share herders' daily life while collecting data.

In a previous report, Fulani was described as transhumant pastoralist practicing subsistence crop farming, while Gando practiced a village-based mixed farming where production of various crops is associated with livestock keeping (Dehoux & Hounsou-Ve 1993). Accordingly, in all study areas dominated by Fulani, livestock was the main occupation, whilst in Gando-dominated areas, crop farming was the main occupation. Interestingly, in areas where Fulani and Gando were present the main activity was not related to the ethnic group. The source of income was closely related to the main activity. Some Fulani chose crop farming as source of income and some Gando intensively practiced herding. The proportion of Fulani farmers practicing animal traction was higher than previously reported (Bierschenk & Forster 2004; Djenontin *et al.* 2003). This suggests that Gando farming techniques may be adopted by Fulani. According to previous reports (Bierschenk & Forster 2004), Fulani farmers tend to be less involved in market oriented crop production. However, we could observe in mixed areas, high frequency of Fulani involved in cotton production and sale of corn harvest. These results suggest that there is no more clear distinction in farming practices between both ethnic groups. Interestingly the new behaviors

were mostly observed in mixed and Gando dominated areas which compared to Fulani dominated areas showed characteristic of open population made of settlers coming from different areas. Thus, increasing contact between farmers of different origin and ethnic groups favors farming practices exchange. Similar exchanges among crops farmers and pastoral communities have also been reported in the semi-arid savannah of Central African sub region (Awa *et al.* 2003) and in Nigeria (Jabbar *et al.* 1995). However, this dynamic in farmers' behavior seems also to be an adaptation to their environment, probably reflecting their response to constraints as observed among other cattle farmers' communities (Moritz 2008; de Jode *et al.* 1992; Daodu *et al.* 2009).

Cattle farmers have a clear knowledge of genetics and based on their cultural background, environmental constraints like climate, diseases in the area, available resources, and production objectives, they are able to decide on the best fitted cattle type in their herd (Kohler-Rollefson 1993; Ayantunde *et al.* 2007; Jabbar & Diedhiou 2003; Bebe *et al.* 2003). According to our results, farmers generally had Borgou, a breed that is adapted to the area, is docile and trypanotolerant. Moreover, herds of only Zebu were rare because Borgou district climate is inadequate for them. Previous works (Dehoux & Hounsou-Ve 1993) reported increasing usage of Zebu sire in Borgou herds for the sake of upgrading herd conformation. In this study however, majority of farmers independently of the ethnic group used Borgou sire. This supposes that the physical characteristic of offspring is not the main objective of surveyed farmers.

Cattle herd size in North East Benin depend on several factors namely ethnic group, household size, environmental constraint and period of the year (Djenontin *et al.* 2003). In this study, Fulani dominated areas compared to Gando dominated areas had larger herds as has been reported previously (Ayantunde *et al.* 2007, Jabbar *et al.* 1995). The cultural background and the

roles of cattle in their life can explain Fulani tendency to have larger herds. The differences of debut of milking period between Fulani dominated areas and other surveyed areas, suggest that milk is one of the reason why they keep more cattle. Also, cow milk has been reported as a major component of Fulani diet (Dehoux & Houssou-ve 1993; Bierschenk & Forster 2004). It is necessary to point out that majority of farmers of Bouka and Nikki centre at the moment of the study, had part of their cattle in other location and these other location animals were not included in the analysis. Knowing that farmers having large herds are more susceptible to divide their herd, it is possible that the average herd size in Bouka and Nikki centre had been underestimated.

According to Djenontin (2003, 2010), based on climatic condition, land access and production objectives, farmers decide on strategy and plan cattle feed sources usage. In the current study, during the rainy season, cattle are mainly fed on natural pasture but due to differences in the availability of non-use lands, grazing pastures location were different. In Nikki and Kalale divisions because there was less pressure on lands, grazing pastures were located close to the house. In Sinende however they were located far. In dry season farmers needs to find other strategies to deal with the decrease of the biomass. We observed in this study that they use crops residues and browsing, and when there are no more feeds in the area, they temporally move to other areas, by then doing transhumance. It appears that herd size, quantity of pasture and crops residues available in the homestead, the availability of labor force, will determine the decision to store or not crops residues and move or not for transhumance. Fulani particularly, due to limited involvement in crops farming and reduced surface of land cropped, when possible store crops residues and move for transhumance. On the other hand Gando as observed in Dunkassa, are highly involved in crops, have smaller herds, and generally don't feel the need to store crop residues or move. Interestingly, in Fulani dominated areas not all farmers moved,

meaning that transhumance practice is also an individual decision made by the farmer based on its necessity, the availability of manpower to follow the herd, and the threat of diseases contamination. According to agricultural extension services 60% of Sinende division is under cultivation, likely the practice of rainy season transhumance in this area is explained by the will of avoiding damages to crops.

Fulani keep cattle more for cultural reasons than for economic benefits (Bierschenk & Forster 2004). In contrast, Gando farmers keep cattle for economic reasons. Interestingly, in this study, besides Gando, Fulani showed the tendency to sell cattle. We suggest that Fulani farmers are joining more and more modern life, for example almost all of them had cell phone and motorbike which definitely increase their need of cash. In Nikki centre however the low frequency of cattle sale can be explained by the high involvement in cotton and corn sale. Cattle purchase frequency was relatively low in all areas supporting the idea that majority of farmers increase their herd through inheritance and births as has been reported previously (Dehoux & Houssou-Ve 1993). In Dunkassa, the high frequency of farmers having bought at least one cattle during previous year can be explained by the fact that Gando who are majority in the area, just installed and started to build their herd.

The current results showed that all cattle farmers are aware of diseases and the importance of cattle health care. However, the methods used vary according to the area and this can be due to the availability or affordability of veterinary services. Also, we suggest that the availability of the veterinary services depend of the distance between farmer's location and main city of the area. The ethno-veterinary knowledge of Benin Fulani has been previously reported (Bierschenk & Forster 2004). Accordingly in Fulani dominated areas, even though majority of farmers rely on veterinary assistant for animal health care, some of them treat sometimes by themselves and the

use of traditional medicine was frequently reported. Similar traditional practices in health care associated with intervention of veterinary extension agents for untreatable ailments have been reported among Northwest Cameroon Fulani (Boboh 1993). Gando on the other hand, don't have the same cultural background, thus are more dependent on veterinary services providers. As a result, in Gando dominated areas, farmers rely only on veterinarian for information on animal management; veterinary drugs usage is more frequent and deworming is done twice a year which corresponds to the frequency of official vaccination campaign coupled with calves' deworming. Interestingly in mixed areas which are close to one of the main city of the area, all farmers reported relying more on veterinary services.

In accordance to previous studies using the seasonal calendar method with cattle keepers' communities (Catley *et al.* 2002a, 2002b; Mochabo *et al.* 2005) our results confirmed the sound knowledge of farmers. The year division in Fulani terminology was similar to the Fulani pastoral calendar reported by Bierschenk and Forster (2004) and Djenontin (2010). Farmers' agreement on rain falls and pasture availability distribution confirmed that the three areas are located in the same agro-ecological zone. The absence of agreement concerning diseases supposes that each area has a particular epidemiological situation, and this can be related to the variability in access to veterinary services and environmental conditions. Surprisingly, Pasteurellosis was considered as an important disease even though all surveyed farmers took part in the official vaccination campaigns carried out twice in a year (Benin Livestock Department 2010). The reasons given by farmers for their scoring were different, complex and based on their ideas of the diseases causes. While in Nikki centre farmers considered ticks as Maasso (Trypanosomosis) vectors, those in Sikki and Bouka formally identified biting flies. Some farmer located high incidence of Maasso in Seeto which is the period of first rainfalls associated with the increase of ticks and biting flies

populations while others located the disease in Yanne (beginning of dry season) which is located just after the peak of vectors population and associated with a residual population of tick and flies. Maaso seems therefore to be associated to these vectors; however there is a need to do more investigation to know if this disease is Trypanosomosis as single infection or a mixed parasitism of Trypanosomosis and tick borne diseases.

In comparison to the interventions in crop farming, government attention for cattle farmers is limited and mainly concentrated on vaccinations programs, and disease surveillance (Haan *et al.* 1990). With the liberalization of veterinary services, diseases remain a major problem and new constraint namely forages scarcity has added a burden to cattle farming. Farmers try their best to adapt by settling, adopting new farm activities, relying more on veterinary services, and joining training. Yet some part of the problems of cattle farming cannot be solved by farmers alone. Specifically the forage access problem affects Fulani tribe. In some areas like Nikki division, veterinary assistant, NGO, and herder association leaders interviewed reported a steady decrease in cattle number due to the tendency that settled Fulani are leaving the area for the Southern part of Borgou district or towards center Benin in quest of forages. In contrast, since Gando have better land access, they are less likely to leave the area. This supposes that if nothing is done to secure Fulani access to forage, the supply in beef will depend on Gando who have lower herd size, are highly dependent on veterinary services and less experienced in cattle rearing. Knowing that veterinary practitioners are scant in Benin there is a need to help Fulani in their adaptation and improve Gando knowledge in cattle farming.

