GENETIC PREFERENCES OF SMALLHOLDERS AND TRYPANOTOLERANT CATTLE IN SOUTHERN BURKINA FASO

BY
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A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirements of the degree

of

DOCTOR OF PHILOSOPHY

ABSTRACT

This study investigates livestock owners preferences for cattle characteristics in southern Burkina Faso. The most important animal traits were identified using focus group interviews with cattle owners, recommendations from animal scientists and formal surveys. Preferences were assessed using ranking and rating schemes and conjoint analysis. Baoulé, Zebu and Méré were the breeds of cattle raised in the area.

Focus group interviews and recommendations from animal scientists provided seven traits of bulls and seven traits of cows. The most ranked traits for bulls were fitness to traction, disease resistance, selectivity in feed and temperament. The most highly ranked traits of cows were fecundity, milk yield and disease resistance.

Producer survey data indicated three main production systems and various herd structures. Survey data also indicated that Baoulé were preferred to Zebu and Méré only in disease resistance and grazing habits while Zebu were preferred to Baoulé in several traits such as milk yield, size, fecundity, weight gain and traction ability.

Assessment of farmers' preferences for Baoulé showed that involvement in subsistence system, being an indigenous farmer and the fact that some farmers regarded Baoulé as having an "overall desirability" relative to Zebu and Méré were significant determinants of the adoption of Baoulé.

Finally, conjoint analysis provides partworths for the levels of traits and the relative importance of the traits considered in the study. Disease resistance, good fitness to traction and high fertility were the most preferred traits of bulls while fecundity, disease resistance and feeding ease were the most important traits for cows. Weight gain and milk yield were less preferred.

This study results indicate that the potential role for an effective genetic research for livestock development in the area needs to use a participatory approach so as to integrate farmers' preferences in the breeding program.

The use of conjoint analysis can also help design more effective livestock breeding programs. The increasing adoption of Zebu may indicate the need for breed improvement schemes focussing on ways of adapting traits of Zebu by crossbreeding Zebu with trypanotolerant breed such as Baoulé.

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Chapter 1

Introduction

1.1 Cattle production in West Africa

The share of livestock production in the contribution of agriculture to total Gross Domestic Product (GDP) was about 12% for sub-Saharan Africa in 1994 (World Bank, 1996). Over the 1990-95 period, total production of cattle, sheep, goats and chickens of sub-Saharan Africa represented about 14% of the world production (FAO, 1996). This relative low performance of livestock production systems in sub-Saharan Africa contrasts with the potential role that livestock play in most economies. In general, the importance of livestock in agricultural and rural economies goes beyond the provision of food and income to include various uses such as draught power, transport, manure for crop production as well as social and cultural uses (dowry, funerals and sacrifices).

Animal health is one of the major constraints to increasing livestock production in developing countries. Disease-related problems range from direct losses through deaths and reduced performance to the opportunity cost of not using all available resources in areas of disease prevalence. In sub-Saharan Africa, losses due to diseases may be equal in value to one quarter of the regional annual total animal production (ILRI, 1996).

Until the mid-1970s most livestock in sub-Saharan Africa were kept in the arid and semi-arid zones, away from the wetter sub-humid and humid zones (map 1.1). The arid and semi-arid zones cover 46% of total lands of sub-Saharan Africa and contained 51% of cattle, 57% of sheep and 64% of goats of the region (de Leeuw et al., 1995). In the northern two agro-ecological zones, rainfall precludes reliable cropping and limits the land carrying capacity for livestock.

Livestock management systems are generally extensive and most livestock, particularly cattle, are kept in a constant search of pasture and water. Although most farmers own various types of livestock (poultry, goats, sheep, cattle, donkeys etc), cattle production is the main activity in west African pastoral societies. In these communities, cattle are usually under the management of a member of the stock-owning family or a hired herdsman. During the rainy season, animals graze on local communal and open lands. In the dry season, the shortage of water and pasture makes it necessary for the herdsmen to travel with their animals south into the humid and sub-humid zones. Animals are herded back to their local area at the end of the dry season. This seasonal move in search for pastures in the humid zone by pastoralists is known as transhumance.

The reason why most livestock in sub-Saharan Africa were kept away from the sub-humid and humid zones is that these regions are infested with the tsetse fly, a blood-sucking dipteran insect that transmits African Animal Trypanosomosis (AAT). In cattle, AAT causes poor growth, low milk yield, weight loss, reduced work capacity, infertility, abortion and death. On the African continent, the distribution of tsetse flies exceeds 7 million Km^2 and seems to be closely related to relief, hydrography, climate and vegetation. The presence of trypanosomosis in an area generally leads to deaths of animals as well as to an under-exploitation of natural resources. Thus, a lower level of livestock production occurs than could be achieved if the disease were eliminated. Trypanosomosis has, therefore, a significant economic and sociological impact on communities in the humid and sub-humid zones of Africa.

Until the mid-1970s, the geographical distribution of cattle breeds in Sub-Saharan Africa showed predominance of the taurine and trypanotolerant breeds in the humid and sub-humid areas while trypanosusceptible breeds (generally, *Bos indicus* breeds such as Zebu) dominated in the drier arid and semi-arid areas. The taurine cattle are derived from the humpless cattle (*Bos taurus*) which appeared in ancient Egypt in the middle of the second millennium B.C. and were introduced in West Africa during the second half of the first millennium B.C.(Rege et al., 1994). The taurine cattle can be divided into two main subgroups including the Longhorns (*Bos taurus longifrons*) which are represented by only two breeds (N'dama and Kuri) and the Shorthorns (*Bos taurus brachyceros*) represented by various breeds (Rege et al., 1994). Taurine cattle are reported to survive and be productive in areas of low to moderate trypanosomosis risk without the aid of drugs. For this reason they are known as trypanotolerant cattle. They are also reported to have superior levels of resistance to other diseases (streptothricosis, tick-borne diseases, helminthiasis) as well as abilities to be productive under conditions of high humidity, heat stress, water restriction and poor quality feed (Murray et al., 1990; d'Ieteren, 1994; Rege et al., 1994).

Taurine cattle are found in pockets across the sub-humid and humid zones of West and Central Africa (Jabbar et al., 1997). In West Africa, they are found in southern Mali, across the southwestern Burkina Faso and in central and northern Côte d'Ivoire. They were introduced in some countries in Central Africa: the Democratic Republic of Congo in 1904, in Gabon in the 1940s and in the Central African Republic from 1955 to 1979 (Felius, 1995; FAO, 1980; Jabbar et al., 1997).

Several changes that occurred in West Africa over the last twenty years affected the traditional distribution of cattle and resulted in a large and permanent influx of cattle into the sub-humid zones from the northern arid and semi-arid zones. This was essentially due to increased population pressure and successive droughts in the arid and semi-arid zones of the mid-1970's, which forced an increasing number of pastoral Fulani to extend the length of their seasonal transhumance and relocate with their trypanosusceptible cattle into the more humid, tsetse-infested zone.

This change in the distribution of livestock and people had two main impacts on livestock development in the region. First, the proportion of pure trypanotolerant cattle in the herds in the sub-humid zone across West Africa decreased significantly. For example in southwestern Nigeria, from a situation in the 1960s in which most of the cattle were of the trypanotolerant breeds, it was estimated in 1985 that 78% of cattle were of trypanosusceptible breeds (Akinwumi and Ikpi, 1985). Second, land and bush clearance for agriculture by increasing population and specialized tsetse control programs that occurred in the sub-humid zone had made the local environment less hospitable for the tsetse flies and facilitated the settlement of Fulani herders and ultimately provide a strong potential for livestock development in the region.

Over the years the settlement of Fulani pastoralists and various disease management programs in the sub-humid zone have resulted in the emergence of areas of breed overlap where trypanotolerant and trypanosusceptible breeds of cattle and sheep are raised in the same geographical area but under different production and management systems. For example, by the mid-1980s, Zebu cattle which were traditionally restricted to grazing areas outside the tsetse fly zone of West Africa ranged as far south as the tsetse-infested northern Côte d'Ivoire (Bassett, 1986).

1.2 Cattle breeds and disease management in southern Burkina Faso

Burkina Faso is a landlocked country in West Africa bordered by Côte d'Ivoire, Mali, Niger, Ghana, Togo and Benin (map 1.2). The total area is 274,200 square kilometers and the population was over 10 million in 1996. Burkina Faso can be divided into three climatic zones, the sahelian zone, the sudano-sahelian zone and the sudanic zone (map 1.3). The sahelian zone covers about 25% of the country in the north and is very dry with annual rainfall of less than 600 mm and a short rainy season (two months). The sudano-sahelian zone covers about 50 % of the total land and has a rainy season of five to six months (March through August) which allows cropping of millet and sorghum. The sudanic zone is the southern and more humid part of the country with annual rainfall of 1300 mm and an even longer rainy season (March through October) which allows farmers to grow a wide range of cereals, yams and cotton.

Livestock production is an important activity in the country as it involves about 35% of the population; livestock contributed for about 12% to GDP and represented 26% of the volume of total exports and 14% of the value of exports (Caisse Française de Développement, 1995). Total cattle population was 4,341,200 head in 1995. While raising animals is a common activity, most of the livestock are found in the sudano-sahelian and sudanic zones.

The sudanic zone is characterized by a high annual rainfall and a longer cropping season (six months); mixed crop farming provides an opportunity for livestock development in the zone. The success of cotton production, introduced in the region in the 1970s had helped stabilize the rural population in a country which traditionally exports its labour to neighbouring Ghana and Côte d'Ivoire.

As a result of these factors, and in contrast to the rest of the country, the southern region consisting of the following six provinces Kossi, Mouhoun, Houet, Kennedougou, Bougouriba, Comoé and Poni had been experiencing a low rate of out-migration and a steady in-migration from the northern provinces of Sourou, Yatenga, Sanmatenga and Boulkiemdé (map 1.4). The proximity of Ghana and Côte d'Ivoire, net livestock deficit countries, provides a strong incentive for livestock production in the region.

There are three main types of cattle owners in the study area. These include crop farmers who own cattle as a supplementary activity. Some of them use cattle for traction and some of their animals are entrusted with Fulani herders. Cattle owners also include various civil servants, city workers and traders who own animals managed by Fulani herders. In contrast to the crop farmers who are familiar with cattle production (they actually keep some of their animals), this second type of cattle owners just own the cattle as they are seldom involved in cattle production. The last group of cattle owners is made by pastoral Fulani whose primary activity is to raise cattle. They migrated in the area in search for pasture and they usually live in separate camps away from the indigenous farmers. They usually settled in the areas with the help of government livestock extension services without the consent of the local population, which is a source of serious conflicts between the two communities.

The southern region is also an area of breed overlap where three main breeds of cattle are raised. These are Baoulé, Zebu and Méré (Méré are Baoulé x Zebu crossbred cattle). The Baoulé is a Shorthorn humpless small animal with a good conformation. Baoulé cows are 90-100 cm in height and weigh 150-200 kg while bulls stand 100-110 cm at the withers and weigh 230-300 kg. The head is massive, the horns short and the coat color varies between black and black pieds with coloured feet (Felius, 1995). Age at first calving is about 52 months, calving interval is about 19 months and milk production is between 120 and 390 kg in a lactation period of 280-350 days (CIRDES, 1995; Felius, 1995).

The second breed found in the region is the Fulani Zebu, a humped (*Bos indicus*) tall, well muscled, symmetrical in appearance and with long lyre-shaped horns. The hump is more prominent in bulls than in cows. Body weight for cows ranges between 300 and 400 kg with height at the withers between 137 and 143 cm (Joshi et al., 1957). Zebu cattle were normally found in the arid and semi-arid zones where they were herded by Fulani under extensive management systems. Calving interval is estimated to be 15 months, the age at first calving is about 45 months and milk production is between 450 and 500 kg in a lactation of 185 days (Joshi et al., 1957; Felius, 1995; CIRDES, 1996).

The third widely raised breed in the region is a Baoulé x Fulani Zebu stabilized crossbred cattle called Méré. In practice, Méré cattle represent various types as the term is commonly used for any crossbred cattle between Savanna Shorthorn humpless and Fulani

Zebu (Felius, 1995). They are found across the northeast of Côte d'Ivoire and the adjoining southwestern Burkina Faso. Méré are smaller than Zebu cattle and the coat colour is mostly black. They may have a hump or not. Calving interval is about 15 months, the age at first calving is about 47 months and milk yield about 535 kg in a lactation period of 250 days (CIRDES, 1995; Felius, 1995).

Based on production index constructed as the number of calves per cow, Baoulé cattle have been found to be less productive than Zebu and Méré. Indexes were 0.4 for Baoulé and 0.5 to 0.6 for Zebu and Méré (CIRDES, 1995). Along with the poor production parameters presented earlier, this low production index explains why Baoulé, despite its trypanotolerance, may not be attractive to cattle owners. Alternative cattle would be Méré and Zebu. Méré would be preferred over Zebu because, as a Baoulé x Zebu crossbreed, they are believed to combine trypanotolerance of Baoulé and the large size of Zebu cattle. Méré may, therefore, represent the ideal breed for a significant expansion of cattle production in areas of high to moderate tsetse threat like the sub-humid zone where use of tolerant breeds potentially reduces the cost of trypanocidal drugs. For this reason the number of Méré cattle as well as their share in the breed composition of herds has been increasing over the last decade in the sub-humid zone (Felius, 1995).

In a study of cattle production under village conditions in southern Burkina Faso, CIRDES (1996) showed that the number of Méré calves has increased from 23% in 1991 to 41% in 1993 for all calves born in sample herds. The increase in Méré was associated with a decrease in Baoulé from 48% to 36% and in Zebu from 29% to 23% over the same period. This same trend has been observed elsewhere in the tsetse fly zone. A study of cattle production in traditional systems conducted in southern Nigeria found a large shift away from the indigenous and trypanotolerant Muturu to the exotic and trypanosusceptible White Fulani (Jabbar et al., 1997).

1.3 Problem statement

A set of complex factors such as the settlement of Fulani pastoralists, the changes in resource availability, an increased demand of livestock products in the coastal countries (Ghana, Côte d'Ivoire, Togo, Benin) and the differential access to curative and preventive trypanocidal drugs seem to be responsible for the ongoing changes in the breed composition of the herds in the area.

The current status of this process and the possible future trend in the distribution of the breeds need to be assessed because, for cattle development to expand in the area, the main factors that determine the current breed composition of herds need to be identified and evaluated. What are the main cattle production systems and the major herd structures? What are the main functions of livestock and the main reasons for raising cattle? Does the existence of various breeds in the area mean that farmers have to choose between trypanotolerant cattle and susceptible breeds? Which breed is the most preferred breed and why? Is there any real threat of extinction of the indigenous Baoulé?

The considerations raised above will provide the guidelines for the study of farmers' breeding practices and breed preferences in southern Burkina Faso. Results of this study would help understanding the relative importance of Baoulé, Méré and Zebu in the area and the likely future trend in their distribution. Knowledge of the main reasons for raising cattle and farmers' perceptions of the strengths and weaknesses of each breed would also provide valuable information for the design of more focused scientific research and appropriate cattle development strategies.

1.4 The Collaborative Program on Trypanosomosis and Objectives of the Current Study.

1.4.1 The Collaborative Program

The issues raised above motivated a study of breed preferences and breeding practices among cattle producers in southern Burkina Faso. The research was an integral part of the Collaborative Research Program on Trypanosomosis and Trypanotolerant Livestock funded by the European Union. Participating research institutions included the International Livestock Research Institute (ILRI), based in Nairobi (Kenya), the Centre International pour le Développement de l'Elevage en zone Sub-humide (CIRDES), based in Bobo-Dioulasso (Burkina Faso) and the International Trypanotolerance Centre (ITC), based in Banjul (The Gambia).

The International Livestock Research Institute was created by the Consultative Croup on International Agricultural Research (CGIAR) in 1995 with a global mandate to conduct strategic research on livestock, following the merger of the International Livestock Centre for Africa (ILCA) and the International Laboratory for Research on Animal Diseases

(ILRAD). CIRDES and ITC are both regional centres specialized in carrying out research on trypanosomosis and related diseases in West Africa.

In the Collaborative program, ILRI was responsible for socio-economic research to be carried out in five research projects in Burkina Faso, The Gambia and Côte d'Ivoire:

1. Socio-economic evaluation of the costs, benefits and impacts of tsetse control. This sub-program considers tsetse control techniques that have been proven to be technically effective in the region and evaluates their costs and benefits (private and social), the willingness of the beneficiaries to contribute to the services, the institutional needs and their impacts on human welfare and resource availability and resource use.
2. Identification and evaluation of the factors affecting livestock owners' breeding practices and breed preferences. The primary objective is to assess farmers' breed preferences and the factors explaining these preferences.
3. Economics of nutrition interventions. The objective is to evaluate the costs and benefits of alternative strategies for improving the nutritional status of cattle and identify the constraints to optimal allocation of available feedstuffs.
4. Economic analysis of strategies for controlling helminths. This sub-program is intended to specify a computer-based model to be used for the evaluation (costs and benefits) of alternative strategies for controlling helminths.
5. Trypanotolerant livestock disease control policies and programs within livestock development in West Africa. The objective is to evaluate patterns of livestock development, human demography and settlement, livestock diseases and land use in

West Africa. In addition the program will carry out a study to assess the macroeconomic conditions, sectoral policies and livestock diseases control strategies.

1.4.2 Objectives of the current study

The current research is a contribution to the second research project. Its general objective is to provide a better understanding of cattle production systems and relevant factors explaining breed choice behaviour of cattle owners in the tsetse affected region of southern Burkina Faso. The specific objectives of this study are to:

1. Identify and evaluate the criteria that farmers in southern Burkina Faso use to evaluate cattle of different breeds.
2. Evaluate the relative weights these farmers place on the criteria when they make decisions about breeds and factors affecting breed choice.
3. Test alternative methods for assessing farmers' preferences.

This research will examine the main policy implications of the study results in reorienting breeding research towards objectives and goals more relevant with farmers' motivations and aspirations.

Data used in this study were generated from a series of surveys: (1) a preliminary survey designed to provide the initial and background information needed for the entire study, (2) a baseline survey to collect data on production systems and breed preferences and (3) a conjoint survey to collect data on farmers' assessment of pre-specified cattle profiles.

Given that most farmers only speak their local languages, data collection procedures involved the use of (1) visual aids to help in the evaluation of cattle traits and profiles, (2) local names of breeds and (3) enumerators able to speak French, the official language in Burkina Faso and the local languages spoken in the study areas.

1.5 Organization of the study

The study contains five chapters. Chapter two describes cattle production and breeding practices and evaluates farmers' preferences for the breeds. This description highlights the relative importance of the main breeds raised in the area, cattle ownership, production and management systems, major motives for raising cattle and the impacts of pastoral Fulani settlement in the region on production systems and herd structure. The chapter also investigates farmers' breed preferences using a set of traits describing various main aspects of cattle production. The method of matrix rating was employed to provide a quantitative assessment of farmers' breeds preferences. The results of this assessment are compared to the results of a direct questioning of farmers about the advantages and disadvantages of each breed.

Chapter three uses a discrete choice model to study how socio-economic and environmental factors affect the choice of trypanotolerant cattle by farmers. Key factors that are examined include main characteristics of trypanotolerant cattle as perceived by farmers, factors related to production and management, and farmers' characteristics. Expected results are very important as they would help explain why despite various weaknesses, Baoulé cattle are kept by farmers. This would help assess the actual demand for Baoulé in the area.

Chapter four uses conjoint analysis to measure relative values placed by farmers on the traits identified in chapter two. The technique uses pre-defined levels of the traits to construct a set of cattle profiles. Characteristics of the profiles and farmers' rating of the profiles are used in an Ordered Probit estimation procedure to determine the marginal values of the traits included in the study. The relative magnitude of the marginal values express farmers' preferences for the selected traits. Based on the fact that preferences stated by farmers for a given breed can be decomposed into marginal values for the traits used to describe the breed, conjoint analysis will provide measures of farmers' preferences for the traits of cattle derived from a decision making process similar to a real world setting characterized by trade-offs. Conjoint analysis results are much stronger than the self-explicated preferences identified in chapter two because the later were based on decision making focusing on single traits (Weiner, 1993).

The main conclusions of the study and the policy implications of the results are presented in chapter five.