Gando and Fulani have different situations. According to Moritz (2010), improvement of livestock production should not be seen as though it evolved out of agricultural systems, but out of pastoral system. Socio-cultural pattern of the farming system, environmental situation, land

pressure, availability of alternatives feeding opportunities, and availability of amenities (water, human health facilities, security, access to veterinary services, and access to market) are factors which determine the forms of sustainable development actions. Also, strategies for improvement of cattle farming system should be global, locally oriented, built on customary institutions, existing techniques, decided by farmers, and supported by appropriate legislation or institution where they are represented, thus based on a participative approach.

Conclusion

The main actors of cattle farming in Borgou district are Fulani and Gando tribes. The two groups through close relationship are exchanging their habits and knowledge in agricultural activities. Fulani previously pastoralists are embracing more and more crops farming, while Gando previously known as crops farmers with livestock are increasing their livestock activities. Our results clearly indicate that the two groups used similar farming practices, yet they don't have the same background in cattle farming as has been previously reported. Facing various constraints like diseases, food scarcity they react by adapting their practices based on characteristics of their living areas and their assets. Moreover, the access to veterinary services seems to have an influence on the current management of cattle diseases. Each areas and each tribe situation is particular and call for participative and locally planned development actions.

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Tables and Figures

Table 1: Estimated livestock population distribution per district in Benin - 2007

Livestock number (x1000)					
District	Cattle	Sheep	Goat	Pig	Poultry
Alibori-Borgou	1233.7	353.5	371.1	18.6	2882.6
Atacora-Donga	438.1	195.9	250.8	72	2057.0
Collines-Zou	93.4	42.1	220.5	73.6	2994.3
Couffo-Mono	13.3	62.3	305.5	36.7	2483.2
Plateau-Oueme	45.7	52.3	174.3	81.0	2324.2
Atlantique-Littoral	32.8	53.8	139.2	33.8	1755.8
Total	1857	759.9	1461.4	315.7	14497.1

Source: Benin Livestock Department 2008a

Table 2: Types of livestock farms in Benin

Farms types	Characteristics	Animal species (in order of frequency)
	Rural areas	
	Herders	Cattle Small ruminants Poultry
	Large herd and flock of local breeds	
Traditional farms	Urban, peri-urban and rural areas	Cattle Small ruminants Pig Poultry Grass cutter Rabbit
	Backyards farms	
	Crop farmers or off farm activity	
	Small herd / flock of local breeds	
	Urban and peri-urban areas	Poultry Pig Rabbit Grass cutter Cattle
	Commercial farms	
	Private company with outlets and processing facilities	
	Large flock of local or exotic breed	
Modern farms	Rural areas	
	State or institution farms	Cattle Small ruminants Pig
	Own by government or research and education structures	
	Large herds of local or exotic breed	

Source: Benin Livestock Department 2007

Table 3: Production and health parameters of Borgou cattle per production system

Parameters	Production environment					
	Traditional herd ¹	Betecoucou Station ²	Pastoralist herds ³	Okpara Station ⁴	Okpara Station ⁵	Private farms ⁶
Calving rate (%)	65.4±13.1	33-75	65	78±8.4	81.55±2.85	-
Calf mortality rate (%)	18.7-26.6	28	20-35	2.5±0.2	2.04±1.23	-
Adult mortality rate (%)	3.2	12	3.1	0.56±0.04	-	-
Birth weight female (kg)	15.6	16±3.9	-	18.48±1.65	19.91±1.95	-
Birth weight Male (kg)	16.4	17±3.1	18	19.23±1.99	19.7±3.11	-
Weight at 1 year (kg)	84.2-124.3	79-130	90	104±22.98	108.72±15.1	-
Cow Adult weight (kg)	235.4±21.7	248	230-260	-	-	-
Bull Adult weight (kg)	193±4.3	307	280	-	-	-
Age at first calving (months)	48.5±2.4		36-48	42.1±5	46.27±7.7	37.4±7.9
Calving interval (days)	573±51	526±145	547	441±75	467.26±114	450±133.3
Milk yield (kg)	-	-	535	-	-	-
Lactation period (days)	-	-	250	-	-	-
Average dressing out (%)	-	52	45-50	-	-	-

1) Traditionally managed herds. Sources: Rege *et al.* 1994a, 1994b, Dehoux and Hounsou-Ve 1993. 2) Betecoucou State Farms, in medium tsetse challenged areas. Source: Aregheore 2009. 3) Traditional pastoralist in North East Benin, light tsetse challenged area. Source: Dehoux and Verhulst 1994. 4) Okpara State farm, light tsetse challenged area: 1994-1997. Sources: Youssao *et al.*, 2000a, 2000b. 5) Okpara farm, 2003-2004, during massal selection program. Source: Adjou Moumouni 2006. 6) Kokoubou monastery farm. Source: Adamou N'diaye *et al.* 2001, 2002.

Table 4: Cattle diseases reported in 2009

Disease	Number of outbreaks	Number of Cases	Number of Fatalities
Trypanosomosis	94	50 503	1531
Foot and Mouth Disease	32	4 749	100
Bovine pasteurellosis	36	1 176	13
Contagious Bovine Peripneumonia	4	42	9
Lumpy skin	2	15	2
Anthrax	1	17	17
Dermatophilosis	2	8	
Bovine tuberculosis	7	651	2
Black leg	1	5	0

Source: Benin Livestock Department 2010

Table 5: Distribution of Benin Veterinary Services technical staff per category

District	Veterinary Surgeon		Veterinary assistant		Para-veterinarians		Total
	Public	Private	Public	Private	Public	Private	
Alibori	0	0	0	1	0	10	11
Borgou	3	10	13	4	77	27	134
Atacora	1	4	22	1	60	8	96
Donga	0	1	0	0	0	3	4
Collines	1	0	1	0	0	0	2
Zou	3	5	16	0	44	2	70
Couffo	0	2	0	0	0	0	2
Mono	2	2	9	0	23	0	36
Plateau	0	0		0		0	0
Oueme	1	7	18	6	43	9	84
Atlantique	3	6	11	9	48	15	92
Littoral	13	17	13	2	7	0	52
Total	27	54	103	23	302	74	583

Veterinary assistant: Agronomist and husbandry techniques engineer; Para-veterinarian: Agriculture high school, junior high graduate and field trained technician.

Source: Benin Livestock Department 2010

Table 6: Socioeconomic characteristics of cattle farmers in 6 study areas, Borgou district, Benin 2011 (*n*=150)

Number of farmers (%)							
Divisions	Nikki		Sinende		Kalale		
Subdivisions	Nikki centre (<i>n</i> =14)	Tasso (<i>n</i> =37)	Sekere (<i>n</i> =32)	Sikki (<i>n</i> =19)	Bouka (<i>n</i> =27)	Dunkassa (<i>n</i> =21)	Total (<i>n</i> =150)
Main occupation							
Livestock	8 (57)	23 (62)	32 (100)	19 (100)	27 (100)	10 (48)	119 (79)
Crops	6 (43)	14 (38)	0	0	0	11 (52)	31 (21)
Incomes sources							
Livestock	8 (57)	18 (49)	29 (91)	19 (100)	0	8 (38)	82 (55)
Crops	6 (43)	10 (27)	3 (9)	0	0	11 (52)	30 (20)
Crop and livestock	0	9 (24)	0	0	27 (100)	2 (10)	38 (25)
Cattle ownership							
Individual	11 (79)	20 (54)	12 (38)	14 (74)	25 (93)	3 (14)	85 (57)
Family	3 (21)	15 (41)	10 (31)	3 (16)	1 (4)	18 (86)	50 (33)
Care taking	0	1 (3)	1 (3)	0	0	0	2 (1)
Mixed ownership	0	0	9 (28)	2 (11)	1 (4)	0	12 (8)

Table 7: Settlement characteristics of cattle farmers in 6 study areas, Borgou district, Benin 2011
(*n*=150)

Divisions	Number of farmers (%)						Total (<i>n</i> =150)
	Nikki		Sinende		Kalale		
Subdivisions	Nikki centre (<i>n</i> =14)	Tasso (<i>n</i> =37)	Sekere (<i>n</i> =32)	Sikki (<i>n</i> =19)	Bouka (<i>n</i> =27)	Dunkassa (<i>n</i> =21)	
Birth place							
Current living place	4 (29)	8 (22)	32 (100)	19 (100)	27 (100)	1 (5)	91 (61)
Other subdivision	0	6 (16)	0	0	0	7 (33)	13 (9)
Other division	10 (71)	21 (57)	0	0	0	12 (57)	43 (29)
Out of Benin	0	2 (5)	0	0	0	1 (5)	3 (2)
Settlement duration							
>0-20 years	0	6 (16)	0	2 (11)	0	15 (71)	23 (15)
>20-40 years	12 (86)	22 (59)	8 (25)	2 (11)	0	6 (29)	50 (33)
>40 years	2 (14)	6 (16)	24 (75)	15 (79)	27 (100)	0	74 (49)
Land ownership							
Owner	14 (100)	32 (86)	30 (94)	19 (100)	27(100)	0	122 (81)
Non owner	0	4 (11)	2 (6)	0	0	21 (100)	27 (18)
Land exploited (ha)							
>0-5	7 (50)	12 (32)	29 (91)	11 (58)	24 (89)	14 (67)	97 (65)
>5-10	2 (14)	7 (19)	2 (6)	7 (37)	3 (11)	7 (33)	28 (19)
>10	5 (36)	18 (49)	1 (3)	1 (5)	0	0	25 (17)

Table 8: Cattle feedings practices in 6 study areas, Borgou district, Benin 2011 (*n*=150)

Number of farmers (%)							
Divisions	Nikki		Sinende		Kalale		
Subdivisions	Nikki centre (<i>n</i> =14)	Tasso (<i>n</i> =37)	Sekere (<i>n</i> =32)	Sikki (<i>n</i> =19)	Bouka (<i>n</i> =27)	Dunkassa (<i>n</i> =21)	Total (<i>n</i> =150)
Pasture location							
Far (>5 Km)	6 (43)	6 (16)	21 (66)	16 (84)	10 (37)	7 (33)	66 (44)
Close (<5 Km)	8 (57)	30 (81)	11 (34)	3 (16)	17 (63)	14 (67)	83 (55)
Feed storage Practice							
Yes	6 (43)	21 (57)	11 (34)	6 (32)	0	0	44 (29)
No	8 (57)	15 (41)	21 (66)	13 (68)	27 (100)	21 (100)	105 (70)
Transhumance							
Yes	6 (43)	5 (14)	32 (100)	17 (89)	16 (59)	0	76 (51)
No	8 (57)	31 (84)	0	2 (11)	11 (41)	21 (100)	73 (49)
Transhumance Season							
Dry season	6 (43)	5 (14)	2 (6)	0	16 (59)	0	29 (19)
Rainy season	0	0	0	0	0	0	0
Dry and rainy seasons	0	0	30 (94)	17 (89)	0	0	47 (31)

Table 9: Farmers' breeding and milk production practices in 6 study areas, Borgou district, Benin 2011 ($n=150$).

Number of farmers (%)							
Divisions	Nikki		Sinende		Kalale		
Subdivisions	Nikki centre ($n=14$)	Tasso ($n=37$)	Sekere ($n=32$)	Sikki ($n=19$)	Bouka ($n=27$)	Dunkassa ($n=21$)	Total ($n=150$)
Type of sires							
Borgou	11 (42)	36 (97)	26 (63)	16 (67)	20 (53)	21 (100)	130 (87)
Zebu	2 (8)	1 (3)	6 (15)	2 (8)	8 (21)	0	19 (13)
Milking frequency							
1 time	8 (57)	15 (41)	0	9 (47)	1 (4)	12 (57)	45 (30)
2 times	3 (21)	18 (49)	30 (94)	10 (53)	9 (33)	1 (5)	71 (47)
Variable	3 (21)	3 (8)	2 (6)	0	17 (63)	8 (38)	33 (22)
Debut of milking							
0-6 days after calving	4 (27)	2 (6)	25 (86)	19 (100)	22 (81)	3 (15)	75 (50)
1 week after calving	9 (60)	32 (91)	3 (10)	0	5 (19)	4 (20)	53 (35)
2 weeks after calving	2 (13)	1 (3)	1 (3)	0	0	13 (65)	17 (11)

Table 10: Comparison of seasonal rainfall patterns as perceived by Fulani farmers and meteorological station data in Borgou district, Benin 2011 (*N*=3 informant groups).

Seasons	Seasonal calendars data (<i>N</i> =3 informant groups)		Data from Weather station 2008-2010	
	Rainfall Median score	Median score as a proportion of total annual score	Mean rainfall (mm)	Rainfall as a proportion of total annual rainfall
Yanne (October-November)	0	0%	129.8	13%
Ceedu (December-April)	0	0%	74.5	7%
Seeto (May-June)	7	35%	220.8	21%
N'Dungu (July-September)	13	65%	621.5	60%