The dissertation is organized according to the paper format where individual chapters are presented as separate papers.

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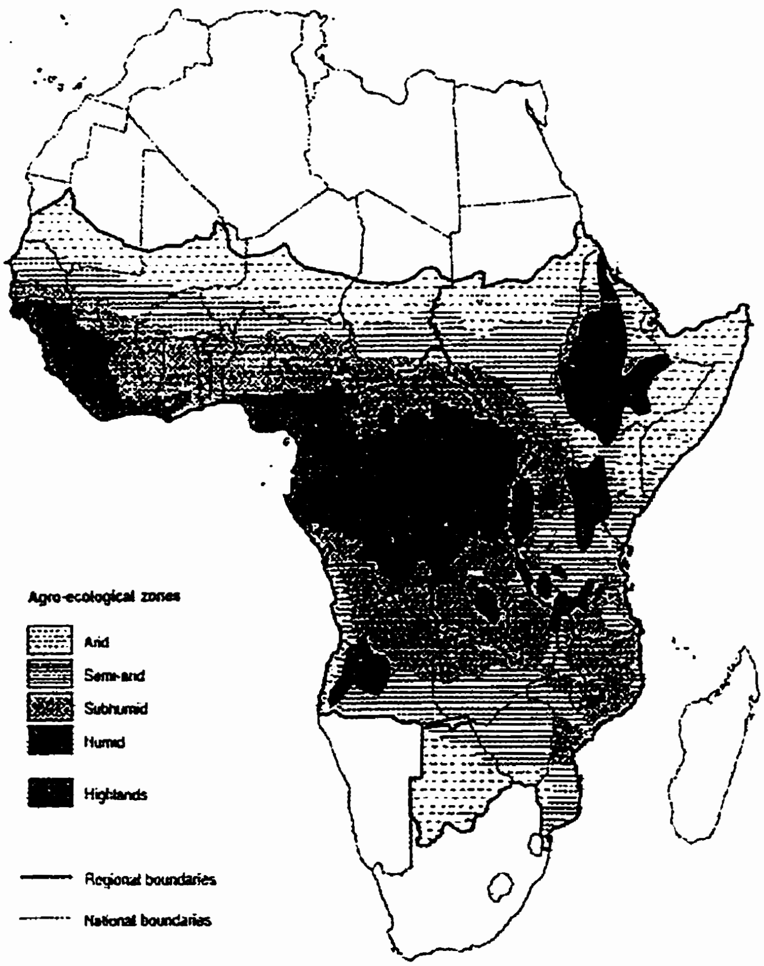
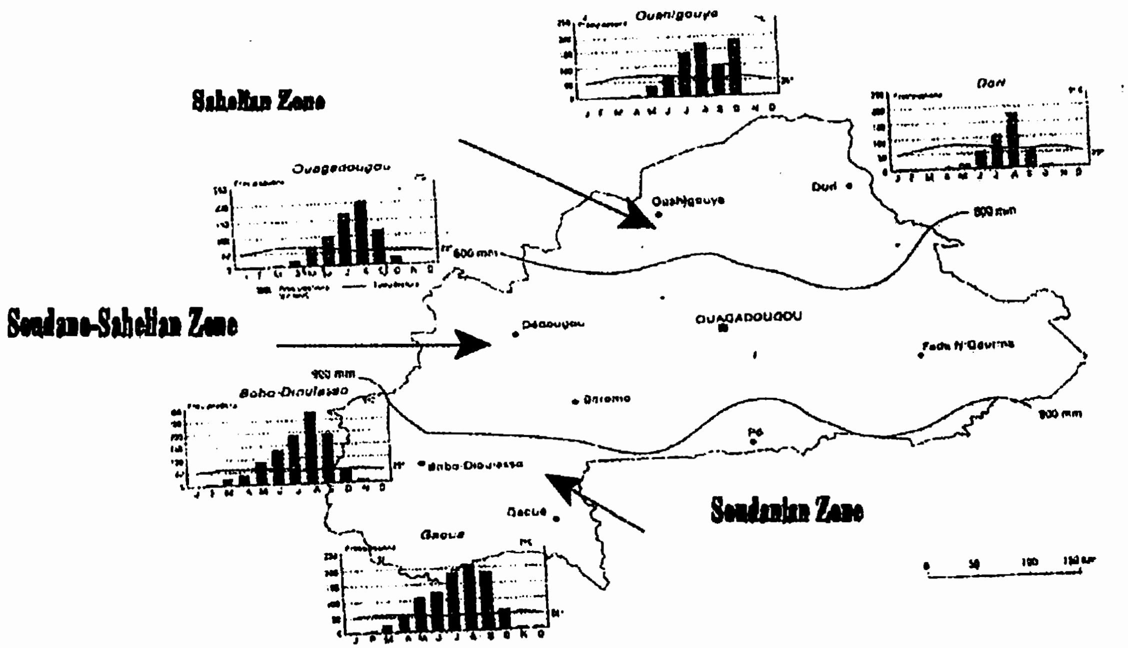
Map 1.1: Agro-Ecological Zones in Africa



Source: de Leeuw and B. Rey (1995), World Animal Review, 83 (2), p.49

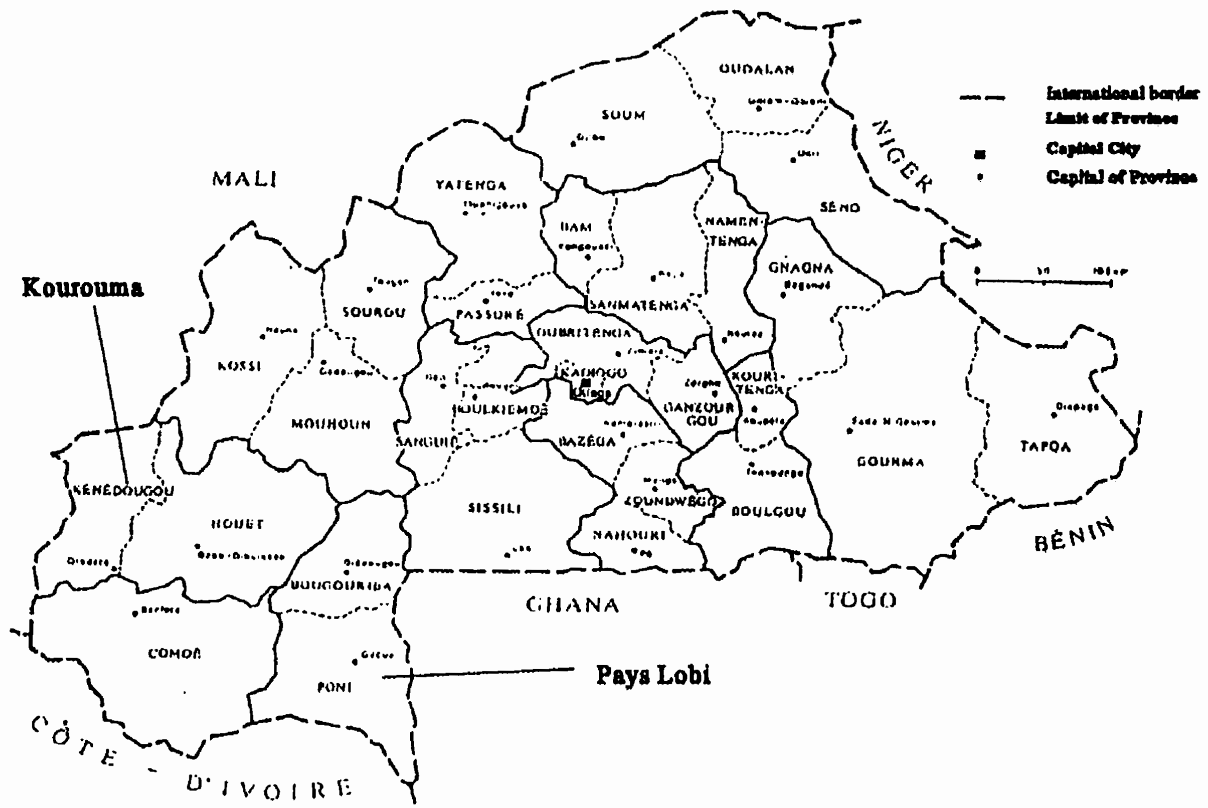
Map 1.2: Burkina Faso in Africa

Map 1.3: Climatic zones of Burkina Faso



Source: Jeune Afrique, Atlas du Burkina Faso, Les Editions Jeune Afrique, 1993, Paris

Map 1.4: Provinces and Regions of Burkina Faso



Chapter 2

Breeding practices and genetic preferences

2.1 Introduction

This chapter uses descriptive statistics to analyze the main features of cattle production systems in southern Burkina Faso, and farmers' perceptions and preferences for the main breeds raised in the region. The analysis focuses on management and production practices that result from recent changes in cattle production and the interaction of production practices with herd structure, breed choice and breed preferences. The primary objective is to gain insights on the current livestock production systems in the region and the prospects for its future development. A clear understanding of farming systems and breed preferences is necessary in order to guide research orientation and provide policy makers with relevant information on the potential demand for improved cattle breeds as a response to current changes.

More specifically, this chapter intends to (1) identify and describe the main cattle production systems (main objectives in keeping cattle, types of breeds, sources of cattle in herds, number and types of animals used for draught and breeding practices), and (2) assess farmers' beliefs and preferences for the main breeds of cattle (perceived advantages and disadvantages of keeping a given cattle breed and perceptions about the relative performances of the breeds).

The main hypothesis is that despite the prevalence of African Animal Trypanosomosis, cattle production in southern Burkina Faso involves an increasing number of susceptible breeds for the following reasons: (1) differential susceptibility in disease is only one of a set of factors that differentiate trypanotolerant breeds from susceptible breeds, and farmers' decision to keep a given breed in their herds depends upon the entire set of factors, (2) farmers' beliefs and perceptions of the relative performances of each breed are key elements affecting breed choice, and most farmers, especially those in the Kourouma area have the perception that Zebu cattle outperform the indigenous Baoulé cattle in draught power and other reproductive traits, and (3) the southward migration of Fulani pastoralists brought production systems oriented towards beef and milk into the southern zone, and Zebu cattle are more productive at both.

The chapter is organized as follows. Section 2.2 examines the important methodological considerations involved in the achievement of the objectives and the research design. Section 2.3 presents the main survey design and the data collection. Section 2.4 discusses the empirical results of the survey and section 2.5 summarizes the main conclusions and implications.

2.2 Methodological considerations and research design

In light of the objectives and hypotheses, two methodological issues were considered in this study. First, it was necessary to identify the main issues in farming systems that needed to be investigated for the understanding of breeding practices, and in particular to define in their own words what potential traits farmers use to evaluate breeds of cattle. The actual prevalence of trypanosomosis would suggest that trypanotolerance or some resistance to diseases is of concern to farmers. This would reduce the task to one of identifying the other cattle traits that are perceived as being important for cattle production in the region. This assumption needed to be tested during a preliminary, non- formal discussion with the people involved in cattle production in southern Burkina Faso.

This issue was first addressed using a focus group approach consisting of a series of guided group discussions with the intention to gain insight about people attitudes, opinions, and behaviour about cattle production in the region. The participants to these interviews included researchers (animal scientists, veterinarians, economists) working on livestock issues, agricultural and livestock extension officers, veterinary assistants involved in sectoral or rural development projects in the south-western region, opinion leaders and groups of farmers at village levels. The interviews also provided an opportunity to stratify the survey region for the selection of villages from which a sample of cattle keeping households were to be chosen for a survey.

The second methodological issue referred to farmers' evaluation of the breeds. Following the procedure used by Jabbar et al. (1997) in a similar study in southern Nigeria, the matrix rating technique was used to generate a matrix of breed ratings for each survey respondent. Using the same methodology also allows easy comparisons of results. The matrix rating technique is a two-way classification method which allows each survey respondent to express preferences by rating each breed (breeds are presented on the horizontal axis) using the set of traits presented in the vertical axis. The method was originally developed by cognitive psychologists and has been applied to market research, urban geography, and agricultural technologies such as crop and tree varieties (Ashby et al.,1989; Asfaw et al., 1991). It has also been adapted to study farmers' understanding and perceptions of the importance of different animal diseases and feed sources in pastoral systems (Waters-Bayer and Bayer, 1994).

2.2.1 Rapid appraisal of production systems and sites selection

This section presents the preliminary research activities carried out in order to provide the necessary information to specify the parameters needed for the description of farming systems and breeding practices and the choice of the areas for the empirical study. The first important research activity consisted of an intensive review of the available literature on livestock production in the region and a series of informal discussions with animal scientists in April and May 1995. The later provided substantial background information on livestock production in the region as well as on the important research network implemented by national and international research institutions such as ORSTOM (the French overseas institution for research), the Burkinabe Institut National de l'Environnement et de Recherches Agricoles (INERA) and CIRDES. These preliminary investigations also led to the choice of the study areas consisting in Pays Lobi of the Poni province and Kourouma in the Kennedougou. These areas represent the main features of cattle production in south-western Burkina Faso with different incidences of the breeds. The choice was also motivated by the opportunity for the ILRI team to interact with CIRDES research teams in the same sites as imposed by the collaborative nature of the program.

Average annual rainfall is about 1100 mm in Kourouma and 1400 mm in Pays Lobi. The two areas also differ in tsetse/trypanosomosis pressure. Trypanomosis prevalence in cattle in Kourouma averages 7.2 % and catches of flies (in traps) per day range from 1 to 2.5 while in Pays trypanosomosis prevalence is about 8% and the number of catches per day ranges from 2.5 to 4.9 (CIRDES, 1995).

On these sites research began by a series of interviews with district officials, agricultural and livestock extension officers, veterinary assistants, village leaders and cattle owners. Interviews were held separately but with the same approach and objectives: courtesy call followed by explanation of the scope, objectives and potential benefits of the research and for approval and clearance. In addition, the support of village and ethnic and religious leaders was requested, which is crucial in gaining farmers' trust and their acceptance of the research process. Interviews were held with agricultural and livestock extension officers and veterinary assistants to provide background information on the local farming and livestock systems, livestock diseases and availability of drugs, and to identify potential traits for breed assessment. Interviews were also held with cattle owners in ten villages in the two selected survey areas. During the interviews cattle owners were asked questions about farming systems, the number and types of breeds they were currently holding, the traits they consider when they have to choose cattle, the relative importance of the traits, their most preferred breed, the advantages and disadvantages of the breeds, and some indication about target breed composition of the herds in the short and long run.

2.2.2 Identification of criteria to evaluate the breeds

The interviews held in the study areas and the literature review led to a list of 13 traits for bulls and 14 traits for cows expressing farmers main preferences in cattle production. These traits and their definition are summarized in Table 2.1.

Market value is important as it affects farmers' income; a high market value assures that farmers' investments in cattle are partly or fully recovered. Mobility is usually correlated with the fact that cattle have selective grazing habits. Hence, sedentary farmers would discount cattle with a strong need for mobility. Weight gain is important because it represents how fast or slow an animal can generate income; and a rapid weight gain would indicate how quick an animal arrives at a mature size. Conformation and weight gain would provide some indications of the live-weight of the animal. A good conformation and a rapid weight gain implies a high market value in a relatively short time. Temperament is important for farmers using animal traction or also for Fulani herders who have to keep animals together when they go out for grazing; in some cases, it expresses the fact that whether or not animals remain in the corral at night or stay together during grazing. Colour is said to be associated with attraction of tsetse flies, white coloured cattle being more likely to attract the flies. Size is important as it has an impact on the market value of the animals and also the access to forage shrubs during the dry seasons.

In order to make the assessment of the breeds workable, the number of traits must be reduced to a manageable size. To facilitate comparison of traits, visual aids were devised, particularly due to the need to provide comprehensible information for illiterate farmers. A large number of traits would overload the survey instrument and may affect the quality of the results. In fact, each respondent would have to memorize all the traits included in the survey before using them to assess the breeds. The reduction in the number of traits was also required for the conjoint survey design that will be presented in chapter 4. The conjoint procedure follows successive steps including (1) the definition of relevant levels for each trait included in the study, and (2) the definition of cattle profiles by combining the levels of traits. The profiles are then submitted to the survey respondents for evaluation. Evaluation data and traits entering in the definition of each profile serve as the main inputs in the procedure used to estimate preferences expressed by survey respondents for each trait. A large number of traits or levels will result in a very large number of cattle profiles, making the evaluation process very difficult because the respondents may be unable to mentally process the available data. Reducing the number of traits will help overcome this overload problem. The conjoint process and the experimental design will extensively be examined in chapter 4.

In reducing the number of traits to include in the study care was taken to avoid overlap and redundancy. For example, market value and conformation were excluded because they are the end result of other traits like weight gain, size and disease resistance. The need for mobility is correlated with feeding ease and coat colour with disease resistance. Social values as a trait represent several complex factors (payment of dowry, sacrifices, funerals...etc) and was excluded. Manure is an organic source of nutrients for crops and can be included in the overall use of cattle for agriculture, already expressed in fitness for traction. Precocity as a measure of early calving was excluded on the ground that another reproductive trait of cows represented by fecundity would be included in the study. In the end farmers' main concerns about cattle production were reduced to seven traits of bulls and seven traits of cows. For bulls, these traits are fitness for traction, disease resistance, weight gain, size, feeding ease, temperament and fertility while final traits for cows include fecundity, milk yield, disease resistance, weight gain, feeding ease, temperament and size.

2.3 Designing the main survey instrument

Designing the survey instrument involved the choice of villages and households. Choice of households in turn required prior knowledge of the actual population of the villages. Village selection was accomplished in two steps: first, a focus village was purposively selected in the area where CIRDES teams conducted health and productivity studies. Second, additional villages were randomly selected from a list of surrounding villages enumerated with the help of local administrative officers.

Kourouma was chosen as the focus village in the Kourouma area. Four additional villages (Sougouma, Djigouéra, Foulasso and Gnignana) were randomly selected from a list of 13 potential villages enumerated with the help of the district officer (Préfet) and extension agents of the Société Burkinabé des Fibres et Textiles (SOFITEX), a parastatal in charge of cotton development. Kourouma is a district capital which actually includes five satellite villages. These satellite villages are Toukorna, Zamakologo, Dougnouna, Sofongo and Gnizanso. Map 2.1 shows the 10 villages surveyed in the Kourouma site.

In Pays Lobi on-going CIRDES projects have identified three villages (Passéna, Batié and Legmoin) for the presence of major breeds raised in southern Burkina Faso. They were retained as focus villages. Additional sites were then randomly selected in the neighbourhood of each focus village from a list of 15 villages assembled with the help of local authorities. These include Guirina, Diatara Dongolona, and Latara in the Passéna area, Dankana, Tobo, and Koure in the Legmoin area and Domsèrè, Bananba, Koriba, Koudio, Zilathion in the Batié area (map 2.2). The choice of the survey respondents required information regarding the actual population of cattle owners in the selected villages and data on the cattle production systems. Since there were no recent data on the farming population in the study areas, a full enumeration of cattle keeping households was conducted as part of a preliminary survey in July and August 1995.

Along with the enumeration of all cattle keeping household heads in the pre-selected 25 villages, the preliminary survey provided data on population ethnicity, breed composition of herds, number of animals involved in traction and main occupation of household heads. The preliminary survey also provided an opportunity to evaluate the relative importance of the seven traits of bulls and cows. This was done by asking each household head to provide separate rankings for the seven traits of bulls and cows.

The ranking process was made much easier by combining drawings of animal traits as visual aids with oral explanation so that the actual ranking consisted in choosing the visual support identifying the materialized trait. The preliminary survey questionnaire is shown in appendix 2.1.

A total of 412 cattle-keeping households for the Kourouma area and 282 for Pays Lobi were enumerated during the preliminary survey, making up 694 households for both sites. The main ethnic groups in Kourouma were Sénoufo (49%), Mossi (32%), Bamana (9%)

and Fulani (7%). Sénoufo and Bamanan are indigenous ethnic groups whereas Mossi and Fulani are migrants. In Pays Lobi, Lobi (27%), Birifor (23%), Dagari (19%) are the indigenous tribes while Fulani (16%) and Mossi (9%) are, as in Kourouma, migrants.