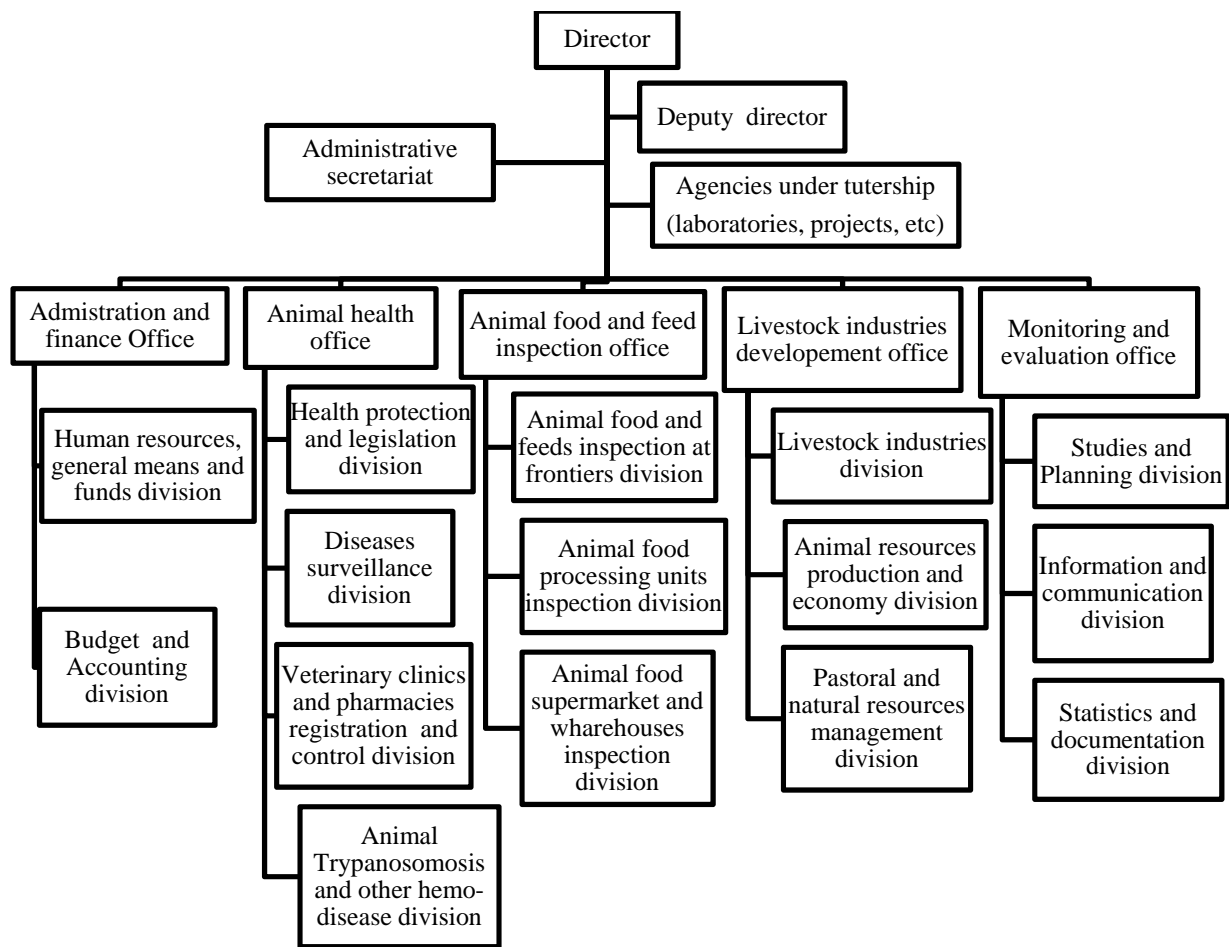


Figure 1: Hierachy of Livestock Department of Benin

Source: Benin Livestock Department 2010

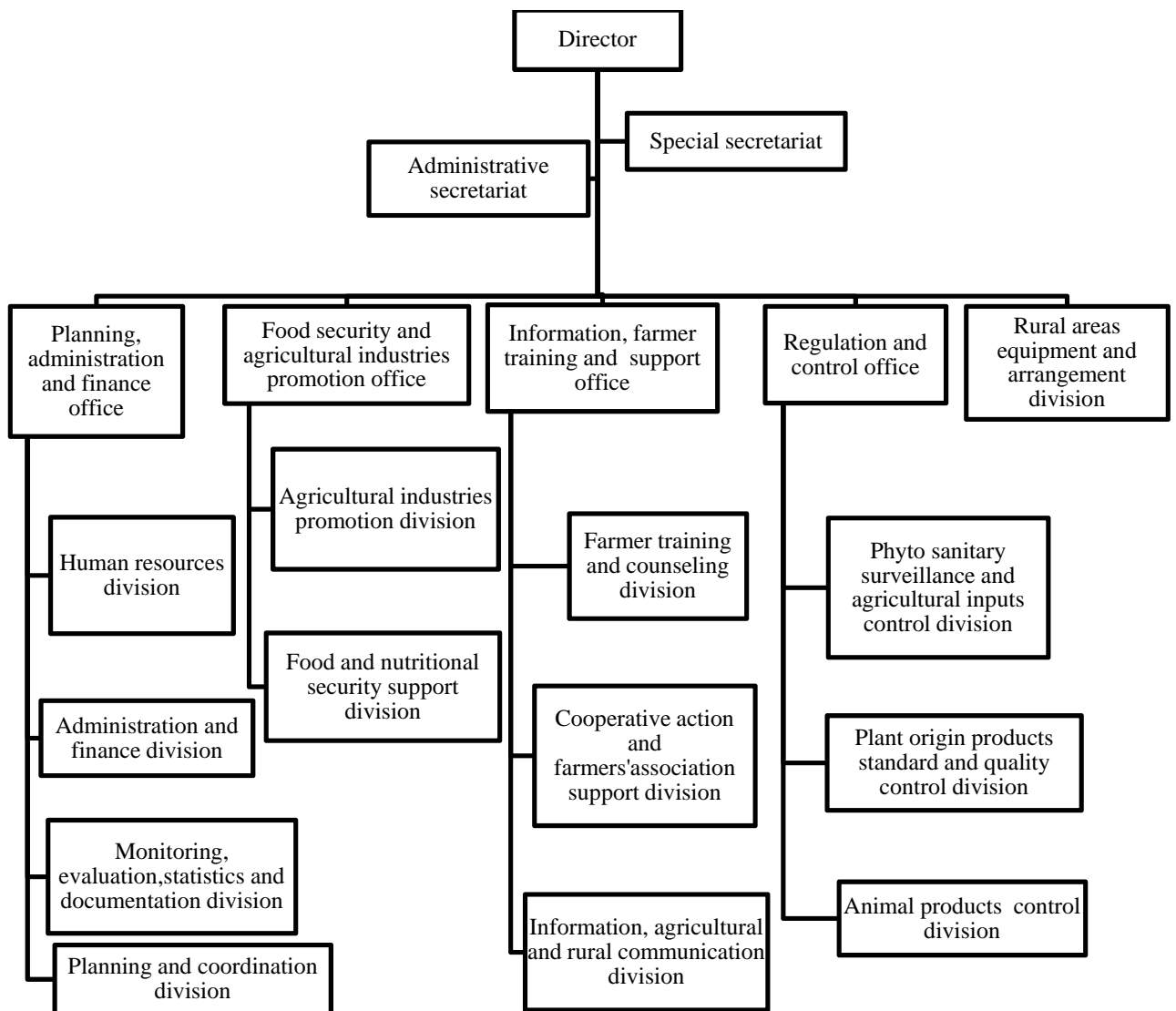


Figure 2: Hierarchy of Agriculture Promotion Regional Center–CeRPA

Source: Benin Livestock Department 2007

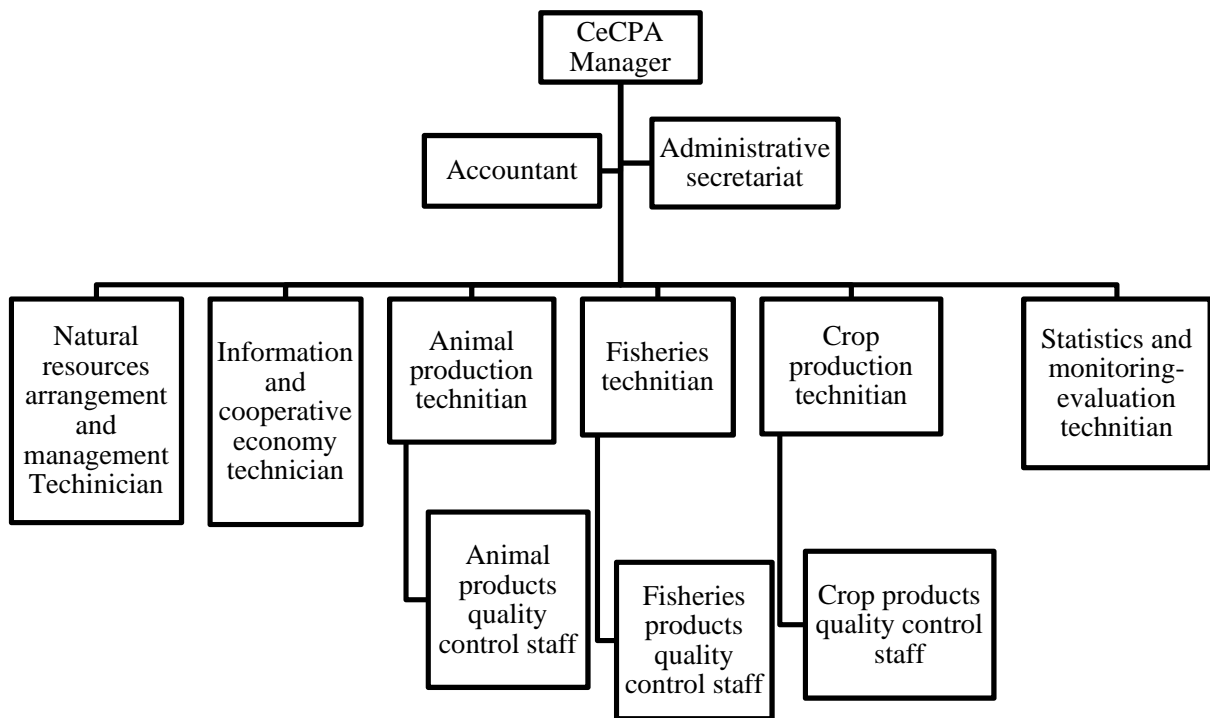


Figure 3: Staff of Agriculture Promotion Communal Center–CeCPA

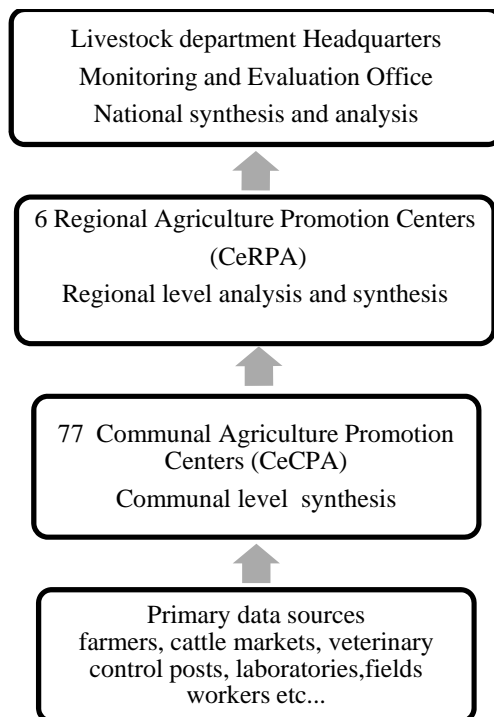


Figure 4: Information pathways of Benin Veterinary Services

Source: Benin Livestock Department 2008b

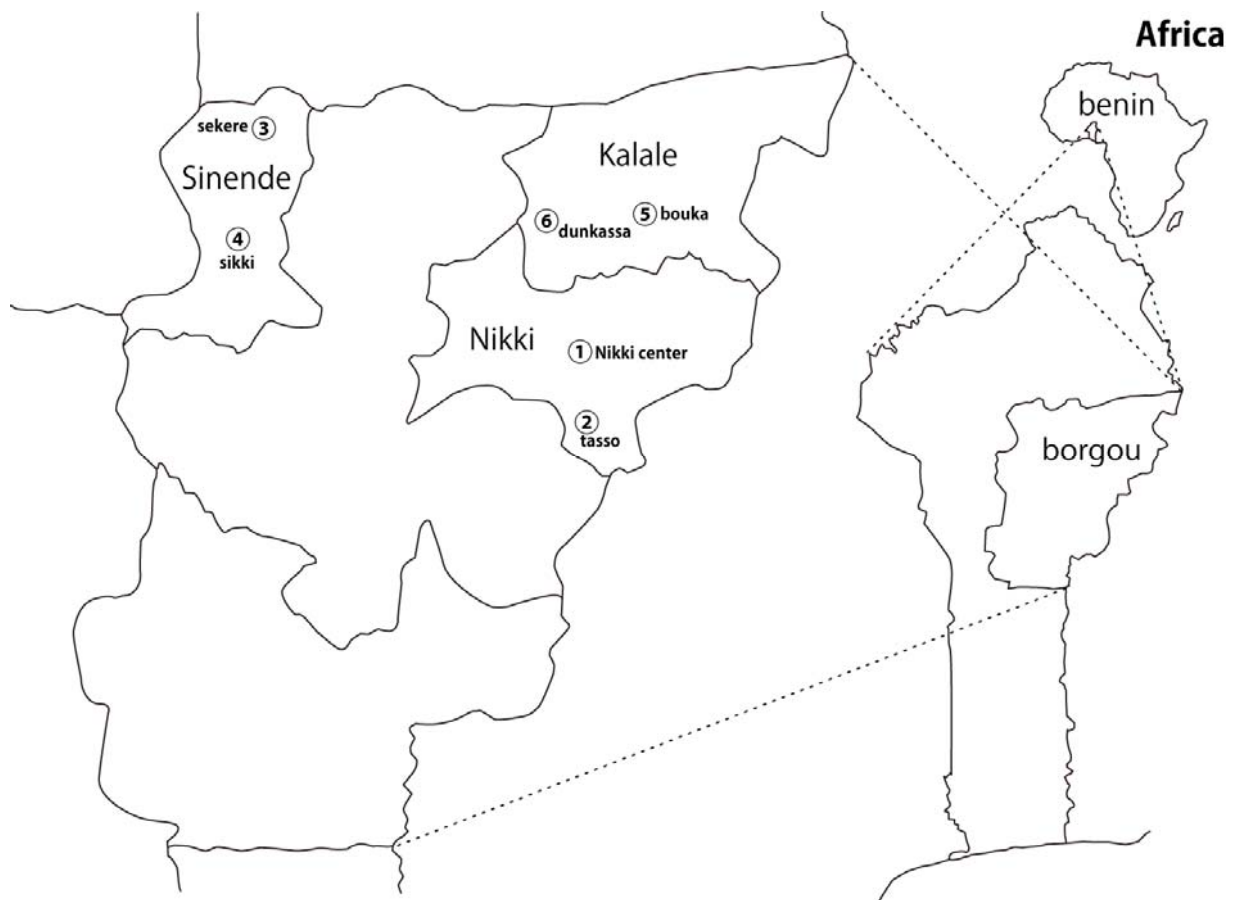


Figure 5: A map showing the study areas

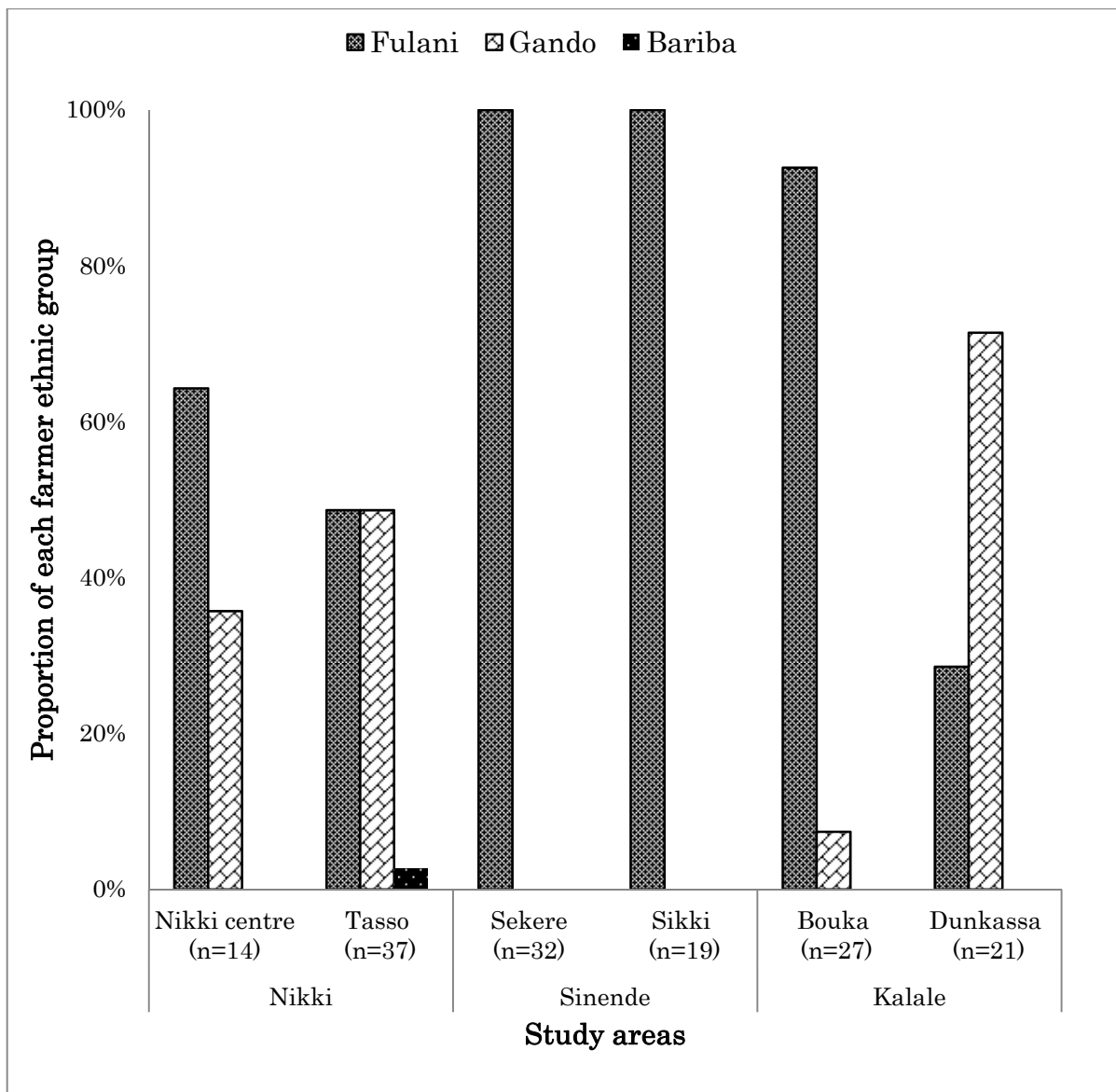


Figure 6: Ethnic group distribution of cattle farmers in 6 study areas, Borgou district, Benin 2011
(*n*=150)

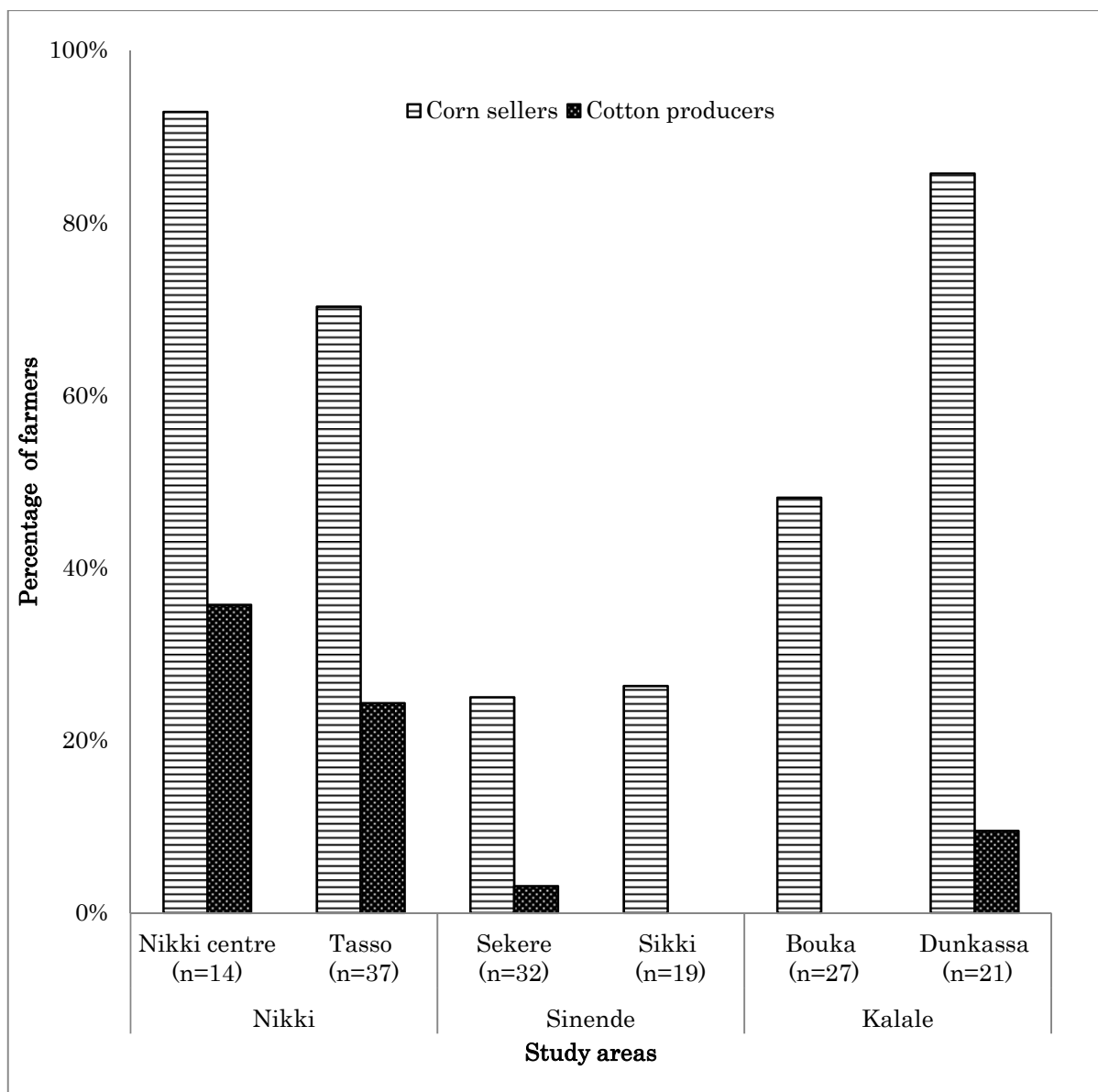


Figure 7: Proportion of maize sellers and cotton producers in 6 study areas, Borgou district, Benin 2011 ($n=150$)