The Sénoufo which represent about 0.8 % of the population of Burkina Faso are found in the western province of Kenedougou. This group has also extensions in eastern Mali and in northern Côte d'Ivoire. They are mostly crop farmers raising cattle, goats, sheep, chickens and guinea fowls. Like the Sénoufo, the Bamanan are indigenous of the Kenedougou province, growing cereals (maize, sorghum, millet, rice), ground nut and raising various types of livestock. Mossi represent about 52% of the population in Burkina Faso and they are found throughout the country and in the neighbouring Ghana and Côte d'Ivoire. Their native land corresponds to the provinces of Sanmatenga, Yatenga, Namentenga and the area around Ouagadougou, the capital city. The droughts that occurred in the central and northern part of the country in the 1970s contributed to their migration in the southern provinces and in the neighbouring countries in search for cropping land. They are farmers growing millet, sorghum and ground nut and also raising a wide range of livestock. With about 11% of the total population, Fulani originated from the northen provinces of Soum, Ouadalan and Seno. They are pastoralists raising cattle, goats, sheep, chickens, guinea fowls. Like the Mossi, the prolonged droughts and the deterioration of range in the north have forced them to settle in the southern regions in search of better pasture for their cattle. Fulani are Muslims while Sénoufo, Bamanan and Mossi have their traditional religions, although some are christians.

Dagari, Birifor and Lobi are the indigenous tribes of Pays Lobi. They represent about 6% of the country's total population. The first two tribes have extension in the Wa region of northwestern Ghana while the Lobi are also found in the Bouna region of north-eastern Côte d'Ivoire. They are all farmers growing cereals (maize, sorghum, rice), yams, ground nut and raise cattle, sheep, goats, pigs, chickens and guinea fowls. They are "traditional believers".

The majority of the surveyed cattle owners reported crop farming as their main occupation: 89% in Kourouma and 80% in Pays Lobi. Only 15 % in Pays Lobi and 7% in Kourouma mentioned cattle raising as their main activity. The remaining cattle owners (4%) include traders, civil servants and urban workers who actually owned animals that are herded by hired Fulani or entrusted to others farmers in caretaking arrangements.

All the three breeds raised in southwestern Burkina Faso were found in both sites, although Baoulé cattle were much more important in Pays Lobi, being the only breed in the herd of 62% of the households. Kourouma had a diversified herd structure, although herds with only Zebu cattle were much more important (27%) than in Pays Lobi (10%). Another distinguishing feature of the two sites was the use of cattle for draught purposes. Animal traction was used by 95 % of households in Kourouma and 32% in Pays Lobi.

After enumeration of actual cattle keeping households in the 25 villages and a stratification into production systems, the next task was to draw the sample households for the main survey in order to collect data on production and management systems and on farmers' preferences for the breeds. Thus a stratified sampling technique was needed so as to allow the final sample to include the main components of the population. Using the main occupation as a the major criterion, the two sub-samples identified comprised mixed-crop farmers and beef and milk producers. Mixed-crop farmers reported crop farming as their main occupation in the preliminary survey whereas beef and milk producers had cattle raising as their main occupation. None of the other farmers who do not actually manage animals were selected. Since the animals were kept by either mixed-crop farmers or beef and milk producers, it was assumed that the study will eventually capture information about these herds. Due to the contrast between Kourouma and Pays Lobi in terms of breed composition of herds and the use of animals for traction, separate samples were drawn for each site. Two practical considerations imposed the following in determining the final size of the total sample: (1) restricting the sub-sample of mixed-crop farmers to 40% of those enumerated due to budget and time limitations in both sites, and (2) maintaining the whole population of enumerated beef and milk producers given their small number in order to allow valid statistical analysis (increased degrees of freedom). The structures of the actual and sample populations per village are given in Table 2.2.

2.4 Data collection

Survey questionnaires were administered by 9 enumerators, including the researcher, through interviews with 330 households out of the 668 that were enumerated in the survey area. Data were collected on cattle production systems and farmers' breed preferences. Based on information gathered during the previous phases, the design of the survey instrument responded to two main concerns.

First, it was necessary to ensure a good communication between the enumerators and the respondents as well as to avoid ambiguity about the breeds. This was achieved by selecting enumerators with some experience in surveys in the study areas and who spoke French and local languages in each site. For example, three of the five enumerators in Kourouma had previously conducted surveys on livestock in the area; they were Sénoufo but spoke Dioula, the most common local language. Of the four enumerators in Pays Lobi, three spoke one of the local languages and were assigned appropriate villages. Interestingly one was a multilingual retired civil servant speaking French, Dagari, Lobiri, Moré, and Fula. Ambiguity about breeds was avoided by using the local breed names: Méré for the crossbreed, Baoulé and Cocrou (for Zebu). To make the discussions about the traits much more easier each one was represented by a drawing on a small piece of wood.

Second, enumerators were provided training before each survey. Training started with full explanation sessions about the survey objectives, questionnaires and major steps involved. Practical tests were then carried out under the supervision of scientists from CIRDES and local livestock extension agents.

2.4.1 Collecting data on production systems

Insights into cattle production and farmers' breeding practices were obtained during the first part of the main survey by asking farmers questions about the breed of their animals, their main purposes for raising cattle, their breeding practices, the sources of cattle in herds, breed type of bull, type and breed of animals used for traction, caretaking arrangements, region of origin, year of settlement for migrants, and their perceptions of the advantages and disadvantages of the three main breeds raised in the area. In a study on breeding practices, information on the sources of cattle in the herds is very important as it provides insights into the amount of discretion that farmers have in changing the breeds of cattle in their herds. Among the available options, the most deliberate ways to exercise discretion over the choice of breed are the purchase of more desirable animals and a real control over the breeding of cows with bulls of more desirable breeds. The least desirable way consists in allowing cows to breed with bulls of neighbouring herds during grazing time.

2.4.2 Assessing farmers' perceptions and preferences for the breeds

This was the last part of the survey on breeding practices and breed preferences. Like the first part it was organized over personal interviews held the same day with the same household heads. It combined pictorial representations and verbal explanations of the selected cattle traits. The traits considered in the study include: disease resistance, size, weight gain, feeding ease, temperament, fitness to traction, milk yield, female fecundity and male fertility. Each trait was caricaturely represented on a small piece of wood. Main entries of the matrix were the three main breeds on the horizontal axis and the 9 traits on the vertical axis. The actual interview started with an introduction explaining the meaning of each row, column and cell in the matrix to the surveyed farmer. Then the farmer was asked to explain his or her understanding of the matrix to the enumerator. This usually took between 20 to 30 minutes and was repeated as necessary. The second phase corresponds to the actual evaluation of the breeds. Each respondent was asked to consider the first trait and the first breed and assess preferences for the breed using a five-point (1- 5) preference scale, where 1 means lowest preference and 5 the highest. The respondent was asked to continue the evaluation by considering the other 8 traits for the first breed and the 9 traits for the last two breeds in the same way.

Out of the 75 beef and milk producers selected for the survey, 18 in Pays Lobi and 8 in the Kourouma zone did not participate in the survey or provided incomplete data regarding breeding practices and breed preferences. Among the mixed-crop farmers, 2 could not be reached in Pays Lobi at the time of the survey because one moved and settled in the neighbouring north-eastern Côte d'Ivoire and the other was not actually a full time resident in the village where the animals were kept. In Kourouma, 3 mixed crop farmers migrated and relocated in another province. In the end, 98% of the selected mixed-crop farmers and 66% of beef and milk producers provided complete data on their breeding practices and breed preferences. Analysis was performed on the 299 households who provided complete data sets. Questionnaires used to collect these data are shown in appendix 2.2

A number of difficulties were encountered, typical when collecting data in rural areas in Africa. The most important factor was the choice of appropriate time for the interviews. Because each interview required at least one hour, it is was decided to avoid the rainy season because most cattle owners would be busy with their cropping activities and unable or unwilling to devote time to survey responses. Thus, interviews were only held during the dry season, leading to a concentrated period of survey activity.

Unfortunately the dry season is also the period during which the pastoral Fulani leave the study area and take their cattle for transhumance in more humid zones (northern Côte d'Ivoire). In addition, some mixed-crop farmers used this period of low agricultural activity to visit relatives in other regions or in the neighbouring countries. As a result, return field visits (sometimes three or four times) were necessary in order to complete the surveys for all respondents and ensure a high response rate.

The way in which the research team was perceived by the respondents also affected the data collection process. Care was taken to establish appropriate protocol with local leaders. However, this was not always successful. In one case pastoral Fulani in Koure (a village in Pays Lobi) did not participate in the survey because they associated the survey enumerator with the local district government office.

2.5 Analysis and discussion of the survey results

In this section, descriptive statistics are used to present the results of the main survey in terms of the major features of production and management systems and the relative performances of the breeds. Production and management systems are described using several criteria including the relation with crop production, the level of inputs use, the type of output and the main source of income. In addition, data from the preliminary survey are used to show how farmers in such a tsetse-infested area perceive the relative importance of disease resistance and the other traits of cattle identified in the preliminary phases of this research. Farmers' preferences for the breeds are presented first, in terms of their opinions about the advantages and disadvantages of raising each breed; the actual preferences are shown by comparing farmers' perceptions of how each breed performs with respect to the other two breeds in terms of the identified traits. A comparison of farmers' preferences between the Kourouma and Pays Lobi is also provided.

2.5.1 Main characteristics of cattle production

Tables 2.3 to 2.6 present data on sample households in Kourouma and in Pays Lobi regarding their main occupation, cattle ownership and caretaking arrangements, breed composition of the herds, sources of animals in herds and reported main purposes of raising cattle.

2.5.1.1 Main occupation of cattle owners.

Most respondents in both survey sites are mixed-crop farmers who combine cattle and crop farming. In Kourouma 90 % of survey respondents reported crop farming as their main occupation. Only one did not grow any crop in 1995. Main crops are cereals (millet, sorghum, maize and rice), cotton, sesame and ground nut. Millet, sorghum and ground nuts are mainly grown for home consumption while cotton is a cash crop intended to provide the major part of annual cash income. Maize and rice are dual purpose crops as they are produced for consumption as well as for sale on local markets. On average, cotton and maize represent 45% and 46% of the annual hectarage (Lendres, 1992). For the crop year 1995, 19% had grown cereals and ground nuts while 81% were cotton growers. These are small scale farmers cultivating 0.5 to 1.5 hectares per household. Cattle use in agriculture is very important with 94 % of sample households using animal traction. A substantial proportion of farmers (77%) keep cattle for draught purposes.

Cotton was introduced in Burkina Faso in the early 1950s (World Bank, 1988) by the colonial French authority. Production is limited to the southwestern part of the country where rainfall, soils and access to the markets are better than anywhere else. Cotton production in the Bobo-Dioulasso area, including Kourouma, started in the 1970s as part of a larger development program supported by the International Development Agency (IDA) of the World Bank, the Caisse Centrale de Coopération Economique and the Fonds d'Aide et de Coopération of France (World Bank, 1988). The main objective of the program was to increase the national production of cotton, improve the national food security by implementing production systems which include food crops, and to raise the living standards of participating farmers through a substantial increase in their cash incomes.

The cotton development agency, SOFITEX, provides strong incentives to farmers to produce cotton, including (1) a timely distribution by the extension services of seasonal inputs repayable at harvest delivery, and (2) a guaranteed farm-gate price, set annually, announced ahead of the season and paid immediately after cotton is delivered to SOFITEX. Cotton production benefits from the use of animal traction because traction eases the labor constraint experienced in land preparation which leads to increase in the hectarage and consequently farm income. Increased use of animal traction brought substantial financial improvement in small scale agriculture in the Kourouma, which explains the relative importance of the use of cattle for draught purposes reported by survey respondents in Kourouma (Table 2.4).

Analysis of data on the sources of cattle (Table 2.5) indicates that farmers exercise a real discretion over the choice of breeds. About 51% (1601 out of 3113) of cattle in Kourouma and 56% (2935 out of 5210) in Pays Lobi were purchased. Only 6.4% (198 out of 3113) of cattle in Kourouma and 6% (311 out of 5210) of cattle in Pays Lobi herds were acquired by inheritance or caretaking arrangements, the least deliberate and slowest ways to change the breed composition of herds. Zebu cattle were much more purchased than the other two breeds.

In Pays Lobi 76% of the households reported crop farming as their main occupation. Main crops include yams, cereals (millet, sorghum, maize and rice) and ground nut mostly grown for local consumption. They are small scale farmers who produced cereals, yams (42%) and ground nut (45%) in 1995; most cattle do not provide draught power but supply other services. For a minority of the population (21 of 122 households) sale of cattle is an economic activity intended to provide cash income. There are more functions of cattle in Pays Lobi than in Kourouma. Thirty-seven farmers (34%) reported that cattle are kept to meet social needs, or as a store of wealth and only traded when an urgent monetary need arises. As in Kourouma, most cattle were either purchased (56%) or born in herd (38%). Animals were usually purchased at an age ranging from 20 to 32 months. Méré were 1.4 times more costly than Baoulé while Zebu were 1.2 times more costly than Méré (CIRDES, 1996). Despite the high price of Zebu, farmers purchased more Zebu than Méré or Baoulé.

2.5.1.2 Cattle ownership and caretaking arrangements

The majority of cattle are owned by the herd manager alone or with other members of his family. As indicated in Table 2.6, 91% (161 out of 177) of households in Kourouma and 80% (97 out of 122) of households in Pays Lobi managed their own cattle. Management of cattle owned by the other households (9% in Kourouma and 20% in Pays Lobi) involved caretaking arrangements between cattle owners and caretakers. A caretaking arrangement is a case in which the manager of a herd owns part of it, the rest are owned by one or several other farmers or non-farmers (extension agents, other civil servants or private businessman) who might reside in the same village or elsewhere. Such an arrangement can last for several years and is paid for by the sharing of the offspring. A rate of one calf out of two or three calvings for the caretaker is common. The arrangement also gives the manager free access to extra cattle for draught or manure. Caretaking arrangements are based on a verbal agreement between the owner and the manager. Cattle are available any time for the owner's use. Another common caretaking arrangement is the case in which a Fulani herder owning few animals is in charge of animals owned by several farmers or non-farmers living in the same village. Main duties of the herder consists in taking the animals out in the morning for pasture and bringing them back to a corral at night. Herders are usually paid a monthly salary and often allowed to extract any milk they can get from the entrusted cows.

2.5.1.3 Breed composition of herds

Although all the breeds were found in the two sites, there were substantial differences between sites in terms of herd structures as well as production and management practices as indicated in Table 2.3. This table also contains data on herd structures with one breed, a combination of two breeds and herds with all three breeds.

If we consider the number of households having a particular breed in their herds, Zebu were present in 83% (144 out of 177) of households in Kourouma. These include 39 (22%) households with only Zebu cattle in their herds, 51 (28.8%) households having Zebu cattle combined with Baoulé or Méré and 57 (32.2%) households with all three breeds in their herds. About 60% (107 out of 177) of households had Baoulé cattle in their herds as either the only breed of the herds (7 households) or associated with one of the other two breeds (43 households) or with the other two breeds (57 households). Méré cattle were also important as they were found in 58% (103 out of 177) of households. Like Baoulé and in contrast to Zebu, Méré cattle were much more often kept in combination with other breeds.

Herd structures in Pays Lobi indicate the relative importance of Baoulé cattle. About 73% (89 out of 122) of households have Baoulé cattle in their herds, the majority of them have Baoulé as the only breed of the herds. The proportion of households with Méré or Zebu is relatively lower than in Kourouma.

Another interesting point is the relative importance of herds with only one breed in each site. About one third (54 out of 177) of the surveyed households in Kourouma had only one breed, the majority (22%) having only Zebu. In contrast, 61% (74 out of 122) of households in Pays Lobi had one breed, with 48% of them having only Baoulé. Another distinctive feature of herd structure in Kourouma is the relative equal distribution of household herds into herds with only one, two and three breeds. About 31% of household had only one breed in their herds, 37% of them had herds with two breeds and the remaining 30% had all three breeds.

2.5.1.4 Cattle production systems

Three main production and management systems can be distinguished using the relation with crop production, the level of input use, the type of output and the proportion of annual income provided by livestock compared to crops. Besides minor specific features, it seems that in general, production and management systems are mostly extensive. Cattle continue to rely on communal natural pastures and fallows which depend largely on the variability of rainfall. The systems adapt to fluctuations in feed supply, with cattle losing weight and producing less milk in the dry season. In some cases, crop residues and few external inputs are used as supplements.

The main feature of mixed crop farming is the integration of cattle and crop production. For this reason, this system is also referred to as agropastoral. Cattle provide draught power and manure, while crops provide fodder and residues to cattle and income for the subsistence of the family, allowing injection in the system of external inputs such as preventive and curative drugs and feed supplements. In addition to the bulls used for traction (castrated or not) the herd size in mixed crop farming is small, although animals are still herded by a herdsman.

As shown in Tables 2.3 and 2.6, mixed crop farming systems predominate in Kourouma, most of them involving Zebu and Méré cattle. About 82% (123 out of 150) of the mixed crop farmers in Kourouma had Zebu, with 20% (30 out of 150) having only Zebu, 28% (42 out of 150) having Zebu associated with Méré or Baoulé and 34% (51 out of 150) having Zebu and the other two breeds. Baoulé were less important than Zebu but they were present in a significant proportion of mixed crop farmers (62%), with only 4% having Baoulé as the only breed.

The second production and management system is the pastoralism or dual purpose milk and beef system which usually involves little crop production i.e. maize, sorghum and millet as compound crops. The system is particularly known for seasonal movements of animals as a management technique adapted to the variability in feed availability due to fluctuations in rainfall. In contrast to mixed-crop systems, herds in pastoral systems usually have structures reflecting the main outputs of the system: live cattle for sale and milk for consumption and sale. The system is based on an extensive use of communal land. With the growing demand for meat and live cattle in the coastal countries (Côte d'Ivoire, Ghana, Togo and Benin), pastoral systems in south-western Burkina Faso are becoming much more market oriented with substantial investments in fencing and purchased inputs in some cases. Pastoral systems are the second largest cattle production and management system in both Pays Lobi and Kourouma sites (Table 2.3). Annual cash income is provided by cattle. Zebu cattle were the most important breed for this system in both sites. About 87% (21 out of 24) of beef and milk producers in Kourouma and 66% (27 out of 41) in Pays Lobi had Zebu cattle. In comparison, the proportions of beef and milk producers with Baoulé or Méré cattle were 46% (11 out of 24) and 33% (8 out of 24) respectively in Kourouma and 44% (18 out of 41) and 58% (24 out of 41) in Pays Lobi (Table 2.6).

The last production and management system is more a traditional way of subsistence than a production system designed for optimal offtake. Like the other two systems, animals graze on communal lands but, in contrast, the output is not very specific and sale of animals is usually motivated by urgent monetary needs. The main purpose for keeping cattle in this system is to use them as a store of wealth and an insurance against risks and misfortunes in harsh environments. Although offtake is generally very low, cattle provide a wide range of functions including the provision of cash reserve, milk, means of transport, manure as well as meeting various social needs (funerals, sacrifices and dowry). This multiplicity of functions make the introduction of any technical change aiming at improving only livestock productivity very difficult. This, in turn, can be an advantage from the perspective of maintaining domestic animal biodiversity. Traditional subsistence system was not important in Kourouma, whereas it is the most important cattle production and management system in Pays Lobi where it involves about 46% of the respondents (Table 2.3). Considering the case of Pays Lobi for which valid statistical analyses can be done we see that subsistence systems mostly rely on Baoulé cattle (Table 2.6).

Table 2.7 presents the main characteristics of the production systems. There are significant differences among these systems on several key issues. Average herd size is larger for pastoral Fulani (beef and milk system) than for mixed-crop farmers who, in turn, have more cattle in their herds than the subsistence farmers. Zebu and Mere are more important in herds owned by pastoral Fulani than the other types of cattle owners. Subsistence farmers typically have small herds that are predominantly comprised of Baoulé. It is also worth noting that pastoral Fulani use more animal traction than subsistence farmers and are involved in food production to complement beef and milk production. For mixed-crop farmers, animal traction is the primary use of roughly of one third of their herds.

These production systems have mutually beneficial arrangements but they also have some areas of conflict. Caretaking arrangements provide mutual benefits to Fulani herders as well to mixed-crop farmers who entrust their animals. For mixed-crop farmers, the use of herders is a relatively cheap labour for herd management: herders are paid a small salary but they are allowed to take and sell any milk from the entrusted cows as part of their remuneration. However, serious conflicts have developed between pastoral Fulani on one hand and crop farmers (mixed-crop and subsistence farmers) on the other over crop destruction and the remuneration for the damage.

2.5.2 Settlement of Fulanis and changes in breed composition of herd

Another insight into herd structures is provided by investigating breed composition of herds kept by migrant and indigenous farmers. Fulani and Mossi were the main migrant farmers in both sites, whereas Sénoufo, Bamanan and Bolon were the main indigenous farmers in Kourouma; main indigenous farmers in Pays Lobi were of the following tribes:

Lobi, Dagari and Birifor. Table 2.8 contains data on herd structures for indigenous and migrant farmers in both sites.

The most striking result provided by data on Table 2.8 is that in Pays Lobi, migrant farmers own Zebu cattle, whereas indigenous farmers own Baoulé cattle. About 70% (38 out of 54) of the migrant farmers in Pays Lobi had Zebu cattle in their herd while 41% (22 out of 54) of them had Baoulé cattle. In contrast, only 6% of the indigenous farmers (4 out of 68) had Zebu cattle in their herd and 98 % of them (67 out of 68) had Baoulé cattle. The situation in Kourouma is slightly different from that of Pays Lobi. In Kourouma as in Pays Lobi, more migrant farmers have Zebu cattle (70 out of 79) in their herds than Baoulé (29 out of 79) but there were as many indigenous farmers with Zebu cattle as those with Baoulé cattle (77 out of 98).

The settlement of Fulani pastoralists in southwestern Burkina Faso had at least three main impacts on cattle and agricultural development. First, the introduction of Zebu cattle in the region was a significant incentive for agricultural development in the region through the promotion of animal traction as a means of overcoming the limitation of farm size resulting from reliance on hand cultivation.

Second, some indigenous farmers with substantial resources generated with cash crop production or through trade started their own production of Zebu cattle by reinvesting some of their crop returns into herd accumulation (de Leeuw and Rey, 1995). The adoption of Zebu by indigenous farmers is reflected by the relative important number of indigenous farmers having Zebu cattle in their herds in Kourouma (78%) compared to the proportion (6%) of indigenous farmers with Zebu in Pays Lobi (6%). In fact, breed composition of herds has changed more in Kourouma than in Pays Lobi, resulting in significant shift away from Baoulé cattle in Kourouma. About 28% of indigenous farmers have given up the Baoulé breed. Baoulé cattle were replaced either by only Zebu (20%) or a combination of Zebu and Méré. Only 6% of migrant farmers have introduced Baoulé cattle in their herds, without giving up Zebu; the main reason is to crossbreed with Zebu to obtain Méré. In Pays Lobi, only two migrant farmers have replaced Baoulé cattle with Zebu or Méré for draught purposes. Two other migrant farmers added Baoulé breed to their herds.

Last and in spite of a greater access to crop residues, the increase in human and livestock densities in the region has resulted in a greater pressure on communal pastures. Pressure on land is reflected in the number of conflicts between Fulani pastoralists and crop farmers over crop damage. In general, Fulani pastoralists move continuously in response to variability in forage availability. This constant movement of herds was also seen as a managerial practice intended to reduce trypanosomosis risk (Bassett, 1986). Usually tsetse fly densities are highest in areas of well-developed gallery forest with minimal degradation. Modification of this environment by land clearing, burning and cultivation reduces tsetse challenge and trypanomosis risk. Pastoral Fulani would consequently take their Zebu herds for grazing in or near the margins of agricultural zones where tsetse fly densities are much lower than in uninhabited areas (Chataigner, 1978; Bassett, 1986). Conflicts between Fulani pastoralists and crop farmers usually arise over the remuneration for crop damage caused by Fulani cattle to crop farmers fields.

2.5.3 Relative importance of cattle traits

Investigation on the relative importance of the traits was carried out in order to obtain a ranking in terms of the priority given by farmers to each trait. Insights into the order of preference of the traits by the farming community provide an opportunity to assess farmers' main concerns in cattle production, which represent a valuable information for livestock research and development programs. The analysis is based on non parametric procedures using the ranks of the traits. Non parametric procedures were chosen over parametric approaches because we were dealing with categorical and ordinal data represented by the ranks of the traits.

As indiacted earlier, results from focus groups interviews conducted during the preparatory phase of the survey and interaction with resource-persons helped identify seven traits of bulls and seven traits of cows as relevant in describing the main features of cattle production in the region. In a preliminary sampling design survey, 668 of the 694 farmers that were enumerated in 25 villages ranked the seven traits of bulls and cows. The purpose of the ranking process was to determining if there was a significant difference in farmers' perceptions of the selected traits and what hierarchy would result from these perceptions. The main hypothesis is that all the traits are not preferred the same way because preferences for each trait depend on factors such as production systems, ethnicity and other socio-economic attributes of farmers. For the purpose of the analysis, ranking data were organized into seven samples of bulls and seven samples of cows, each sample defined as the set of all the rankings given to a particular trait by all farmers. These samples were related to one another because the same farmers provided rankings in each sample.

Establishing the relative importance of the traits was conducted by comparing the mean ranks. We followed a sequential approach which consists in (1) looking at any statistical difference among the mean ranks and (2) using the mean ranks to establish a hierarchy of the traits.

2.5.3.1 Statistical differences among the mean ranks

Before setting up a hierarchy of the traits based on the mean ranks, it was necessary to see whether or not the survey data provide enough evidence that the samples of ranks of traits of bulls (cows) have equal means. The results would provide a preliminary test of the hypothesis that all traits are not regarded by farmers as being equally important. The issue is investigated using the Friedman nonparametric analysis of variance (Daniel and Terrell, 1992; Mason, 1978). The Friedman test is the appropriate test here because (1) there are more than two traits in the analysis, (2) samples of ranks of traits are related since each farmer ranked all the traits, and (3) the evaluation criteria (rankings) are ordinal scaled. The procedure uses the following null (Ho) and alternative (Ha) hypotheses:

Ho: There is no difference in the overall importance of the traits, i.e., the traits included in the study are equally preferred

Ha: There is a significant difference in the overall importance of the traits, i.e., the traits are not equally preferred

The test statistic approximates a χ^2 distribution with k - 1 degrees of freedom and its value is given by the following equation:

$$\chi^2 = \frac{12}{nk(k+1)} \Sigma_{j=1}^{k} (R_j)^2 - 3n(k+1)$$

where n is the sample size, k is the number of traits and R_j is the sum of all the ranks given by respondents to trait j. As usual, the null hypothesis is accepted if the computed test statistic is less than the critical value, otherwise it is rejected. The critical value of chi-square with 6 degrees of freedom at the 1% level is 18.54. Table 2.9 presents the average rankings of the traits of bull and cows and the results of the Friedman test. The computed statistics for bulls and cows in Kourouma are 471.78 and 533.94 respectively. Similar statistics for Pays Lobi are 433.63 for bulls and 734.31 for cows. As indicated in Table 2.9, the Friedman test statistics for both survey sites are statistically significant at the 1% level implying that there is a significant difference in the overall importance of traits reported by survey respondents. This would mean that data provided evidence that traits included in each set (bull or cow) are different from farmers point of view.

Once the traits included in the study were found to be statistically different, the next task is to establish the relative importance of each trait using the mean rankings computed from the data. The most preferred trait will be the one with the lowest rank value, the last being the trait with the highest value. The resulting hierarchy of traits only reflects the crude rankings as the absolute difference in the mean rankings may be so close that the relative importance of traits cannot be stated with certainty.

On the basis of the mean rank values presented in Table 2.9 crude rankings of the traits of cows and bulls for Kourouma (Table 2.10) and Pays Lobi (Table 2.11) were established. Crude rankings in Table 2.10 indicate that in Kourouma the most important traits for bulls in an ascending order are fitness to traction, feeding ease, temperament, disease resistance, weight gain, fertility and size. Corresponding traits for cows are fecundity, milk yield, feeding ease, disease resistance, temperament, weight gain and size. Using the same criteria and data in Table 2.11 most important traits in Pays Lobi for cows are fecundity, weight gain, disease resistance, milk yield, feeding ease, temperament and size. Traits for bulls in the same site can be ranked as follows: weight gain, disease resistance, fitness to traction, fertility, feeding ease, temperament and size.

2.5.3.2 Relative importance of traits

As already shown in Table 2.9, the mean rankings of contiguous and some non contiguous traits are so close that further testing is needed to establish whether the differences are statistically significant and validate the hierarchy based on the crude rankings. The Wilcoxon nonparametric matched-pair signed-ranks test was performed on various pairs of traits to test the statistical significance of the traits (Daniel, 1990; Daniel and Terrell, 1992; SPSS, 1994). The purpose of this test is to see whether the relative importance of the traits based only on the mean rank values still holds in case of small differences among the means.

Results of these tests presented in Table 2.12 show that for bulls in Pays Lobi, all the traits were statistically different at the 1, 5 or 10 % levels except the pairs: disease resistance -

fitness to traction and weight gain-disease resistance. Data for cows in Table 2.13 indicate that all traits were statistically significant at 1, 5 and 10%. Table 2.14 indicates that for bulls in Kourouma four pairs of traits were not statistically different. These include: temperament-disease resistance, feeding ease-temperament, disease resistance-temperament and fertility-size. The remaining traits were statistically different. For cows in Kourouma (Table 2.15) only two pairs of traits (disease resistance-feeding ease and temperament-disease resistance) were not statistically different. On the basis of these results, statistical rankings (Table 2.10) of the traits can be established to reflect the fact that some traits were not really different despite some differences in the mean rankings.

Overall, the Wilcoxon test results brought slight changes in the initial hierarchy of the traits based only on the mean rank values. Statistical rankings presented in Table 2.10 indicate that in Kourouma, fitness to traction for bulls is still in first place but feeding ease, temperament and disease resistance are all tied in the second place because their respective pairs did not proved to be statistically different. For cows in Kourouma, the fact that the pairs feeding ease-disease resistance and disease resistance-temperament were not statistically different but feeding ease and temperament were statistically different would indicate that disease resistance and temperament are tied in fourth place after fecundity, milk yield and feeding ease and followed by weight gain and size.

In Pays Lobi, no change has occurred in the initial hierarchy for cows based on the crude rankings only because all traits were statistically different. The fact that for bulls in Pays Lobi two pairs of traits (disease resistance-fitness to traction and weight gain-disease resistance) were not statistically different but weight gain and fitness to traction were statistically different would result in disease resistance and fitness to traction being tied second, after weight gain and followed by fertility, feeding ease, temperament and size.

Results from the Friedman and Wilcoxon tests confirm the notion that, in general, farmers in the study areas consider various traits when they value cattle. Moreover, there are only slight differences between Kourouma and Pays Lobi with respect to the relative importance of the traits. For example, for bulls fitness to traction, the most important trait in Kourouma is tied second in Pays Lobi, but disease resistance tied second trait in Pays Lobi, is also tied second in Kourouma. Also size is the last trait in both sites. For cows the relative importance of milk yield, disease resistance and weight gain varies between Pays Lobi and Kourouma, but fecundity and size have similar importance in both sites.

2.5.4 Perceptions of the relative performances of the main breeds

An indirect insight in farmers' breed preferences was provided by their opinions about the strengths (advantages) and weaknesses (disadvantages) of the main breeds.

2.5.4.1 Perceived advantages and disadvantages of the breeds

Tables 2.16 and 2.17 contain data on the reported advantages and disadvantages of Baoulé, Zebu and Méré for both sites. Results for both sites show that disease resistance and feeding ease were the main relative strengths of Baoulé cattle over the other two breeds. Baoulé was also granted some ability to traction in the Kourouma (32 out of 177). Their relative small size which leads to a relatively low price and their difficulty of handling are the main weaknesses.

The main advantages of Zebu cattle are their large size and their traction ability, the later being much important in Kourouma (56 out of 177) than in Pays Lobi (8 out of 122). Their susceptibility to diseases and their selective grazing habit were perceived as main disadvantages in both sites. As a crossbreed Méré cattle were seen to combine the advantages and disadvantages of Baoulé and Zebu. Their main advantages reported in Kourouma include disease resistance, fitness to traction, large size and rapid weight gain. Disease resistance, fitness to traction and size were also reported as main advantages in Pays Lobi. Farmers in Pays Lobi reported the difficulty of handling as the main disadvantage of Méré cattle while farmers in Kourouma added disease resistance to difficulty of handling. The fact that disease resistance was reported as an advantage and a disadvantage reflects the fact that farmers in both sites perceived Méré cattle as having some degree of trypanotolerance. It is worth mentioning that Baoulé and Zebu cattle have almost polar opposite weaknesses and strengths while Méré combine the strengths and weaknesses of Baoulé and Zebu. These results were consistent with preferences that farmers expressed for the breeds and which are discussed below.

2.5.4.2 Relative performances of the breeds

One important issue investigated in this study was to use the pre-selected seven traits of bulls and cows to evaluate the three breeds raised in the area. The purpose is to get some quantitative assessment of farmers' perceptions of the breeds. For that purpose survey respondents in both sites were asked to use the pre-selected traits and rate each breed using a 1-5 rating scale.

Table 2.18 contains data on the average ratings given by farmers to the three breeds. As expected Zebu was rated higher than Baoulé for most of the traits. Zebu was rated low for every trait for which Baoulé was rated high and vice-versa. Baoulé was rated highest for feeding ease, disease resistance and lowest for fitness to traction, weight gain, temperament, size, milk yield and fertility. Méré was rated between Baoulé and Zebu for all the traits except fitness to traction. To make comparisons among breeds much more meaningful, separate Analysis of Variance and Bartlett's homogeneity tests were performed on the ratings. The Analysis of Variance (ANOVA) tests would test for the equality of means while Bartlett's homogeneity test is intended to test for the equality of variances (Daniel, 1990; Daniel and Terrell, 1992; SPSS, 1994)). Results of these tests are presented in Table 2.17. Critical values for the ANOVA tests were $F_{2,528} = 3.02$ in Kourouma and $F_{2,363} = 3.04$ in Pays Lobi. On this basis results of the ANOVA test indicate that the average ratings for Baoulé and Zebu in both sites were statistically significant at the 1% level. Bartlett's homogeneity test results also indicated statistical significance at the 1% level implying that for the main breeds the traits included in this study do not have the same variance. These results imply that farmers in the study area perceived that the preselected traits of cattle can be used to describe Baoulé, Zebu and Méré.

Paired t-tests of ratings of specific traits for the breeds were performed in order to see if there were significant differences between pairs of breeds for the same traits. Results presented in Table 2.19 indicated that for both sites most of the traits were statistically significant at the 1% levels for the pairs Baoulé-Zebu, Baoulé-Méré and Méré-Zebu; there were only six cases out of the 60 possible pairs shown in Table 2.19 where the differences in ratings between pairs of breeds were not statistically significant. These include temperament for the pair Baoulé-Méré in Pays Lobi, weight gain, fecundity and fertility for the pair Zebu-Méré in Pays Lobi, fertility and the overall rating for the pair Zebu-Méré in Kourouma.

In general, the paired t-tests results provided another indication that Baoulé, Zebu and Méré were perceived as being different on the basis of the major traits. However, in six cases survey respondents did not perceive any real difference in performances between the pairs of breeds that were compared. For example, Baoulé and Méré were seen as having identical performances with respect to temperament in Pays Lobi. There is also some similarities between Zebu and Méré in Pays Lobi when fertility, weight gain and fecundity were considered. The two breeds were also found to be identical only on the basis of fertility in Kourouma. Finally, when the overall rating was considered, all breeds were found to be quite different in Pays Lobi, while in Kourouma Zebu and Méré were not statistically different.

The relative differences in ratings between Baoulé cattle and the other two breeds are shown by figures 1 to 3. These figures were based on data contained in Table 2.20 where differences in ratings between pairs of breeds were computed from data in Table 2.18. Figure 1 shows that Baoulé outperformed Zebu in disease resistance, feeding ease and temperament in Pays Lobi or fecundity in Kourouma. The overall preference is quite different between both sites. Baoulé was preferred in Pays Lobi, which was the opposite in Kourouma. Compared with Méré, Baoulé was rated higher in disease resistance, feeding ease and fecundity. The overall rating is much higher for Méré in both sites, suggesting a net preference for Méré to Baoulé. When Zebu and Méré are compared, farmers provided quite different assessments. In Pays Lobi, Méré was the overall preferred cattle; they were outperformed by Zebu cattle only in size, milk yield and fecundity. In Kourouma, Zebu were rated highest in six out of the nine traits: weight gain, temperament, fitness to traction, size, milk yield and fecundity. In terms of the overall preference, both breeds seemed to be equally preferred. Ratings for the two traits (disease resistance and feeding ease) for which cattle owners in both sites gave the highest rating to Méré were higher in Pays Lobi than in Kourouma.

A comparison of average ratings of traits between sites is also interesting as it provides some insight in how, using the same criteria, a given breed was perceived by farmers in each survey site. Paired t-tests of ratings of traits by breed between Kourouma and Pays Lobi were performed for that purpose. Statistical significance would mean that survey respondents in both sites gave different ratings to the given trait of the given breed, which would reflect differential perceptions of the breeds in question when that particular trait is considered.

Results of these tests presented in Table 2.21 indicate three main trends in the ways farmers in southern Burkina Faso perceive the main cattle breeds raised in their area. First, there is a global disagreement in perceptions of Zebu cattle between Kourouma and Pays Lobi because the tests were statistically significant at the 1 and 5 % levels in all traits except fertility.

Second, there is also a fairly global disagreement in farmers' perceptions of Méré cattle as tests were not statistically significant only for fertility and feeding ease. This result differs from that of Zebu in that here, tests were significant at 5% for three traits and at 10% for two traits.

Last, farmers' disagreement in the perceptions of Baoulé was larger than in the case of Zebu (3 against 1) or Méré (3 against 2). Farmers in both sites reported similarities in their perceptions of Baoulé in milk yield, fecundity and feeding ease, the only traits for which the tests were not statistically significant. These results provided another dimension in the differential perceptions of breeds between farmers in Kourouma and Pays Lobi.

2. 6 Conclusions and implications

Descriptive and non-parametric statistical tools were used in this chapter to gain insights into cattle production and breeding practices and farmers' preferences for the main breeds of cattle raised in southwestern Burkina Faso.

The review of the literature on livestock production in southern Burkina Faso and the use of focus group interviews with farmers in two representative areas indicated several traits of cattle of interest to farmers when they make choice about breeds. In order to investigate farmers preferences for the breeds, the most important traits were selected.

An analysis of survey data involving 299 households indicated three main production systems and various herd structures ranging from specialized herds with only one breed of cattle to more composite herds combining all three breeds. These herd structures seem to reflect different options in disease management and potential use of animals. For example, specialized herd structures with only Zebu cattle seem to be meant for beef and milk production or cash crop production which will provide enough returns to allow farmers to purchase preventive and curative drugs for disease control. In contrast, resource unavailability would force farmers with only Baoulé cattle in their herds to rely on their natural resistance to diseases.

The analysis of the herds structures by study site indicated significant differences between Kourouma and Pays Lobi. When we consider the number of herds having one, two or all the three breeds, Zebu and Méré predominated in Kourouma while Baoulé was the main breed in Pays Lobi. When the specific case of Baoulé is considered, the results show that of the 60% of farmers having Baoulé in their herds in Kourouma, only 4% have herds with only Baoulé; in contrast, of the 73% of farmers with Baoulé in their herds in Pays Lobi, 48% had Baoulé as the only breed. The frequent association of Baoulé and other breeds of cattle in Kourouma reflects the continuous interbreeding that has been occurring in the region, and which may lead to the extinction of Baoulé. The risk of extinction of Baoulé is lower in Pays Lobi where interbreeding has been limited.

The analysis of production systems also indicated that in addition to the production of meat and milk, cattle have other important roles such as animal traction, use as a cash reserve, means of transport, production of manure and an important social role (dowry, sacrifices and other social ceremonies).

Direct questioning of farmers about the advantages and disadvantages they perceive in each breed indicated that (1) Baoulé cattle were preferred to Zebu and Méré only in disease resistance and grazing habits, and (2) Zebu were preferred to Baoulé in several traits such as milk yield, size, fecundity, weight gain and traction ability.