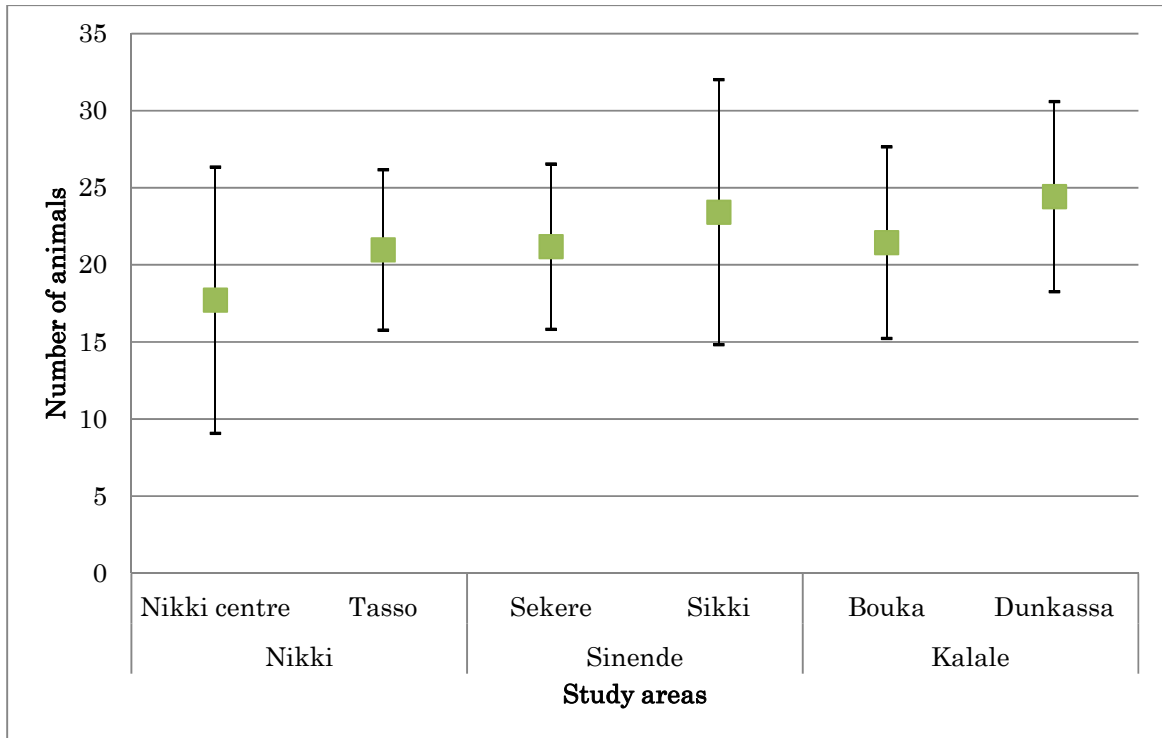


Figure 8: Comparison of average small ruminants flock size based on 95% confidence intervals in 6 study areas, Borgou district, Benin 2011 ($n=150$).

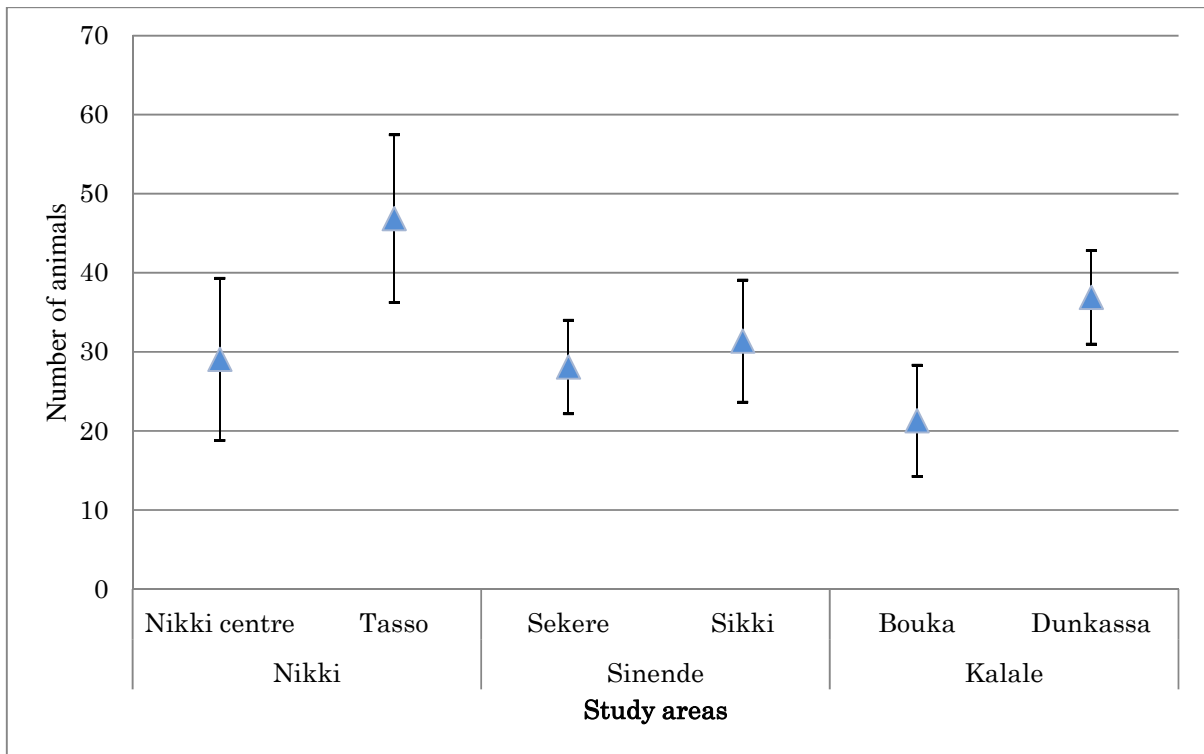


Figure 9: Comparison of average poultry flock size based on 95% confidence intervals in 6 study areas, Borgou district, Benin 2011 ($n=150$).

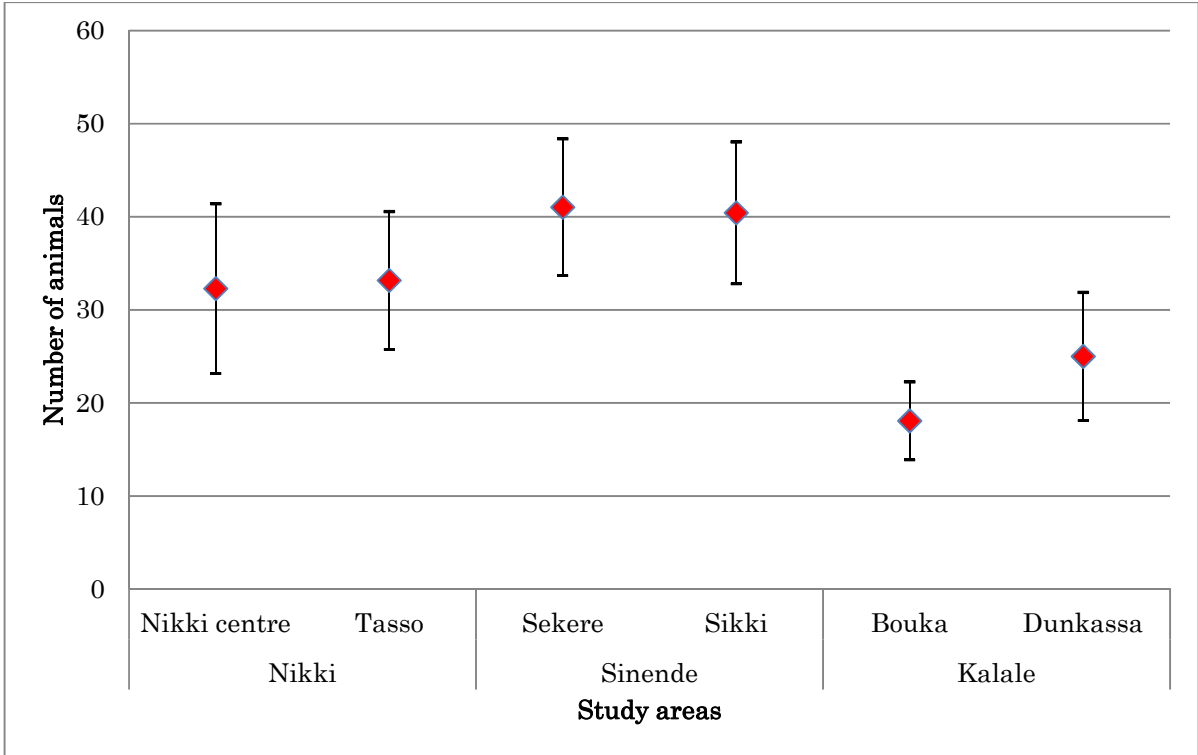


Figure 10: Comparison of average cattle herd size based on 95% confidence intervals in 6 study areas, Borgou district, Benin 2011 ($n=150$).