The use of the matrix rating technique to evaluate the most important traits in assessing farmers' preferences provided results that were consistent with those obtained by directly questioning of farmers about the advantages and disadvantages they perceive in each breed. The relative advantages of Baoulé were their ability to graze a variety of forage and their resistance to diseases while Zebu was granted advantages in most of the reproductive traits and in traction. These relative advantages of Zebu provide the main explanation why farmers purchased more Zebu than Baoulé, despite the higher cost of Zebu relative to Baoulé.

The use of the matrix rating technique also allowed descriptive as well as quantitative analyses of the preferences. This allows a more in-depth analysis than was possible with the data provided by direct questioning of farmers. For example it was shown that farmers in both sites perceived significant differences in the traits of Zebu, with the tendency by farmers in Kourouma to give higher ratings for most traits.

This difference in assessing Zebu could be due to a better familiarity with Zebu on the part of farmers in Kourouma. There was also a widespread agreement among farmers about the strengths of Baoulé; in particular, there was no statistical difference in the ratings of disease resistance and feeding ease given by farmers who had Baoulé in their herd and those who did not.

Given that the increased trend towards Zebu seems to be driven by some important traits, it would be interesting for scientific research in breed improvement to focus on a more controlled adaptation of Zebu by cross-breeding with Baoulé. This is what most farmers have been doing but in a non discriminate way, which results in a wide range of crossbreeds.

Compared to a direct questioning of farmers, the matrix rating technique is a better investigating tool for assessing farmers' preferences for cattle breeds or crop varieties (Jabbar et al. 1997; Waters-Bayer and Bayer, 1994). Its main limitation, however, is that it is based on a decision making process focusing on single traits.

Results of a ranking process of the seven traits of cows and bulls indicated that the most important traits of cows were fecundity, weight gain, disease resistance, milk yield, feeding ease, temperament and size. For bulls the order of importance is fitness to traction, weight gain, disease resistance, feeding ease, fertility, temperament and size. The fact that rankings of traits provided by farmers in Kourouma and Pays Lobi showed some statistical differences provides an opportunity to characterize stylized profile of bull or cow for each zone. Farmers in Kourouma would prefer a bull with an ability for traction, able to graze various types of forage, easy to handle and resistant to diseases. They prefer fecundity, milk yield and feeding ease in cow. Cattle owners in Pays Lobi showed a high preference for weight gain, disease resistance and fitness to traction in bulls; their most preferred traits for cows are fecundity, weight gain and disease resistance.

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Table 2.1 Most important traits of bulls and cows revealed by farmers

Traits	Definition	Bulls or Cows
Market value	Expected selling price for the animal	bulls and cows
Mobility	Tendency for cattle to walk long distances for grazing.	bulls and cows
Weight gain	**Growth rate with which cattle arrive at mature size**	**bulls and cows**
Conformation	Represents the body condition	bulls and cows
Temperament	**Difficulty or ease of handling for traction or milking**	**bulls and cows**
Coat colour	Colour of the coat	bulls and cows
Size	**Combined measurement of height and body condition**	**bulls and cows**
Manure	Manure produced	bulls and cows
Social values	Sacrifices, bride prices and other traditional ceremonies	bulls and cows
Disease resistance	**How animals react to Trypanosomosis and other diseases**	**bulls and cows**
Feeding ease	**Ability of animals to graze various types of grass or to bear water shortage in dry seasons**	**bulls and cows**
Fitness to traction	**Performance in traction**	**bulls**
Fertility	**Libido**	**bulls**
Milk yield	**Amount of milk produced per day**	**cows**
Precocity	Early calving, short calving interval	cows
Fecundity	**Time period between successive calvings**	**cows**

Traits that are highlighted are those which were selected for the rest of the study in order to keep the survey designs with manageable size

Table 2.2: Population, sample households for the survey on breeding practices and breed preferences in southern Burkina Faso

	Mixed-crop farmers			Beef and milk producers	
Villages	Population	Sample	Complete data	Sample[1]	Complete data
Total Pays Lobi	**226**	**95**	**93**	**47**	**29**
Batié	34	16	14	0	0
Zilathéon	3	2	1	9	8
Koudio	11	4	4	9	9
Domsèrè	6	2	2	1	1
Bananba	20	8	7	5	4
Koriba	9	4	4	2	2
Passéna	25	10	10	0	0
Guirina	39	16	16	0	0
Latara	16	7	7	0	0
Dongolona	7	3	2	3	3
Diatara	12	5	5	0	0
Legmoin	13	5	5	0	0
Tobor	26	11	11	0	0
Koure	0	0	0	10	2
Dankana	5	2	2	8	0
Total Kourouma	**367**	**160**	**157**	**28**	**20**
Kourouma	170	69	68	3	3
Foulasso	39	18	18	8	5
Djigouéra	38	20	20	2	2
Gnignana	18	4	4	1	0
Sougouma	36	16	16	0	0
Zamakologo	8	5	5	7	5
Sofongo	17	7	7	5	5
Dougnouna	14	6	6	0	0
Toukorna	14	6	5	0	0
Gnizanso	13	9	9	1	0
Total survey	**593**	**255**	**250**	**75**	**49**

Source: Survey data. 1. Sample of Beef and Milk Producers equals the population

Table 2.3: Characteristics of survey respondents, southern Burkina Faso

	Number of respondents		Percentage of respondents	
	Kourouma	Pays Lobi	Kourouma	Pays Lobi
Main occupation				
Cattle	19	29	10.7	23.8
Crops	158	93	89.7	76.2
Total	177	122	100	100
Cattle ownership				
Owner	161	97	91	79.5
Owner and caretaker	16	25	9	20.5
Total	177	122	100	100
Breed composition of herds				
Households with:				
Baoulé only	7	59	4	48.4
Zebu only	39	11	22	9
Méré only	8	4	4.5	3.3
Méré and Baoulé	15	17	8.5	13.9
Baoulé and Zebu	28	4	15.8	3.3
Méré and Zebu	23	18	13	14.8
All three breeds	57	9	32.2	7.4
Total	177	122	100	100
Main production and management systems				
Mixed-crop	150	25	84.2	20.5
Beef and milk	24	41	14.7	33.6
Traditional	3	56	1.1	45.9
Total	177	122	100	100

Source: Survey data

Table 2.4: Number and percentage of households by main purposes of raising cattle, southern Burkina Faso

	Number of respondents		Percentage of respondents	
Main reason	Kourouma	Pays Lobi	Kourouma	Pays Lobi
Selling live cattle and milk	18	35	10.17	28.69
Sacrifices, dowry[1], and other social events	3	38	1.69	31.15
Draught purposes	150	25	84.75	20.49
Cattle as of store of wealth	6	24	3.39	19.67
Total	177	122	100	100

Source: Survey data

(1) In southern Burkina Faso, when a man is getting married, it is customary that his uncles give cattle (heifers, cows and calves) to the bride's family as the bride price.

Table 2.5: Number of cattle breeds by sources, southern Burkina Faso, Jan. 1996.

	Born in herd	Purchased	Inherited	Caretakenn	Total
Kourouma site					
Baoulé	442	441	12	32	927
Zebu	451	633	28	67	1179
Méré	421	537	5	54	1017
Total Kourouma	**1314**	**1601**	**45**	**153**	**3113**
Pays Lobi					
Baoulé	450	290	95	104	939
Zebu	938	1649	26	7	2620
Méré	576	996	15	64	1651
Total Pays Lobi	**1964**	**2935**	**136**	**175**	**5210**
Total study area	**3278**	**4536**	**181**	**328**	**8323**

Source: Survey data

Table 2.6: Herd structures by production systems and cattle ownership, southern Burkina Faso

	Production systems			Cattle ownership	
	Traditional	Mixed-crop	Beef and milk	Individual	Multiple
Kourouma site					
Baoulé only	0	6	1	7	0
Zebu only	1	30	9	39	1
Méré only	0	7	1	7	1
Méré and Baoulé	0	14	1	14	1
Baoulé and Zebu	0	22	6	24	4
Méré and Zebu	1	20	2	22	1
All three breeds	1	51	4	49	7
Total	3	150	24	162	15
Pays Lobi site					
Baoulé only	40	9	10	45	14
Zebu only	1	4	6	11	0
Méré only	0	3	1	4	0
Méré and Baoulé	13	1	3	12	5
Baoulé and Zebu	0	3	1	3	1
Méré and Zebu	1	1	16	18	0
All three breeds	1	4	4	4	5
Total	56	25	41	97	25

Source: Survey data

Table 2.7 Main characteristics of cattle production systems, southern Burkina Faso

	Mixed - crop	Beef and milk	Subsistence
Herd size			
Average number of animals	16	77	10
Average breed composition of herd (number of animals)			
Baoulé	5	6	12
Zebu	5	47	1
Méré	6	24	1
Herd management			
Percentage farmers using contract herders	95 %	0%	20%
Main ethnic groups (% of population)	Mossi (35%)	Fulani (78%), Lobi (10%)	Dagari (34%), Lobi (31%)
Crops grown in 1995			
Farmers growing cotton (%)	77%	0%	0%
Farmers growing food crops (%)	100%	92 %	100%
Use of animal traction			
Average number of animals used	5	1.4	0.5

Source: Survey data

Table 2.8. Herd structures of migrant and indigenous farmers in Kourouma and Pays Lobi, southwestern Burkina Faso

Herd structure by site	Migrant farmers	Indigenous farmers	Total
Kourouma			
Baoulé only	2	5	7
Zebu only	34	6	40
Méré only	3	5	8
Baoulé and Zebu	15	13	28
Baoulé and Méré	4	11	15
Zebu and Méré	13	10	23
All three breeds	8	48	56
Total number of farmers	79	98	177
Pays Lobi			
Baoulé only	6	53	59
Zebu only	10	1	11
Méré only	4	0	4
Baoulé and Zebu	3	1	4
Baoulé and Méré	6	11	17
Zebu and Méré	18	0	18
All three breeds	7	2	9
Total	54	68	122

Source: Survey data

Table 2.9: Mean rank values of traits and results of Friedman non-parametric test

	Kourouma		Pays Lobi	
	Bulls	Cows	Bulls	Cows
Traits				
Fitness to traction	2.59	n.a	3.07	n.a
Feeding ease	3.43	4	4.27	4.55
Temperament	3.6	4.41	5.05	5.36
Disease resistance	3.71	4.21	2.97	3.15
Weight gain	4.23	4.68	2.77	2.91
Fertility	5.08	n.a	3.48	n.a
Size	5.15	5.44	5.37	5.85
Fecundity	n.a	1.87	n.a	1.71
Milk yield	n.a	3.05	n.a	3.73
Friedman test parameters				
Chi-square	471.78	533.94	433.63	734.31
Degrees of freedom	6	6	6	6
Sample size	409	409	281	251
Significance	0	0	0	0

Source: Survey data. n.a: non applicable

Table 2.10. Crude and statistical rankings of traits of bulls and cows in Kourouma

crude and statistical rankings of bulls			crude and statistical rankings of cows		
crude rankings	Traits	statistical rankings	crude rankings	traits	statistical rankings
1	Fitness to traction (2.59)	1	1	Fecundity (1.87)	1
2	Feeding ease (3.43)	2	2	Milk yield (3.05)	2
3	Temperament (3.60)	2	3	Feeding ease (4.00)	3
4	Disease resistance (3.71)	2	4	Disease resistance (4.21)	4
5	Weight gain (4.23)	3	5	Temperament (4.41)	4
6	Fertility (5.08)	4	6	Weight gain (4.68)	5
7	Size (5.15)	5	7	Size (5.44)	6

Source: Analysis of survey data

The mean ranks of the traits are indicated in parentheses.
The crude rankings are based on the mean ranks of traits computed from the survey data and prior to the test of equality of means
The statistical rankings are based on the crude rankings and the results of the Wilcoxon test of equality of mean ranks of pairs of traits.

Table 2.11. Crude and statistical rankings of traits of bulls and cows in Pays Lobi

Crude and statistical rankings of bulls			crude and statistical rankings of cows		
crude rankings	Traits	statistical rankings	crude rankings	traits	statistical rankings
1	Weight gain (2.77)	1	1	Fecundity (1.71)	1
2	Disease resistance (2.97)	2	2	Weight gain (2.91)	2
3	Fitness to traction (3.07)	2	3	Disease resistance (3.15)	3
4	Fertility (3.48)	3	4	Milk yield (3.73)	4
5	Feeding ease (4.27)	4	5	Feeding ease (4.55)	5
6	Temperament (5.05)	5	6	Temperament (5.36)	6
7	Size (5.37)	6	7	Size (5.85)	7

Source: Analysis of survey data

The mean ranks of the traits are indicated in parentheses.

The crude rankings are based on the mean ranks of traits computed from the survey data and prior to the test of equality of means

The statistical rankings are based on the crude rankings and the results of the Wilcoxon test of equality of mean ranks of pairs of traits.

Table 2.12. Wilcoxon test results for Bulls in Pays Lobi, southwestern Burkina Faso

	Fitness to traction	Feeding ease	Temperament	Disease resistance	Weight gain	Fertility	Size
Fitness to traction							
Feeding ease	-7.71*						
Temperament	-10.09*	-5.01*					
Disease resistance	-0.98	-8.32*	-10.57*				
Weight gain	-2.02**	-8.49*	-10.65*	-1.33			
Fertility	-2.15**	-4.73*	-8.08*	-3.26*	-4.53*		
Size	-11.35*	-6.84*	-2.08**	-11.46*	-12.16*	-9.05*	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 2.13. Wilcoxon test results for Cows in Pays Lobi, southwestern Burkina Faso

	Fecundity	Feeding ease	Temperament	Disease resistance	Weight gain	Milk yield	Size
Fecundity							
Feeding ease	-12.89*						
Temperament	-13.31*	-5.24*					
Disease resistance	-9.39*	-8.41*	-10.92*				
Weight gain	-8.35*	-9.71*	-12.11*	-1.61***			
Milk yield	-11.16*	-5.21*	-8.16*	-3.87*	-4.98*		
Size	-13.51*	-9.08*	-3.42*	-12.69*	-12.87*	-11.68*	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 2.14. Wilcoxon test results for Bulls in Kourouma, southwestern Burkina Faso

	Fitness to traction	Feeding ease	Temperament	Disease resistance	Weight gain	Fertility	Size
Fitness to traction							
Feeding ease	-6.71*						
Temperament	-6.97*	-1.38					
Disease resistance	-7.82*	-1.96	-0.93				
Weight gain	-9.23*	-5.73*	-4.25*	-3.81*			
Fertility	-13.04*	-10.15*	-10.12*	-9.58*	-5.88*		
Size	-12.86*	-10.78*	-9.78*	-9.45*	-7.21*	-0.81	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 2.15. Wilcoxon test results for Cows in Kourouma, southwestern Burkina Faso

	Fecundity	Feeding ease	Temperament	Disease resistance	Weight gain	Milk yield	Size
Fecundity							
Feeding ease	-11.55*						
Temperament	-12.83*	2.56*					
Disease resistance	-12.78*	-1.44	-1.11				
Weight gain	-12.59*	-4.25*	-1.76**	-3.52*			
Milk yield	-8.96*	-5.99*	-8.22*	-7.22*	-8.45*		
Size	-13.69*	-7.89*	-6.01*	-5.35*	-5.08*	-11.45*	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 2.16: Number of households reporting the following advantages and disadvantages of different breeds, Kourouma in southwestern Burkina Faso

Cattle traits	Baoulé	Zebu	Méré
Reported advantages			
Feeding ease	18	0	8
Disease resistance	101	0	35
Fitness to traction	32	56	56
Temperament	2	10	10
Milk yield	4	6	6
Fecundity / Fertility	7	6	4
Size / Marketability	0	85	21
Rapid weight gain	1	10	18
Never experienced the breed	12	4	12
Like everything in the breed	0	0	7
Total	177	177	177
Reported disadvantages			
Selective grazing habit	0	35	1
Disease high mortality	0	108	15
Handling difficulty	83	9	36
Not support long hours of work	0	3	0
Small size / Marketability	55	0	0
Low milk yield	3	0	3
Low weight gain	5	3	0
Poor draught performance	8	0	2
Like everything in the breed	9	18	91
Never experienced the breed	14	4	28
Total	177	177	177

Source: Survey data

Table 2.17: Number of households reporting the following advantages and disadvantages of the main breeds in Pays Lobi, southern Burkina Faso

Cattle traits	Baoulé	Zebu	Méré
Reported advantages			
Feeding ease	34	0	4
Disease resistance	59	0	10
Fitness to traction	4	8	18
Temperament	12	0	5
Milk yield	0	1	4
Fecundity / Fertility	7	1	1
Size / Marketability	0	90	9
Rapid weight gain	1	7	5
Never experienced the breed	3	15	47
Do not like the breed	2	0	19
Total	122	122	122
Reported disadvantages			
Selective grazing habit	2	21	3
Disease high mortality	0	71	4
Handling difficulty	50	8	28
Not support long hours of work	2	1	1
Small size / Marketability	45	0	0
Low weight gain	5	0	0
Low milk yield	1	0	0
Never experienced the breed	3	19	58
Breed has no specific disadvantages	14	2	28
Total	122	122	122

Source: Survey data

Table 2.18: Average ratings of cattle breeds by surveyed households in southern Burkina Faso using a 1-5 scale

	Kourouma site (n=177)			Pays Lobi site (n=122)		
Cattle traits	Baoulé	Zebu	Méré	Baoulé	Zebu	Méré
Disease resistance	4.6(0.90)	2.5(1.1)	3.9(0.6)	4.8(0.6)	1.5(1.1)	4.2(1.4)
Weight gain	2.6(0.93)	4.6(0.85)	4.03(0.7)	2.5(1.2)	4.2(1.2)	4.3(1.3)
Feeding ease	4.3(1.13)	2.9(1.35)	3.9(0.6)	4.4(0.9)	1.8(1.1)	3.8(1.5)
Temperament	3.2(0.11)	4.1(1.3)	3.6(0.7)	3.9(1.3)	2.9(1.4)	3.9(1.5)
Fitness to traction	3.6(1.02)	4.3(1.05)	3.9(0.7)	2.8(1.4)	3.6(1.2)	4.3(1.5)
Size	2.5(0.94)	4.8(0.52)	3.9(0.5)	2.2(1)	4.6(0.8)	4.1(1.3)
Milk yield	3.2(1.26)	4.3(1.16)	3.7(1)	3(1.6)	4.7(1.1)	4.2(1.8)
Fecundity	4.1(1.22)	3.4(1.3)	3.8(0.9)	3.8(1.9)	4.2(1.7)	4.3(1.8)
Fertility	3.5(1.32)	3.9(1.32)	3.8(0.9)	3(1.5)	3.9(1.3)	3.8(1.7)
Overall rating	3.12(1.14)	4.01(1.02)	4.06(0.8)	3.4(0.7)	3.2(0.7)	3.6(0.7)
ANOVA test statistic F	70*	80.22*	4.20*	54.27*	109.5*	2.21
Bartlett's test statistic χ^2	90.48*	196.9*	163.1*	179.6*	78.4*	30*

Source: Survey data.

- Standard deviations are indicated in parentheses. Standard errors are not reported. For Kourouma, standard errors for ratings range between 0.07 and 0.11.for Baoulé, 0.04 and 0.10 for Zebu and between 0.04 and 0.08 for the Méré For Pays Lobi , standard errors for the same ratings range between 0.06 and 0.17 for Baoulé, between 0.07 and 0.13 for Zebu and between 0.12 and 0.17 for Méré cattle.
- * Statistically significant at the 1% level. Critical values of tests statistics are 3.02 for the ANOVA and 3.04 for Bartlett's test

Table 2.19. Paired t-tests of average ratings of traits between pairs of breeds in Kourouma and Pays Lobi, southern Burkina Faso

	Pays Lobi site			Kourouma site		
	Baoulé - Zebu	Baoulé - Méré	Zebu - Méré	Baoulé - Zebu	Baoulé - Méré	Zebu - Méré
Disease resistance	31.65*	5.20*	-16.74*	16.33*	8.98*	-15.32*
Weight gain	-9.08*	-10.06*	-0.53	-19.14*	-16.59*	6.26*
Feeding ease	15.56*	4.16*	-10.50*	7.79*	4.39*	-8.05*
Temperament	4.31*	-0.45	-4.69*	-5.03*	-3.34*	4.52*
Fitness to traction	-3.55*	-7.96*	-4.18*	-5.47*	-3.48*	-3.25*
Size	-18.18*	-11.91*	3.64*	-25.71*	18.24*	14.64*
Milk yield	-10.75*	-6.47*	2.74*	-8.93*	-4.61*	6.60*
Fecundity	-1.77***	-2.71*	-1.17	4.08*	1.95**	-3.48*
Fertility	-4.09*	-4.02*	0.71	-2.37**	-2.49**	0.79
Overall rating	2.49**	-2.02**	-6.21*	-11.84*	-17.04*	-0.79

Source: Analysis of survey data

*, **, *** Statistically significant at 1%, 5% and 10 % level respectively

Statistical significance means that survey respondents in Pays Lobi or Kourouma gave different ratings for the given trait and to the given pair of breeds. For example, farmers in both sites perceived all three breeds as being different to one another when disease resistance is considered; in contrast, farmers in Pays Lobi did not perceive any difference between Méré and Zebu when weight gain, fecundity or fertility were considered.

Table 2.20: Differences in average ratings of paired-breeds by survey site

	Pays Lobi site			Kourouma site		
	Baoulé - Zebu	Baoulé - Méré	Zebu - Méré	Baoulé - Zebu	Baoulé - Méré	Zebu - Méré
Disease resistance	3.39	0.68	-2.7	2.13	0.73	-1.4
Weight gain	-1.71	-1.8	-0.08	-1.96	1.4	0.56
Feeding ease	2.57	0.6	-1.98	1.33	0.43	-0.9
Temperament	0.9	-0.07	-0.98	-0.94	-0.45	0.49
Fitness to traction	-0.7	-1.43	-0.72	-0.69	-0.36	0.33
Size	-2.41	-1.93	0.48	-2.3	1.43	0.87
Milk yield	-1.68	-1.25	0.43	-1.15	-0.52	0.63
Fecundity	-0.37	-0.56	-0.19	0.61	0.21	-0.39
Fertility	-0.89	-0.75	0.14	-0.38	-0.29	0.08
Overall	0.26	-0.21	-0.48	-1.09	-0.94	-0.05

Source: Computed from average ratings of Table 16.
Column values are differences in average ratings of the indicated pair of breeds. For example column 2 shows for the given traits the differences in average ratings of Baoulé and Zebu. Negative values mean that in Pays Lobi Zebu cattle are perceived performing better than Baoulé cattle in weight gain, fitness to traction, size, milk yield, fecundity and fertility. Values in the other columns are interpreted the same way.

Table 2.21: Paired t-tests statistics of average ratings of traits by breeds between Kourouma and Pays Lobi, southwestern Burkina Faso

Cattle traits	Baoulé	Zebu	Méré
Disease resistance	2.57*	7.76*	2.02**
Weight gain	-2.25**	-3.35*	1.74***
Feeding ease	0.5	-8.37*	-0.76
Temperament	4.19*	-7.08*	2.08**
Fitness to traction	4.75*	-5.13*	2.44**
Size	-2.52**	-2.21**	1.92***
Milk yield	-1.09	2.51**	3.01*
Fecundity	-1.41	3.97*	2.79*
Fertility	-2.75*	0.26	0.12
Overall	3.76*	-10.23*	-5.98*

Source: Survey data.

*, **, *** Statistically significant at 1%, 5% and 10% levels respectively

Statistical significance means that survey respondents in Kourouma and Pays Lobi gave different ratings to the given trait of the given breed. For example, disease resistance for all three breeds was perceived differently by farmers in Kourouma and Pays Lobi; in contrast, feeding ease of Baoulé and Méré was perceived the same way by farmers in both sites

Fig 2.1: Net rating of Baoule to Zebu
in southern Burkina Faso

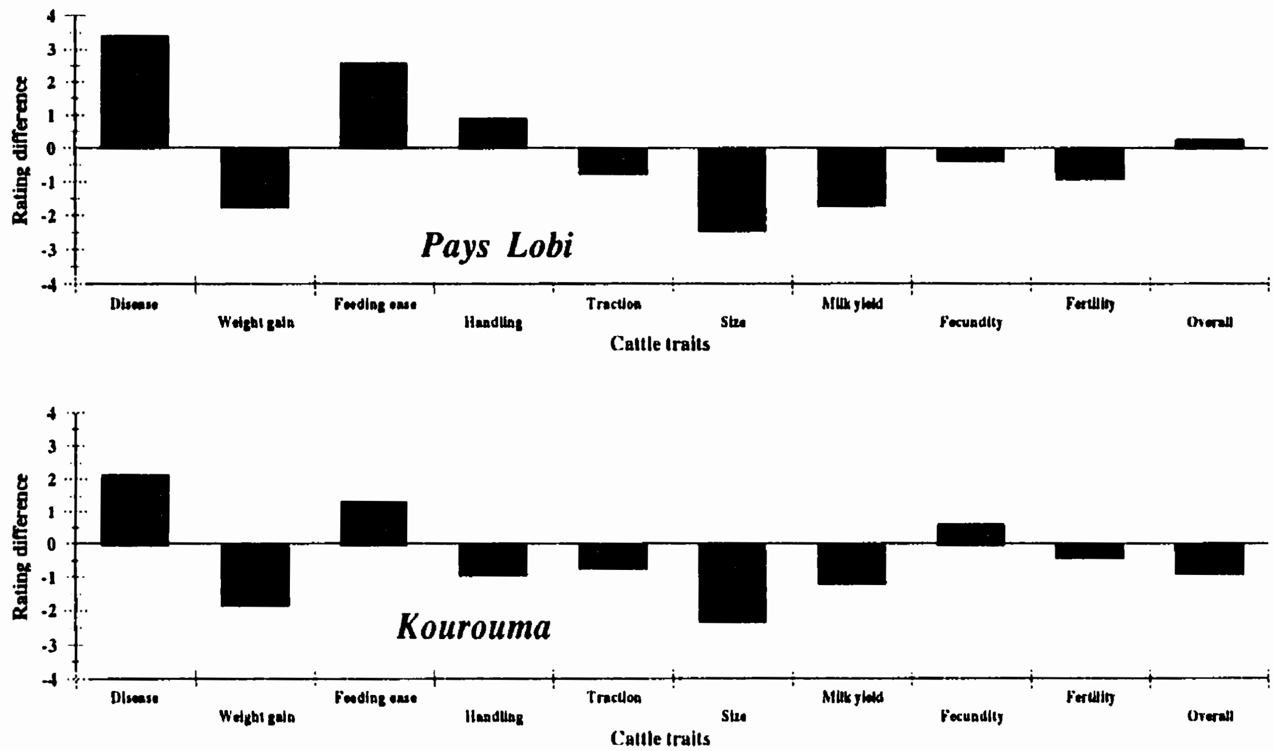
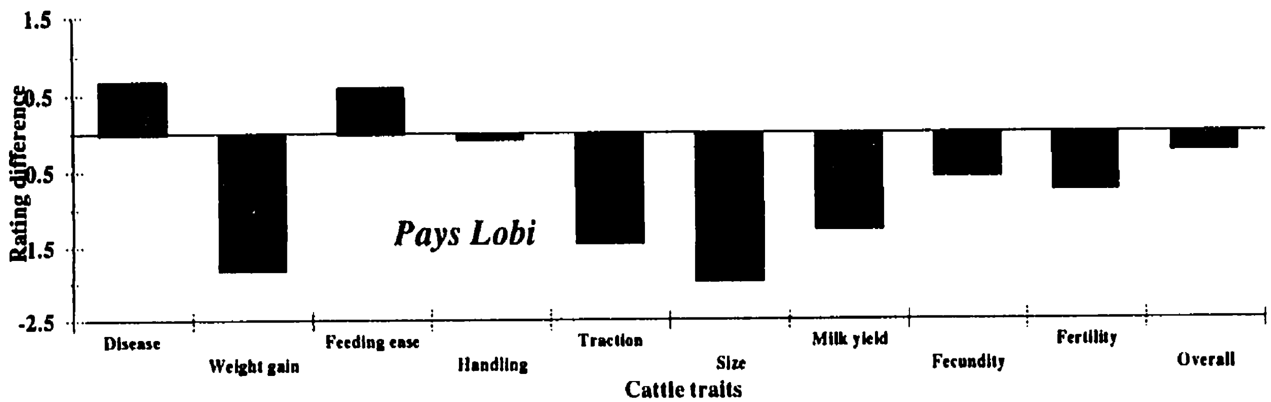


Fig 2.2: Net rating of Baoule to Mere
in southern Burkina Faso



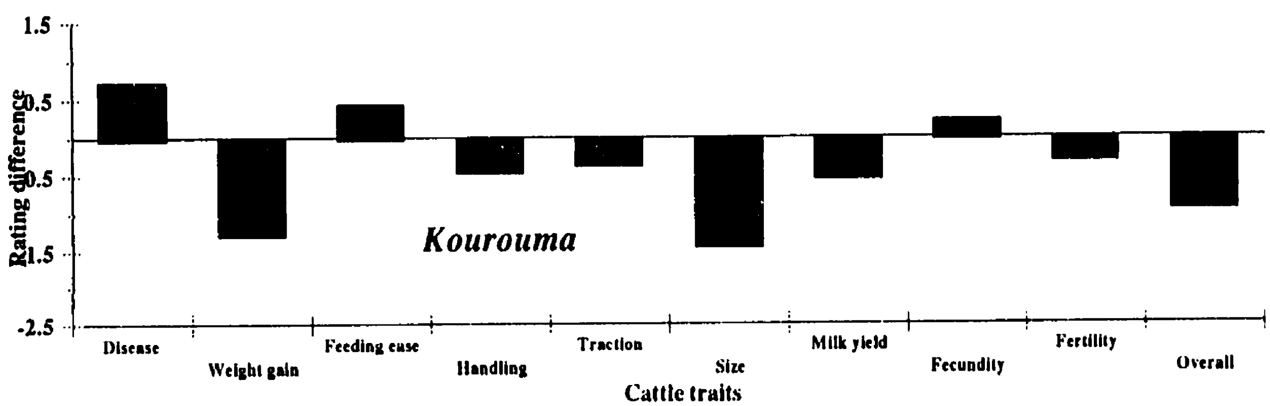
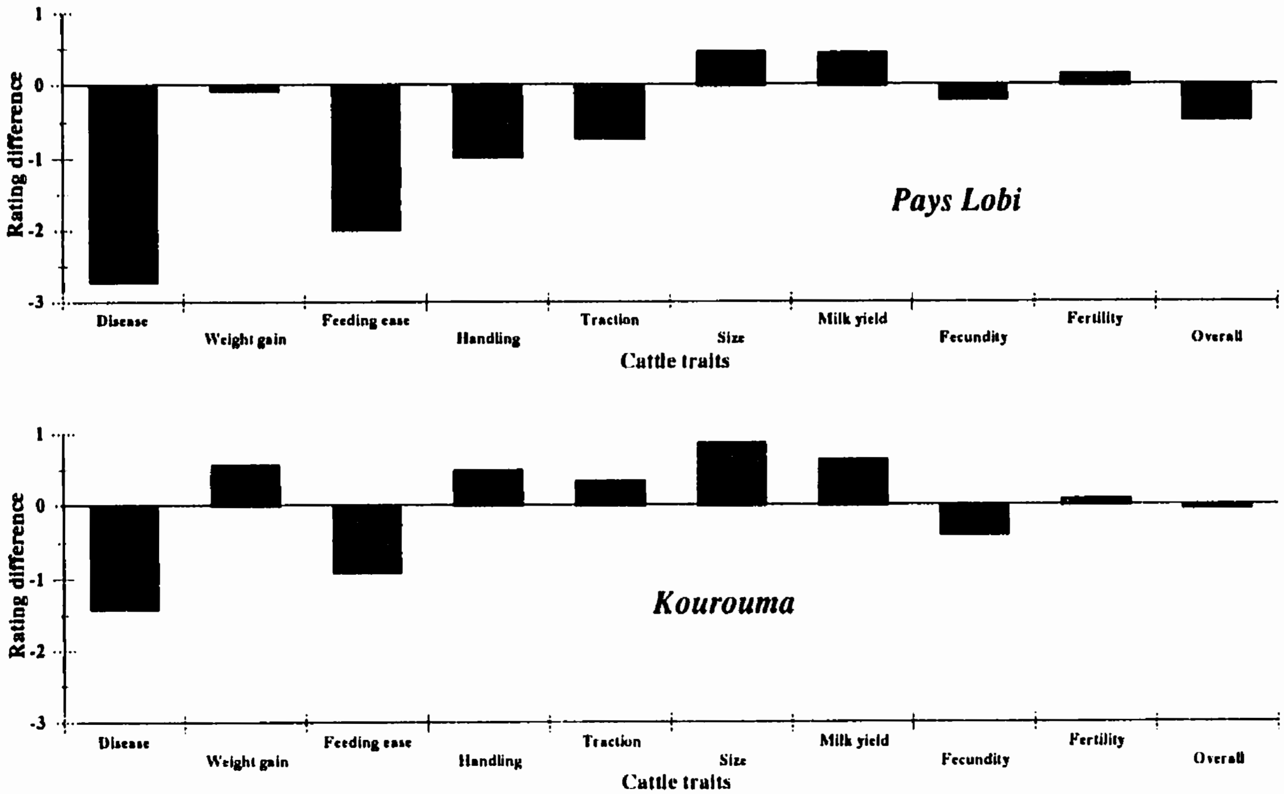
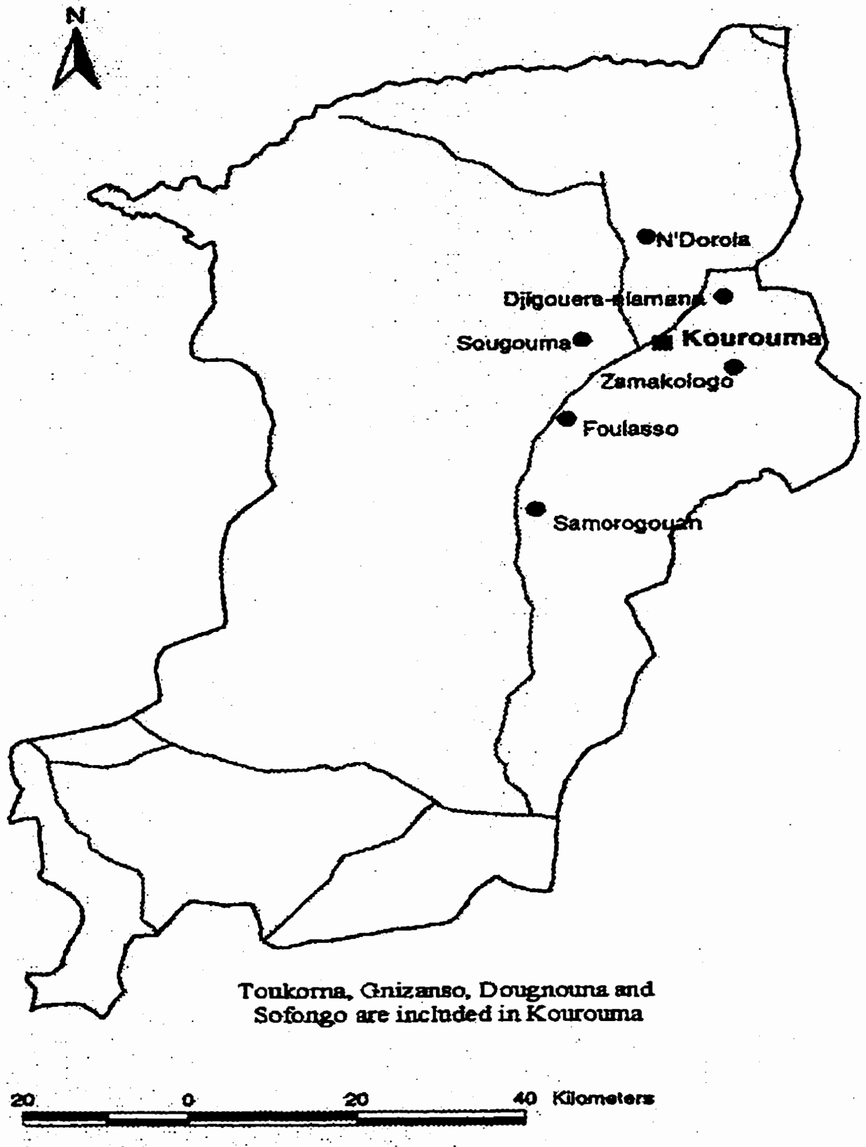


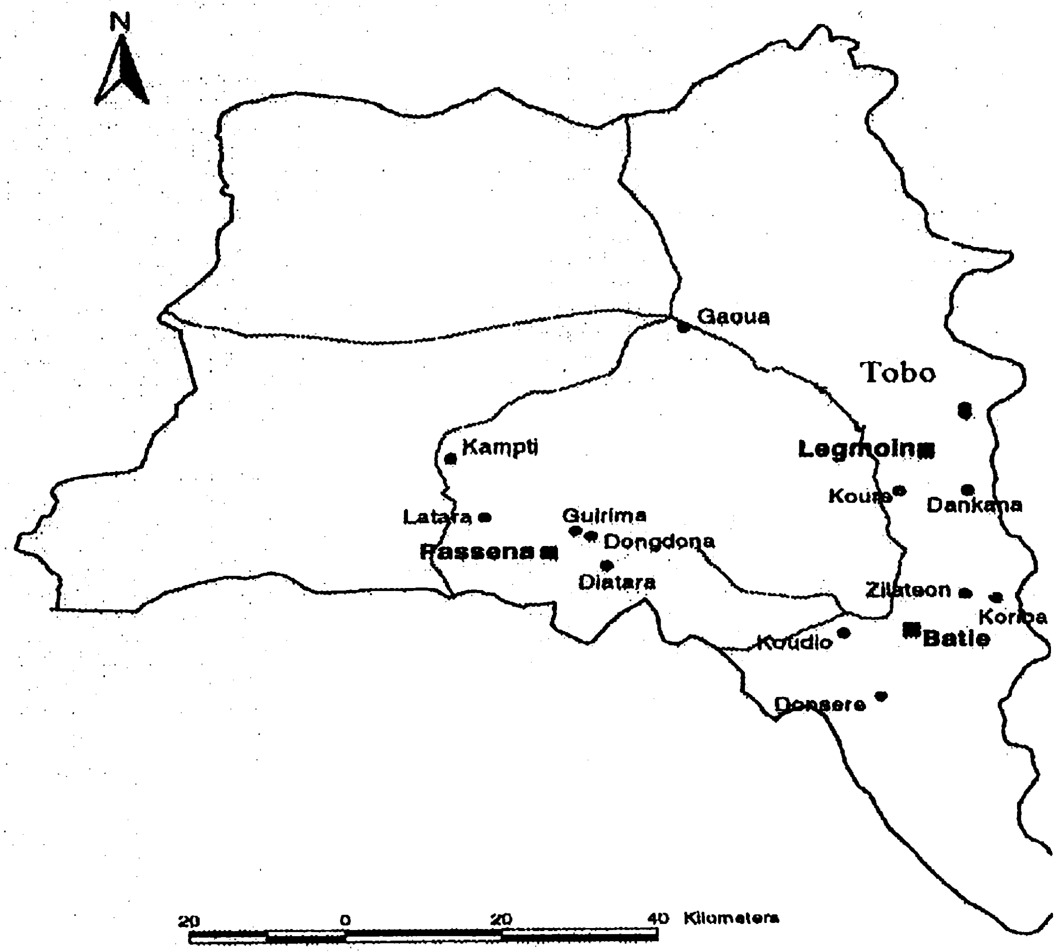
Fig 2.3: Net rating of Zebu to Mere
in southern Burkina Faso



Map 2.1: Survey villages in Kourouma, Kennedougou province



Map 2.2: Survey villages in Pays Lobi, Poni Province



APPENDIX 2.1

QUESTIONNAIRE FOR THE PRELIMINARY SURVEY ON THE RANKING OF THE TRAITS IN KOUROUMA AND PAYS LOBI

English translation

CIRDES / ILRI

CATTLE KEEPING HOUSEHOLDS CENSUS AND RANKING OF TRAITS OF BULLS

INSTRUCTIONS: Explain the meaning of the traits using the appropriate drawings. Ask the household head to rank all the traits indicated in the table. Use row per household head. Record the rankings in the cells.