Fulani farm activities calendar				
	<i>Dugue gawori-daboune</i>	<i>Baatodi</i>	<i>Haoure nafa</i>	<i>Dengal</i>
	Sorghum harvest	Transhumance	Seedling	Weeding
Fulani seasons				
	<i>Yanne</i>	<i>Ceedu</i>	<i>Seeto</i>	<i>N'Dungu</i>
	October - November	December-April	May - June	July- September
Rainfall (Proportion of total annual rainfall) (W=1*)	0 (0-0)	0 (0-0)	●●●●● ●●●● 7 (7-8)	●●●●●●●●●● ●●●●●●●●●● 13 (12-13)
Pasture availability (W=0.91*)	●● ●● 4 (2-4)	0 (0-0)	●●●●● ●●●●● 8 (6-11)	●●●●●●●● ●●●●●●●● 10 (5-10)
<i>Maaso</i> Trypanosomosis (W=0.38 NS)	●●●●●●●● ●●●●●●●● 11 (3-12)	●●	●●●●	●●●● ●●
<i>Heree</i> Pasterellosis (W=0.69 NS)	●●	●●●●	●●●●●●●● ●●●●●●●● 11 (11-11)	●● ●●
<i>Tchaabou</i> FMD (W=0.47 NS)	●●●●	●● ●●	●●●● ●●	●●●● ●●
<i>Coneje</i> Brucellosis (W=0.33 NS)	●●●● ●●	●●●● ●●	●●●● ●●	●●●● ●●
<i>Boola^a</i> Skin disease	●●●●● ●●●●●	●●●●	●●●● ●●●●	●●●●
<i>Cooti^b</i> Ticks	●● ●●	●	●●●●●●●● ●●●●●●●● 8.5 (5-12)	●●●●● ●●●●● 7.5 (5-10)
<i>Boobi^b</i> Flies	●●●●	●●	●●●●● ●●●●● 7.5 (6-9)	●●●●● ●●●●● 8.5 (6-11)

Figure 11: Summarized seasonal calendar for rainfall, pasture availability, cattle diseases, ticks and biting flies in Borgou district, Benin 2011. N=3; W, Kendall's coefficient of concordance, the higher the value, the higher the level of agreement between the informant group (*p<0.05; NS: p>0.05). The black dots represent the median number of nickernuts used during the construction of seasonal calendars and show the level of association between a variable and the season. Numbers are medians and the minimum and maximum values are shown in parentheses. a: *Boola* was scored only in Bouka; b: Ticks were scored in Bouka and Nikki centre while flies were scored in Bouka and Sikki.

Annex 1

Study Village: Bet. Kal. Nik. Sin. Code : H-.....

Survey questionnaire for sedentary Fulani herders

Date: Hamlet /camp name: Ethnic group :(1) Fulani (2) Fulani Gando (3) Other

A. IDENTIFICATION AND DEMOGRAPHIC INFORMATION

1. Household's head name:

2. Contact address or Phone Number:

3. Birth place: (1) Current living place

(2) Other in Benin (3) Out of Benin. For how long have you been living here?.....Years

4. Age: Gender: (1) Male (2) Female

5. Household permanent size:

6. Main occupation: (1) Crops (2) Livestock raising (3) Other (Specify).....

7. Secondary occupation: (1) Crops (2) Livestock raising (3) Other (Specify).....

8. Main source of incomes: (1) Crops (2) Livestock raising (3) Livestock and crops (4) Other.....

9. Type of land ownership: (1) Own land (2) loan/lease (3) free usage (4) Other (specify)....

10. Size of land holdings:

11. Cattle ownership: (1) Individual (2) Family herd (3) Caretaking (4) Mixed

12. Years of experience in cattle rearing:

13. Educational level: (1) Zero (2) Koran school (3) Primary school (4) Secondary school or higher

14. Do you intend to live here longer? (1) Uncertain

(2) No. Why?

(3) Yes. Why? : (1) Enough water/forage (2) No Conflicts (3) Fertile Soils
(4) Good climate (5) few epidemics (6) Others

B. LIVESTOCK MANAGEMENT AND PRODUCTION SYSTEM

I- Production system

15. Which cropping activities have you been involved in the last 12 months?

Crops		Data of last cropping season		Size (ha)	Harvest	Sales
Cultivated Products	Cotton (hotollo)					
	Corn (kotokoliri)					
	Sorghum (ngauri)					
	Millet					
	Groundnuts					
	Beans					
	Rice					
	Yam (dondurre)					
	Cassava					
	Other					
Plantation	Fruits					
	Cashew nuts					
	Others					
Gardening :.....						
Forages :.....						

16. Do you use animal traction for crops production? (1) Yes . (2) No

17. Which type of cattle do you have in your herd? (1) Zebu (2) Taurine (3) Crossbred (4) Zebu+crossbred (5) Zebu and taurine (6) Crossbred and Taurine (7) Others

18. Except cattle are you raising any other livestock? (1) Yes .How many?.....
Sheep.....Goat....chicken.....Other

(2) No. **Why?**.....

II- Cattle herd inventory and structure

19. How many cattles do you have now in your herd for each age-sex group? :

Male/ category	Heads	Female /category	Heads
Calf		Calf	
Steer		Heifer	
Bull		Cow	
Oxen			
Total		Total	

20. How many calves were born alive between May 2010 and now? Number of them that died at this date?.....

21. Do you have part of your herd in another location? : (1) No (2) Yes.

III- Off take and in take

22. What could be reasons for purchasing cattle? : (1) Change bull (2) Replace sold animals (3) Improve herd (4) others (specify).....

23. Did you purchase any cattle during the last 12 months? (1) No. Why?

(2) Yes. **Animal purchase:**..... Calf ♂Calf ♀ Steer.....Heifers...Cow.....Bull.....Oxen.

24. What could be reasons for selling a cattle?: (1) Diseased animal (2) Surplus males (3) Old animal (4) Need of cash (5) others (specify)

25. Did you sell any cattle during the last 12 months? (1) No. Why?

(2) Yes. **Animal sale:** ... Calf ♂Calf ♀ Steer.....Heifers...Cow.....Bull.....Oxen.

26. Did you receive any cattle either as gift or care taking/exchange or loan during last 12 months?

(1) No.

(2) Yes. **How many?**

27. Did you offer (present, dowry, inheritance, care taking) any animal of your herd during the last 12 months?

(1) No.

(2) Yes. **How many?**

28. Did you slaughter any animal of your herd for house consumption during the last 12 months?

(1) No.

(2) Yes. **How many?**

29. Did you experience theft of animal the last 12 months? (1) No. (2) Yes. How many?

IV- Feeding Management

30. How do you feed your cattle in rainy season? (1) Grazing only (2) Grazing and browsing (3) Grazing, and crops residues (4) Grazing, browsing, and crops residues, (5) Others.....

31. How do you feed your cattle in dry season? (1) Grazing only (2) Grazing and browsing (3) Grazing, and crops residues (4) Grazing, browsing, and crops residues, (5) Others.....