N ^{0}	Name of respondent	Temperament	Weight gain	Disease resistance	Size	Fertility	Feeding ease	Fitness to traction
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

CIRDES / ILRI

CATTLE KEEPING HOUSEHOLDS CENSUS AND RANKING OF TRAITS OF COWS

INSTRUCTIONS: Use this side of the sheet for the rankings of cows. Make sure that the characteristics of the respondents reported here are identical to what was recorded for bulls. Fill in the form following the same procedure used for bulls.

N⁰	Name of respondent	Temperament	Weight gain	Disease	Size	Fecundity	Feeding	Milk
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

APPENDIX 2.2

QUESTIONNAIRE FOR THE SURVEY ON FARMING SYSTEMS AND GENETIC PREFERENCES IN KOUROUMA AND PAYS LOBI

English translation

Centre International de Recherche - Développement sur l'Elevage en zone Subhumide
International Livestock Research Institute

Collaborative Program on Trypanosomosis
Trypanotolerant Livestock in West Africa

Breeding Practices and Breed Preferences
in southern du Burkina Faso

Survey on Farming systems and Breed Preferences in Kourouma and Pays Lobi

Kouadio Tano,
Graduate Fellow, ILRI

Supervisor: Dr J.B. Mulumba Kamuanga,
Regional Economist, West Africa ILRI / CIRDES
Bobo - Dioulasso Burkina Faso

January 1996

1. Location N° /____/

Village:../_____/ Centre:................................/___/

2. Household head

Name:...

Ethnicity........................../___/ Gender: 1 = Male 2 = Female /___/

Main Occupation: 1 = Agriculture 2 = Cattle raising 3 = Other (specify)................/___/

Secondary Occupation 1 = Agriculture 2 = Cattle raising 3 = Other

(specify).............../___/

3. Main reasons for keeping cattle

First reason../___/

Second reason.../___/

Third reason../___/

4. Region of origin

Region of origin.../___/

Year of settlement.../___/

List of previous locations and reasons for leaving these locations

....

....

5. Herd Management

1 = Own herd 2 = Caretaking 3 = Own herd and

caretaking................................/____/

6. Cattle ownership

Manager......../___/ Managers' parents (brothers, Sisters, Father, Mother, uncle):....../___/ Spouses...../___/ Children...../____/ Caretaking......../___/

7. Modes of payment of caretaking arrangements

....

....

8. What are the advantages of the following breeds?

Baoulé..

Zebu..

Méré...

9. What are the disadvantages of the following breeds?

Baoulé...

Zebu...

Méré...

10. Breeding practices

Number of breeding bulls in herd Baoulé.../___/ Zebu..../___/ Méré...../___/

Why did you choose the breed type?.../___/

....

How do you mate the animals? 1 = Uncontrolled 2 = Controlled...............................

..../___/

Is it difficult to have the desired bull? /__/

1 = Yes If yes, specify../__/

2 = No If no, specify.../__/

11. Milk Production

Number of milking cows.../____/

Average quantity of milk collected every day (litres)?................................/___/

What proportion is sold ? ..../____/

1=All 2=Half 3=Less than half 4=More than half

What proportion is used for home consumption?../____/

1=All 2=Half 3=Less than half 4=More than half

12. Herd structure

List of all cattle in herd using the following table

Number	Breed	Male/Female	Age (months)	Castrated	Source	Use	Colour
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

Source: Inheritance, Dowry / Gift, Purchase, caretaking, Exchange.
Use: Traction or non traction

13. List all animal sales from January to December 1995

Number	Breed	Category[1]	Month	Price (CFA)[2]	Reasons for sale
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Use an additional sheet if required
1. Category could be: calf, bull, steer, heifer, cow
2. CFA Franc is the local currency ($1.00 C = 400 CFA F in 1996)

14. List all animal purchases from January to December 1995

Number	Breed	Category [1]	Month	Price (CFA)[2]	Reasons of purchase
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Use an additional sheet if required
1. Category could be: calf, bull, steer, heifer, cow
2. CFA Franc is the local currency ($1.00 C = 400 CFA F in 1996)

15. Crop farming

List of crops grown in 1995

Field number	Major crop	Additional crops	Size (ha)	Location*

* Location: distance from homestead

16. Grazing areas

How far are the grazing areas used in ?

1. The dry season ..../_____/ 2. The rainy season ..../____/

17. Matrix rating to assess the relative importance of the traits

Use a 1 to 5 scale and rate each breed on the basis on their relative performance in each of the traits. A value 1 to a breed means a poor performance of the breed for that trait and a value 5 means an excellent performance.

Traits	Baoulé	Zebu	Méré
Disease resistance			
Weight gain			
Feeding ease			
Fitness to traction			
Fertility			
Temperament			
Size			
Milk yield			
Fecundity			
Overall desirability			

Chapter 3

The determinants of the adoption of trypanotolerant cattle in southern Burkina Faso

3.1 Introduction

The southern region of Burkina Faso is a tsetse-infested area where three breeds of cattle, Baoulé, Zebu and Méré, are raised under different production and management systems. Baoulé, an indigenous breed found in pockets across West Africa, is known as trypanotolerant because of the ability to survive and produce in areas of low to moderate tsetse challenge without the aid of drugs (Rege et al., 1994; Jabbar et al., 1997).

Zebu were formerly raised outside the tsetse-infested areas, but their owners have been forced to settle in the humid, tsetse-infested zones by the prolonged droughts and the deterioration of range in their original locations.

Méré is a stabilized cross between Baoulé and Zebu. For Zebu owners who settled in tsetse-infested areas, crossbreeding Zebu with Baoulé was intended to reduce the risk of mortality due to trypanosomosis (Bassett, 1986). Farmers owning Baoulé also resort to crossbreeding of Zebu with Baoulé in order to produce larger animals for draught purposes. In fact Méré are believed to combine the trypanotolerance of Baoulé and the large size of Zebu.

The analysis of breeding practices and breed preferences conducted in chapter two indicated that Zebu were the most frequently owned cattle by mixed-crop farmers and beef and milk producers. Zebu were present in 83% of herds owned by mixed-crop farmers and beef and milk producers, of which 22% had only Zebu in their herds. In contrast, subsistence farmers tend to have herds with more Baoulé than any other breeds. About 73% of subsistence farmers had Baoulé in their herds, of which 48% had Baoulé as the unique breed.

Farmers' preference for each breed was based on their assessment of the strengths and weaknesses of the breed. Compared to Baoulé, Zebu were seen to have relative strengths in milk yield, size, fecundity, weight gain and traction ability while Baoulé cattle outperformed Zebu only in disease resistance and easy grazing habits.

This relative preference for Zebu is a serious threat for Baoulé, a breed with unique adaptive abilities in tsetse-infested areas. The risk of extinction of trypanotolerant cattle in tsetse-infested areas was assessed in a previous study of breeding practices and breed preferences in cattle in southern Nigeria (Jabbar et al., 1997). That study found a large shift away from the indigenous, trypanotolerant Muturu cattle and an increasing trend towards the White Fulani, a local variant of Zebu. The study also found that Muturu cattle were no longer raised in the study area because of their poor market value, low milk yield, small size and difficulty in handling.

Despite their abilities to survive under the unique conditions of the sub-humid zones (presence of tsetse, high humidity and heat stress), trypanotolerant cattle are under the threat of extinction in the humid and sub-humid zone of West and Central Africa due to indiscriminate slaughter for traditional ceremonies, continuous interbreeding with the other breeds, inappropriate husbandry techniques and neglect (Aboagye et al., 1994).

In this chapter we use a discrete choice model to estimate the determinants of trypanotolerant breed choice using survey data from southern Burkina Faso. The analysis of rating data conducted in chapter two indicated farmers' preferences for the most important traits of cattle. No explicit investigation was carried out about the factors affecting the adoption decisions of farmers. In fact, a high rating to a given trait provides limited information about farmers choice behaviour. This issue is well illustrated by the comparison shown below of ratings of disease resistance and feeding ease of Baoulé by farmers who owned Baoulé at the time of the survey and those who did not. Although farmers who did not own Baoulé tended to give lower ratings, their ratings for most of the traits were not statistically significant from those given by farmers who owned Baoulé as indicated in Table 3.1. Only the overall desirability and fertility would potentially explain the adoption. Thus, other factors have significant impact on the adoption of Baoulé by farmers in the study area.

In addition, the presence of Baoulé in the farming systems in southern Burkina Faso could well mean that this breed has some potential for livestock development in the area, despite the trend of mixed crop farmers and beef and milk producers towards Zebu. And for Baoulé to play a significant role in livestock development in this area, the main factors that are likely to affect its adoption need to be identified.

Findings of this study would help assess the actual demand for trypanotolerant cattle and their potential contribution to livestock development in the study area. Particularly, knowledge of factors that could help identify farmers most likely to keep Baoulé cattle would help devise effective policies intended to improve the performance of production systems involving Baoulé cattle. In addition, given that *in situ* conservation of indigenous cattle requires the actual use of the cattle in the production systems (Udo,1995), the study results would help design a genetic resources conservation strategy aiming at reducing the potential risk of extinction of the Baoulé cattle in the region. Finally, the results would provide guidance for the release and distribution of improved cattle breeds, given that private and public agencies have not proved to efficiently perform this tasks in most developing countries.

3. 2 Research objectives and organization of the chapter

This research investigates farmers' decisions regarding the use of Baoulé cattle in their production systems. The purpose is to determine the factors that affect the adoption of Baoulé. The emphasis is placed on the role of farmers' subjective perceptions of Baoulé and the other breeds on the decision whether or not to raise Baoulé. The following specific questions were investigated. How do farmers' perceptions of Baoulé, Zebu and Méré affect the patterns of adoption of Baoulé? Is there an identifiable demand for trypanotolerant cattle Baoulé in southern Burkina Faso? What factors would help identify farmers most likely to keep Baoulé?

The rest of the chapter is organized into five sections. Section 3 outlines major methods used to control trypanosomosis in Africa. Section 4 presents the conceptual model for the analysis and section 5 describes the variables, the empirical model and the source of data used for the analysis. The empirical results of the study are discussed in section 6 while section 7 summarizes the main conclusions of the study and their implications.

3. 3 Typanosomosis control methods in Africa

This section presents the most important methods of trypanosomosis control in the areas infested by tsetse flies. This overview of the control techniques is intended to show the extent of choice for disease management in the infested areas.

In cattle, AAT causes poor growth, low milk yield, weight loss, reduced work capacity, infertility, abortion and death. The consequences of trypanosomosis in cattle vary from place to place but, in general, it leads to a substantial under-exploitation of natural resources of the infested areas. Thus, a lower level of livestock production occurs than could be achieved if the disease were eradicated.

The methods to control trypanosomosis can be classified in two broad categories, the direct and the indirect methods. The indirect methods control the disease by trying to alter the environment so as to make it unsuitable for the tsetse fly. The direct methods aim at destroying the insects or eliminating their ability to breed.

3.3.1 Indirect methods to control trypanosomosis

The most important methods consist in (i) selective land clearing and (ii) the elimination of wildlife hosts. The destruction of the vegetation which harbours the flies affects the microclimate that may cause the tsetse flies to disappear. The technique requires a precise knowledge of the biology of the species in the infested areas. It can be very expensive as the cleared land must be monitored to avoid subsequently re-infestation unless it is kept cleared by intensive farming (Finelle, 1974; Jahnke, 1976). It may also lead to soil erosion.

A few wild animals can be an important source of blood meals for tsetse flies. A control method has been developed to eliminate the most preferred hosts. Besides the technical difficulties and the cost of carrying out a selective elimination of wild animals, ethical questions with regard to biodiversity can be raised about this practice. Given increasing concerns for wildlife protection and preservation, disease control measures with such negative impacts on wild animals are unlikely to enjoy widespread adoption.

3.3.2 Direct methods to control trypanosomosis

The most important methods are (i) the spraying of insecticide, (ii) the release of sterile males, (iii) the use of trypanocidal drugs, (iv) the use of traps and insecticide impregnated targets and (v) raising of trypanotolerant cattle.

Spraying of insecticides is carried out in the dry season and consists in applying the insecticide either over the entire tsetse-infested area or from the ground on the most preferred resting sites of tsetse flies. This requires a precise knowledge of the biology and ecology of the species in the area. Moreover its effectiveness depends upon a suitable isolation of the treated area from other contaminated regions either by clearing or re-treating the edge of the treated area with insecticide so as to prevent crossing by tsetse flies. It would also require checking movements of people, livestock and wildlife along the cleared or treated strip.

Chemical control of tsetse fly also raises the problem of pollution of the area concerned (Finelle, 1974).

The use of genetically controlled flies is another direct method to control tsetse flies. It consists in the breeding and release of a sufficient number of sterile males in a tsetse-infested area. Given that a female tsetse fly generally copulates only once at the beginning of its life, a significant reduction in the progeny due to the sterile males would result into a reduction or eventually an eradication of the population (Finelle,1974).

The sterile male method is quite attractive since it does not have any substantial negative impact in the natural equilibrium, because the tsetse fly is being used to destroy itself. However, it can be very expensive as it requires a large number of sterile males produced in laboratory by breeding and gamma irradiation. Moreover, it is possible that artificially bred flies may not behave as intended when they are released in a natural environment.

Several other methods involving the use of insecticide impregnated traps and targets have been introduced in recent years as a means of tsetse control (Kamuanga et al., 1995; Echessah et al., 1997). As they are much more focused in the use of the insecticide, these methods are environmentally safer than the aerial spraying. They have been effective in reducing tsetse challenge in various tsetse-infested areas in Western and Eastern Africa (Merot et al., 1984; Bauer et al., 1992; Grundler and Siguiri, 1991; Willemse, 1991). However, their effectiveness as a sustainable way to control trypanosomosis depends on a strong and constant support of beneficiary farmers.

Farmers' participation to the control activities is complex because of the potential free rider problem. As far as cattle production is concerned, the use of insecticide impregnated traps and targets can be considered as a public good because the benefits due to its implementation accrue to all herds in the treated areas. These methods provide a nonrival and nonexclusive service.

The free rider problem arises when a farmer deliberately decides not to participate in the control activities on the grounds that other farmers will carry out the control activities anyway, and that he or she will therefore enjoy the benefit without contributing to the provision of the control method. Farmers' involvement generally ranges from a passive form where people would restrain from vandalizing or removing targets and traps placed around their villages to an active form involving construction, monitoring and maintaining of their own traps and targets (Swallow and Woudyalew, 1994).

Using trypanocidal drugs is the most common direct method of controlling the effect of trypanosomosis in most tsetse-infested areas used by farmers. It has the advantage of being a private good because only the treated herds are protected. Its main disadvantages are the cost and the discontinuity in drugs availability. Also, the lack of qualified personnel in rural areas and the lack of adequate diagnosis of the disease could lead to an inappropriate drug usage, under-dosing and the consequent development of drug resistance (Jordan, 1993).

There is also evidence that pour-on formulations of insecticides applied directly to cattle (moving target) can control tsetse (CIRDES, 1995). However, applications of pour-ons can be considered as mixed private-public local good.

Utilizing cattle that have developed the ability to survive and produce in tsetse-infested areas, without the aid of a drug treatment is another potential way to control the effect of trypanosomosis. By taking advantage of their trypanotolerance, it is possible that livestock could more effectively utilize available resources. At the farm level, it is the alternative to the use of trypanocidal drugs, with the advantage of being a much lower cost disease management technique. In addition, problems related to the availability and the application of drugs, and the sustainability of the control technique would be avoided. Furthermore, the threat of extinction of indigenous breeds such as Baoulé or Muturu and the related issue of *in situ* conservation would be alleviated. However, this technique has the disadvantages pertaining to the relative weaknesses of Baoulé with respect to Zebu.

3.4 Theoretical model of adoption of Baoulé cattle

This section outlines the model used to investigate the probability of adopting Baoulé cattle in the study area. The approach follows a discrete choice framework in modeling farmers' decisions on whether or not to raise Baoulé. It is based on the theory of the demand for characteristics which reflects the fact that the utility of a product depends of its characteristics rather than the product per se (Lancaster, 1966). The model specification is based on a general framework provided by McFadden(1974), Domencich and McFadden(1975), Rahm and Huffman (1984) and Ben-Akiva and Lerman (1985) who used a random utility formulation. The general framework also assumes that, when facing a set of mutually exclusive alternatives, individuals choose the alternative that gives the largest utility. The random utility formulation which reflects the fact that all factors regarding factors affecting the individuals' choices are not known. Thus, the utility that an individual would derive from choosing an alternative can be expressed as a function of observable attributes of the chosen alternative and the individual, and a random component capturing variations in choice among decision makers, omitted variables, measurement errors and imperfect information.

Recall that we are investigating a case where farmers have the choice between raising Baoulé along with the other breeds and raising only the other two breeds. A general discrete choice model for the adoption of Baoulé is specified using a utility maximization procedure (Rahm and Huffman, 1984) and assuming a linear relationship between the dependent and the independent variables. As shown in equation (3.1), the utility U_{ij} that a farmer derives from choosing Baoulé is assumed to be a function of observed characteristics of the farm, the farmer and Baoulé cattle, and a random disturbance term with zero mean.

$$U_{ij} = X_j \alpha_i + Y_j \beta_i + Z_j \gamma_i + e_{ij} \qquad i=1,2; \qquad j=1,2,3,\ldots n; \qquad (3.1)$$

where i represents the alternatives (i=1 means that farmers choose to raise Baoulé, and i=2 means that they do not raise Baoulé), j represents the farmer making the choice, and X_j is a matrix of farmer's characteristics, Y_j represents the farm characteristics and Z_j includes the characteristics of the cattle breed.

The following is a derivation of the general model of the adoption of Baoulé which follows Ben-Akiva and Lerman (1985), Rahm and Huffman (1984) and Maddala (1983). Assuming that farmers choose the alternative that gives the largest utility, the j^{th} farmer will adopt alternative 1 if U_{1i} exceeds U_{2i} The adoption decision based on a qualitative variable D_j can be expressed as follows:

$$D_j = \begin{cases} 1 \textit{ if } U_{1i} > U_{2i}, \textit{ Baoulé cattle are raised,} \\ 0 \textit{ if } U_{1i} < U_{2i}, \textit{ Baoulé cattle are not raised} \end{cases}$$

Using the utility specification shown in equation (3.1), the probability of adopting Baoulé represented by $D_j=1$ can be expressed as:

$$P_j = P_r(D_j = 1) \qquad (3.2)$$

$$P_j = P_r(X_j\alpha_1 + Y_j\beta_1 + Z_j\gamma_1 + e_{1j} > X_j\alpha_2 + Y_j\beta_2 + Z_j\gamma_2 + e_{2j}) \qquad (3.3)$$

$$P_j = P_r(e_{1j} - e_{2j} < X_j(\alpha_2 - \alpha_1) + Y_j(\beta_2 - \beta_1) + Z_j(\gamma_2 - \gamma_1)) \qquad (3.4)$$

$$P_j = P_r(\mu_j < X_j\alpha + Y_j\beta + Z_j\gamma) \qquad (3.5)$$

$$P_j = F(X_j\alpha, Y_j\beta, Z_j\gamma) \qquad (3.6)$$

where P_j is the adoption probability, $\mu_j=e_{1j}-e_{2j}$ is a random term because it is the difference of two random terms, $\alpha=\alpha_2-\alpha_1$, $\beta=\beta_2 - \beta_1$, $\gamma=\gamma_2 - \gamma_1$ are vectors of coefficients, and $F(X_j\alpha, Y_j\beta, Z_j\gamma)$ is the cumulative density function for μ_j evaluated at $(X_j\alpha, Y_j\beta, Z_j\gamma)$. The right-hand side of equation (3.5) is a cumulative density function because it represents the probability that the random variable μ_j is below the known value $(X_j\alpha, Y_j\beta, Z_j\gamma)$. Estimation of equation (3.6) requires some knowledge of the distribution of F which is determined by the distribution of the random component of the utility μ_j. The solution to this common problem of discrete choice models is to assume some distribution of μ_j and derive the adoption probability. The probit model results from assuming that the random component of the utility is normally distributed while the logit model would result if the random components of the utility are assumed to be independently and identically distributed as a Weibull (or extreme value) distribution.