32. How long time does it take from your house to the grazing areas used?Hours...minutes

33. Do you practice night grazing? (1) No (2) Yes. **If yes When :** (1) Dry season (2) Rainy season (3) Mixed

34. Do you use commercial feeds? (1) No (2) Yes. **If yes Which one?.....When?** (1) Dry season (2) Rainy season (3) Mixed

35. Do you provide mineral supplement do your cattle (1) No (2) Yes. **If yes Which one?..... When ?..**(1) Dry season (2) Rainy season (3) Mixed

36. Which class of animals receives feed supplements? : (1) Sick animals (2) Calves (3) Fattening (4) Lactating cows (5) pregnant cows (6) no one (7) All in the herd

37. How many times does your herd drink in a day? (1) One time (2) Two times (3) More than 2 times

38. Which water sources do you use for your herd? : (1) Borehole (2) River (3) dams (4) pool (5) Other (specify).....

39. How long does it takes from your house to the watering point that you often use?.....H

40. Do you practice transhumance? (1) No **Why?.....**

(2) Yes. **When do you practice transhumance? :** (1) Dry season (2) Rainy season (3) Dry and rainy seasons

Dry season: Departure (month): Return: Host area / location (km) :

Rainy season: Departure (month): Return: Host area / location

V- Management of reproduction

41. How do you breed the animals? : (1) Uncontrolled (2) Controlled (3) Others.....

42. Which sire mates with your dams?

(1) Unidentified

(2) My sire. **Number of breeding bull in herd?..... Breeds?.....Age?.....**

(3) Neighboring herd's sire. **Breeds?.....Age?.....**

(4) Transhumant herd's sire

(5) Others (Specify).....

43. How many years can you use the same sire?: (1) 1 Years (2) 2 years (2) more than 2 years

44. Do you have cases of infertility (old heifers) in your herd? (1) No. (2) Yes. **How many cows?.....**

VI- Milk production

45. Do you milk your cows? : (1) No. **Why?.....**

(2) Yes. **How often do you milk your cow a day?** (1) 1 time (2) 2 times (3) Variable: Dry season
...Rainy season

46. At what time do you milk your cows? (1) Morning (2) Afternoon (3) Both

47. What is the average milk production of a cow per day? In dry seasonL In rainy season....L

48. How long time after calving do you start collecting milk for your consumption?

(1) Just after calving (2) less than 2 weeks after calving (3) 2 weeks after calving (4) Other
(specify).....

49. When do calves start drinking milk? (1) Just after calving (2) less than 2 hours after calving (3) One day
after calving (4) Other (specify).....

50. How many months does the milk production of a cow of your herd last? :

51. How are your calves weaned? (1) Naturally (**Age?:.....**) (2) Controlled. (**Age?:.....**)

52. Do you have cases of mastitis? (1)No (2) Yes. **How many?.....**

VII- Animal health management

53. Did you have cases of abortions or stillbirth in your herd during the last 12 months? : (1)No

(2) Yes .**How many?** Abortion.....Stillbirth....

54. Did you have diseased animals during the last 12 months?: (1)No. (2) Yes. How many?.....

55. Did you have animals that die during the last 12 months? (1)No.

(2) Yes. How many?.....

	Suckling		Weaned Immature		Adult (>4 years)	
	♂	♀	♂	♀	♂	♀
Gender						
Total mortality						

56. What were the causes of animals' mortality for each age-group?

Mortality causes	Heads per Categories		
	Suckling	Weaned Immature	Adult (>4 years)
Perinatal mortality			
Diseases			
Starvation			
Diarrhoea			
Accidents			
Other (specify).....			
Total			

57. Do you vaccinate your herd? (1) No .Why?.....

(2) Yes. **How often?** (1) Every year (2) Every two years (3) Other (Specify).....

58. Do you protect your herd against gastro intestinal worms?

(1) No, **Why?**.....

(2)Yes. **Which animal do you protect?** (1)All the herd (2) Sick animals (3) Calves (4) other.....

How? (1) Veterinary drugs (2) Traditional drugs (3) Other

When and how often ?

59. Do you protect your herd against ticks and fleas ?

(1) No, **Why?**.....

(2)Yes. **Which animal do you protect?** (1)All the herd (2) Sick animals (3) Calves (4) other.....

How? (1) Spray (2) Dipping (3) Traditional method (4) other.....

When and how often ?

60. Are there any other measures you use to protect your herd from disease? (1) No. (2)Yes. **Which one?**.....

61. Who treat diseased animals of your herd?: (1) Veterinary assistant

(2) Me /family (3) Experienced herder (4) others.....

How are treated diseased animals? (1) Only traditional medicine

(2) Veterinary drugs. **Suppliers?** (1) Pharmacy (2) Market (3) Other.....

(3) Traditional medicine and veterinary drugs

C. ACCESS TO EXTENSION SERVICES

62. Are you member of a herder association? (1) No .Why?.....

(2) Yes. **Which one?** :.....

63. Do you receive advice or support from any government services or NGO?:

(1) No

(2) Yes. **Which one?**

Which kind of advice do you receive?

64. How do you improve your knowledge on cattle farming? : (1) Experience (2) Relatives/friends (3) veterinary drugs salesman (4) Extension/Veterinary services (5) cattle salesman (6) Other.....

65. Have you ever attended a livestock rearing training session? (1) No (2) Yes.

Would you like to attend a training session on livestock rearing technique? (1) No. (2) Yes. **Which topic would like to be trained about?**.....

66. Do you have any topic you wanted to talk about and that was not treated during this interview?

(1) No. (2) Yes. **Would you mind telling me?**

Question to the person in charge of collected milk distribution:

1) How do you utilize the produced milk?:

(1) House consumption

(2) Sale. **Average quantity of milk sold per day?** In dry seasonIn rainy season...

(3) Donation

(4) Other.....

Farmer signature

Summary

Concerning livestock development in Benin, failure of attempts to introduce new breeds/techniques from developed countries has been recognized and traditional farmers' knowledge in livestock farming is nowadays widely acknowledged. A better understanding of characteristics of traditional farming system will contribute in identifying needs in trainings and how to merge farmers' knowledge and veterinary science for better disease control and management.

Borgou District, located in the North-Eastern part of Republic of Benin, fits the practice of livestock as well as crop farming due to its semi-tropical climate. In this study, I aimed to describe the cattle farming practices in the district. Using a questionnaire and participatory rural appraisal methods, a cross-sectional survey was conducted in three divisions of the district from May to June in 2011. Within each division, two subdivisions were visited and a total of 150 cattle farmers were interviewed.

The majority belongs to Fulani tribe. In addition, the Gando tribe, originally crop farmers, were among the interviewees. Livestock rearing was the main occupation in Fulani and Fulani-Gando areas. The average cattle herd size was higher in Fulani dominated areas. The practice of dry- and rainy-seasons transhumance were common in Fulani dominated areas, while dry-season transhumance was common in Fulani-Gando areas, and it was inexistent in Gando dominated area. Diseases such as trypanosomosis and pasteurellosis appeared to be an important constraint and their seasonal distribution varied from area to area. All farmers were aware of the importance of animal health care. However, the health care practices were influenced by the cultural background. Fulani farmers rely on traditional methods for ticks' prevention, and despite of their ethno-veterinary knowledge, use government veterinary services when available and assist in training sessions on cattle management. On the other hand, herds' care relies on veterinary assistants, and farmers never attended training at a Gando dominated area. Fulani showed signs of long term sedentarisation and some of them were involved in market orientated crop farming. The Gando has increased their knowledge on cattle farming and introduced to Fulani the practice of crops farming. Cattle farming practices in two tribes are getting similar, and it seems they have been evolved into a unique system suitable for their environmental conditions.

要旨

ベナン国ボルグ県における伝統的な牛飼育管理方法

ベナン国における畜産開発事業では先進国からの技術が一方的に導入される場合が多く、あまり成果を上げていない。伝統的飼育方法に関する知識の重要性が再認識され、生産者のニーズをすくい上げ、彼らの知識と経験をベナン国の畜産開発に利用することが求められている。本稿では、ボルグ県における伝統畜産農家実践している牛の飼育管理方法を記述する。

ベナン国北部に位置するボルグ県は、亜熱帯性気候に恵まれ、家畜飼育だけではなく作物生産も盛んである。2011年の5月から6月にかけて現地を訪問し、横断研究を実施した。質問票と参加型手法を使い、3つの郡から各2地域、

計6地域を訪問し、150の牛飼育農家から情報を収集した。

牛農家のほとんどがフラニ族だが、農耕民であるガンド族も牛を飼育していた。フラニ族だけの地域とフラニ・ガンド両族が住む地域では畜産が主要な収入源であった。フラニ族が多く棲む地域のほうが牛の平均飼育頭数は多かった。家畜の季節移動は、フラニ族は季節にかかわらず、フラニ・ガンド両族の地域では乾季だけ、ガンド族だけの地域ではまったく実施されていなかった。トリパノゾーマ症や出血性敗血症などの疾病も重要な阻害要因であるが、地域により発生頻度が異なっていた。通常フラニ族は伝統医療方法を使い自らの牛を治療するが、政府の獣医サービスの恩恵を受けることもあるし、普及教育の手伝いをすることもある。一方、ガンド族は政府職員に頼りきりで、自らでは治療は行わず、政府の普及事業にも参加していなかった。しかしながら、ボルグ県では、フラニ族が4世代にわたり住みつくなど定住化が進み、商業ベースの作物生産も行っている一方、ガンド族は牛飼育に関する知識と経験を増し、フラニ族に作物生産技術を伝授したりしている。このように、両部族が得意な分野を互いに学びあいながら、環境に適応させたユニークな農業活動を実践していることが観察できた。