Assuming that the μ_j are independently and identically distributed with a Weibull density function, McFadden (1974) has shown that the probability that an individual facing a set of mutually exclusive alternatives will choose alternative i can be derived from the logistic function as:

$$P_j = \frac{e^{X_j\alpha + Y_j\beta + Z_j\gamma}}{1 + e^{X_j\alpha + Y_j\beta + Z_j\gamma}} \tag{3.7}$$

$$\frac{P_j}{1 - P_j} = e^{X_j\alpha + Y_j\beta + Z_j\gamma} \tag{3.8}$$

$$\ln\frac{P_j}{1 - P_j} = X_j\alpha + Y_j\beta + Z_j\gamma \tag{3.9}$$

Equation (3.9) can be estimated with Maximum Likelihood by forming the likelihood function and maximize it with respect to the vector of coefficients β. The estimated parameters are consistent and asymptotically normal and efficient.

Two main reasons motivated the choice of the logit model over other possible models such as Tobit. First, the adoption of trypanotolerant cattle by cattle owners was examined in a tsetse infested area in southern Nigeria by ILRI scientists (Jabbar et al., 1997). Using the same method assists in the comparison of the results over test sites, which will provide a broader understanding of the actual threat of extinction of trypanotolerant cattle in the sub-humid zone of West Africa. The second reason is that preliminary attempts to use a Tobit estimation procedure produced results that were inconsistent with theoretical expectations and minimal statistical significance.

3.5 Data and empirical model specification

This section presents the main source of the data used for the study and discusses how variables used in the analyses were chosen among the relevant variables. The model used for estimation is also presented.

3.5.1 Data type and source

The model of adopting Baoulé is estimated on a sample of cattle-keeping households surveyed in the study sites, i.e Kourouma and Pays Lobi. The sample of 299 households who provided data for the study of breeding practices and breed preferences also provided data for this analysis. They were selected from the population of 694 households enumerated in 25 randomly selected villages in both sites. Data were collected in January and February 1996 and the following information was obtained from each household.

▸ Socioeconomic data of the household head, including sex, ethnic group, main and secondary occupation, region of origin. For non indigenous farmers, additional information were collected on the year of settlement, the number and the duration of previous settlements.

▸ Cattle production and management data, including main reasons of raising cattle, cattle ownership, perceived advantages and disadvantages of each breed, number and type of breeding bull, number of animals by breed, sex, source, current use, and sale and purchase of animals in 1995.

▸ Rating of each breed using the most important traits of cattle that result from preliminary focus group interviews with farmers. These traits included disease resistance, fitness to traction, feeding ease, temperament, weight gain, fertility, fecundity, milk yield and size. In addition, breeds were assessed on the basis of the overall desirability. In assessing cattle, farmers were asked to rate each breed using every important trait on d a 1-5 scale, where 1 represents the lowest ability of the breed for the specified trait, 5 represents the highest ability of the breed for the trait.

3.5.2 Definition of variables and empirical model

The adoption model specified in equation (3.9) will measure the impacts that the vector of characteristics X_j, Y_j and Z_j would have on farmers' decision regarding the adoption of Baoulé. Like in most adoption studies the characteristics of the farm, the farmer and the technology have been considered.

Only few studies have focused explicitly on how farmers' subjective assessments of agricultural technology characteristics affect their adoption decisions (Feder et al., 1985; Adessina and Baidu-Forson, 1995). In this study, we have followed the `adopter perception' paradigm which suggests that farmers have subjective preferences of technology attributes and these could play major roles in technology adoption (Adessina and Zinnah, 1993; Ashby et al., 1989).

The dependent variable represents whether a surveyed household held or did not hold Baoulé cattle in herd at the time of the survey. Two variations of the dependent variable reflecting alternatives herd structures are used. The first case consisting of model 1 represents the case where some (but not all) cattle in herd are Baoulé breed, while model 2 considers the case where Baoulé cattle are the only breed in the herd. The dependent variable, in both models, takes a value of 1 if the household held a Baoulé cattle at the time of the survey and 0 otherwise. The following variables are the main factors that are hypothesized to have an impact on the probability of adoption of Baoulé:

- The decision power that farmers have in herd management
- The farmer migration status
- The type of production system used by farmers
- Farmers' perceptions of the relative performances of the breeds

The type of decision power that was available for herd management. This was measured by two indexes: the management decision power and the discretion over the choice of Baoulé. The index of management decision power is measured by the percentage of the total herd owned by the herd manager. A common herd management practice is caretaking arrangements which occur when a farmer is managing cattle for a portfolio of owners, some of which may have a preference for Baoulé. Farmers involved in such arrangements were hypothesized to be more likely to hold Baoulé breed because of the wider potential source of animals. Caretaking arrangements have been shown to increase the adoption of trypanotolerant cattle (Jabbar et al., 1997). Initial estimations including a variable representing caretaking arrangements provided inconsistent results so that this variable was replaced by the index of discretion over the choice of Baoulé cattle measured by the percentage of total herd represented by Baoulé that were purchased and introduced into the herd. This index is hypothesized to positively affect the adoption of Baoulé.

Farmers migration status. It is a proxy for the length of settlement in the study area, variable which could not be measured for all respondents. Farmers were classified into two broad categories. Indigenous farmers represent one category. Farmers who have their origin in a tsetse-infested area are more likely to keep Baoulé because they had to adjust breeding practices to incorporate resistance to diseases in an environment with low to moderate tsetse challenge. In contrast, migrant farmers who, for the most part, originated from the northern regions would tend to raise Zebu. Although some migrants who have living in the area for a long time would have more Baoulé than the newly arrived ones, migrants in general tend to raise Zebu.

The type of production systems used by farmers. Mixed crop farmers and beef and milk producers are less likely to keep Baoulé because of its poorer draught performance, a low market value and poor productive performances (milk yield, weight gain). However, farmers in the subsistence system are more likely to keep Baoulé because of its low requirements in feed and health and a greater probability of survival.

How farmers perceived the relative performances of Baoulé Zebu and Méré using the important traits. A high rating given by farmers to relevant traits of Baoulé would have a positive impact on the probability of adopting Baoulé. In contrast, a high rating of relevant traits of Zebu or Méré would have a negative impact the probability of adopting Baoulé (Jabbar et al., 1997). However, rating data in Table 3.1 indicated that there is no significant difference in the ratings of disease resistance and feeding ease given by farmers who had Baoulé in their herd at the time of the survey and those who did not. Therefore, the relative strengths of Baoulé in disease resistance and feeding ease may not be reflected as major determinants of the probability of adoption of Baoulé. Three sets of variables representing farmers' perceptions of the breeds are included in the empirical models. The first set consists of fertility and overall desirability of Baoulé, which is hypothesized to have a positive impact on the probability of adoption of Baoulé; a set including fitness to traction and disease resistance of Zebu is hypothesized to have a negative impact on the probability of adoption of Baoulé; and the last set considers the overall desirability of Méré, with a negative impact on the probability of adoption of Baoulé.

Several other variables with potential impact on the adoption of Baoulé could not be included in the analysis for various reasons. Disease resistance and feeding ease of Baoulé were eliminated because the preliminary results were not statistically significant. As indicated earlier, statistical analysis of ratings of traits given by respondents owning Baoulé at the time of the survey and those who did not own Baoulé indicated that both types of respondents gave similar ratings to these traits of Baoulé, so it is likely there was insufficient variation in the sample for this variable to have a significant result. The overall rating of Zebu was highly collinear with that of disease resistance of Zebu and was excluded from the analysis to avoid multicollinearity. Since disease resistance of Baoulé was not included in the analysis, it was important to include disease resistance of Zebu as an indirect way of testing the hypothesis that cattle owners who are likely to hold Zebu would tend to give higher rating for disease resistance of Zebu than those who did not. Thus rating of disease resistance of Zebu should negatively affect the adoption of Baoulé. The definitions and measurements of the variables used in the models, and their descriptive statistics are given in Table 3.2 and Table 3.3 respectively.

Using the Logit model notation specified in equation (5), the estimating equation would be as follows:

$$
\begin{aligned}
ln\,\frac{P_i}{1-P_i} &= \alpha_0 + \alpha_1 Subsist + \alpha_2 Milk + \beta_1 Boval + \beta_2 Fertau \\
&+ \beta_3 Malzeb + \beta_4 Traczeb + \beta_5 Moval \\
&+ \gamma_1 Migrant + \gamma_2 Decipo + \gamma_2` Bapaid \qquad (3.10)
\end{aligned}
$$

A simple additive form was used in the final model because earlier attempts to incorporate interaction variables between traits produced non significant results or parameters with inconsistent signs. In estimating equation (3.10), two independent variables were omitted in order to avoid the dummy variable trap. The omitted variables are draught representing mixed crop farming and indigenous representing the indigenous farmers.

3.6 Results and discussion

The model was estimated using the iterative Maximum Likelihood procedure of Limdep (Greene, 1995) in order to obtain asymptotically efficient parameters. Goodness-of-fit statistics and parameter estimates are presented in Table 3.4. The estimated models fitted the data well as indicated by the whole significance level, the Log likelihood function and the Chi-squared statistics.

When model 1 (which utilizes the broader definition of Baoulé) is examined, four variables are significant at the 0.01 level, two are significant at the 0.05 level and two are significant at the 0.10 level. The variables related to the farming systems and the overall desirability of Baoulé and Méré have the expected significant impacts on the probability of adoption of Baoulé. But rating of disease resistance of Zebu and the discretion over the choice of Baoulé are not statistically significant while management decision power and rating of fitness to traction of Zebu have significant impacts on the probability of adoption of Baoulé. The significance of estimated coefficients resulting from a Maximum Likelihood procedure are normally assessed using the p-value. The estimating procedure of Limdep (Greene, 1995) provided a "Z" statistic computed as the ratio of the estimates and their standard errors. This "Z" statistic was used as it results in levels of significance similar to those that would result with the use of the p-value.

Examining model 2 which considers that only Baoulé was raised, most variables are significant at the 0.01 level. As expected, the discretion over the choice of Baoulé, the overall desirability of Baoulé and subsistence farming system have positive impacts on the probability of adopting Baoulé.

In contrast, the mixed crop farming system, the overall desirability of Méré, the disease resistance of Zebu and a short time spent in the region have negative impacts on the probability of adopting Baoulé. However, the relative strength of Zebu in fitness to traction, and fertility of Baoulé did not have a detectable statistical impact of the probability of adoption of Baoulé.

The positive and statistically significant impact of beef and milk production system on the adoption of Baoulé in both models may reflect the fact that beef and milk producers have some interest in a disease management strategy including the use of trypanotolerant cattle.

Given that the left hand side of equation (3.10) represents the log of the odds ratio in favor of adopting Baoulé, the estimated coefficients actually give the change in the log of the odds ratio for a unit change in the explanatory variables. The impact of the independent variables on the probability of adoption requires that the actual probabilities of choice be computed using the estimated regression (Gujarati, 1988).

To compute the actual probabilities of adopting Baoulé cattle by a given household, he independent variables are replaced by their values for each household in the estimated regression. Using equation (3.11) which represents the estimated regression of model 2, the probability that an average migrant farmer involved in a milk and beef farming system would adopt Baoulé can be derived. As an average migrant farmer involved in milk and beef production is considered, variables milk and migrant in equation (3.11) take the values of 1, the other variables will be replaced by their average values shown in Table 3.3. This is shown

$$In\frac{P_i}{1-P_i} = -0.780 + 1.78\,Subsist + 1.73\,Milk + 1.24\,Boval + 0.17\,Fertau$$
$$- 0.60\,Malzeb - 0.19\,Traczeb - 1.52\,Moval$$
$$- 1.59\,Migrant + 0.013\,Decipo + 0.023\,Bapaid \qquad (3.11)$$

in equation (3.12) where the right-hand side is the result of (a) replacing Subsist by 0, Milk and Migrant by 1 and the other variables by their mean values indicated in Table 3.3, and (b) adding up the different values. Taking the anti-log of both sides of equation (3.12) leads to the result shown in equation (3.13). An algebraic manipulation of equation (3.13) gives the probability that an average migrant farmer involved a beef and milk production to adopt Baoulé to be equal 0.0898 or about 9%:

$$\ln\frac{P_i}{1-P_i} = -\ 2.316 \qquad (3.12)$$

$$\frac{P_i}{1-P_i} = 0.09 \qquad (3.13)$$

Following the same procedure, the probability that an average indigenous farmer involved in traditional subsistence system will adopt a Baoulé breed is 0.714 or 71%. Similarly, an average migrant and mixed crop farmer would have a probability of 0.0005 or near 0% chance of adopting Baoulé cattle.

3.7 Conclusions and implications

The purpose of this chapter was to quantify how several factors including farmers' perceptions about the breeds of cattle raised in southern Burkina Faso accounted for the adoption of Baoulé cattle. The analyses showed that the type of production system and farmers' subjective evaluation of the breeds were significant determinants of the adoption of Baoulé. Indigenous farmers and farmers involved in a subsistence system were also more likely to have Baoulé. In contrast, migrant and mixed crop farmers were less likely to keep Baoulé. The analysis also indicated that farmers' subjective perceptions of the breeds such as the overall desirability of Baoulé or Méré have significant impacts on the probability of adoption of Baoulé.

These results confirm the findings of previous adoption studies about the significant role of farmers' perceptions of the technology characteristics on their adoption decisions (Jabbar et al., 1997; Feder and al.,1985; Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995). However, in this study, the high ratings of disease resistance and feeding ease of Baoulé did not make these traits major determinants of the probability of adoption of Baoulé, in contrast to what has been observed in southern Nigeria (Jabbar et al., 1997). The significant impact of farmers' perceptions on their adoption decisions imply that extension programs may have some role in adoption decisions.

Results indicate that a high perceived overall advantage of Baoulé to the other breeds (i.e., variable Boval), positively affects the odds of having a Baoulé breed in the herd and confirms the role of the subsistence farming system (for breed preservation) where cattle figure much more as living savings that are converted into cash only when the need arises (Udo, 1995). This farming system may have the potential for *in situ* conservation of Baoulé. The target for such a breed conservation strategy could be indigenous farmers using the subsistence farming system (i.e., most farmers in Pays Lobi) who have a high probability of adopting Baoulé.

For cash crop growing areas (i.e., Kourouma), there seems to be very little scope for *in situ* conservation as the probability of adoption of Baoulé for mixed crop farmers is very low. Efforts aiming at preserving Baoulé cattle could also be directed towards beef and milk producers as they showed some interest in a disease management strategy including the use of trypanotolerant cattle.

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Table 3.1 Average ratings of traits of Baoulé by ownership test for the equality of the means.

Traits	Average ratings given by farmers who...		Paired t-statistic for the quality of means
	had Baoulé	did not have Baoulé	
disease resistance	4.74(0.71)	4.66(0.98)	-0.81
weight gain	2.6 (1.04)	2.51(1.05)	-0.71
feeding ease	4.33(0.99)	4.36(1.17)	0.25
fitness to traction	3.37(1.26)	3.11(1.21)	-1.78***
temperament	3.47(1.44)	3.47(1.45)	0.03
milk yield	3.02(1.34)	3.27(1.55)	1.47
fecundity	4.08(1.44)	3.74(1.66)	-1.83***
fertility	3.57(1.41)	2.97(1.39)	-3.50*
size	2.45(0.98)	2.27(0.95)	-1.5
Overall desirability	3.41(0.64)	2.93(0.61)	-6.25*

Source: Survey data
Statistical significance: * 1%, ** 5% and *** 10%
Values in parentheses indicate standard errors

Table 3.2 Definitions of variables in the empirical models

Variable	Definition
Dependent variable	
Trypano (Model 1)	Adoption of Baoulé measured by a binary variable taking value 1 if some (but not all) cattle in herd at the time of the survey are Baoulé, and 0 otherwise.
Baoulé (Model 2)	Adoption of Baoulé measured by a binary variable taking value 1 if the farmer had only Baoulé in his herd at the time of the survey, and 0 otherwise.
Independent variables related to..	
the farm	
SUBSIST	Subsistence production system. Measured by a binary variable taking on value 1 for farmers using this farming system at the time of the survey, and 0 otherwise.
MILK	Milk and beef farming system. Measured by a binary variable taking on value 1 for farmers using this farming system at the time of the survey, and 0 otherwise.
DRAUGHT	Mixed crop production system. Measured by a binary variable taking on value 1 for farmers using this farming system at the time of the survey, and 0 otherwise.
the farmer	
MIGRANT	Migrant farmer measured by a binary variable taking on value 1 for farmers who originated from other provinces of Burkina Faso or countries and settled in the area, and 0 otherwise.
INDIGENOUS	Local farmer measured by a binary variable taking on value 1 for farmers who originated from the area, and 0 otherwise.
herd management	
DECIPO	Decision power. Measured as the percentage of total herd owned by the herd manager.
BAPAID	Discretion over the choice of Baoulé. Measured as the percentage of total herd represented by purchased Baoulé
farmers' perception of breeds	
BOVAL	Overall desirability of Baoulé. Measured by the rating (1-5) given by the farmer to the overall desirability of Baoulé.
FERTAU	Fertility of Baoulé. Measured by the rating (1-5) given by farmers to that trait.
MALZEB	Disease resistance of Zebu. Measured by the rating(1-5) that farmers gave to that trait.
TRACZEB	Fitness to traction of Zebu. Measured by the rating(1-5) given by farmers to that trait.
MOVAL	Overall desirability of Méré. Measured by the rating(1-5) given by farmers to that trait.

Table 3.3. Descriptive statistics of the variables used in the empirical models of adoption of Baoulé cattle, southern Burkina Faso

Variables	Mean	Standard deviation
SUBSIST	0.22	0.41
MILK	0.2	0.4
MIGRANT	0.44	0.49
DECIPO	95.72	14.14
BAPAID	16.82	25.54
BOVAL	3.24	0.67
FERTAU	3.36	1.43
MALZEB	2.07	1.22
TRACZEB	3.38	1.17
MOVAL	3.88	0.59

Source: Survey data

Table 3. 4 Estimated coefficients of the factors affecting choice of Baoulé cattle in southern Burkina Faso

Variables	Baoulé and others	Only Baoulé
CONSTANT	6.17 (3.55)***	-0.78 (2.53)
SUBSIST	1.36 (0.80)***	1.78 (0.53)*
MILK	2.00 (0.83)*	1.73 (0.61)*
MIGRANT	-3.22 (0.68)*	-1.59 (0.53)*
DECIPO	-0.046 (0.015)*	0.013 (0.016)
BAPAID	8.49 (112.9)	0.023 (0.007)*
BOVAL	1.36 (0.49)*	1.24 (0.33)*
FERTITAU	0.11 (0.24)	0.17 (0.16)
MALZEB	-0.19 (0.26)	-0.60 (0.23)*
TRACZEB	-0.46 (0.25)**	-0.19 (0.18)
MOVAL	-1.09 (0.55)**	-.152 (0.43)*
Log likelihood function	-44.649	-77.22
Restricted log likelihood	-193.18	-157.82
Chi-squared	297.064	161.19
Level of significance	0.001	0.001
Degrees of freedom	10	10

Figures in parentheses are standard errors.
Asterisks *, **, *** indicate statistical significance at the 1%, 5%, and 10% respectively.

Chapter 4

Using conjoint analysis to estimate preferences for cattle traits

4.1 Introduction

The purpose of this chapter is to estimate farmers' preferences for cattle traits in southern Burkina Faso using the technique of conjoint analysis. Conjoint analysis is a survey-based system for measuring preferences, originally designed for consumer behaviour in marketing, transportation planning, and recreation studies. Recent application to agricultural production includes cattle breed preferences (Sy et al., 1997) and design of groundnut varieties (Baidu-Forson et al., 1997).

Farmer preferences for traits of cattle were already examined in chapter two, which used data from a sample of farmers that rated the traits that they regarded as the most important using a preference scale. When they were interviewed, farmers were also asked to provide another perspective on their preferences by ranking the same traits according to the relative importance of each trait to their activities.

These self-explicative ratings and rankings shed some light onto farmers' preferences and provide information that could be used in cattle development projects and breed improvement and dissemination programs. However, they are based on single traits, which might be inconsistent with actual decision making. As Weiner (1993) has noted, it is unlikely that farmers would face choice decisions that focus on each trait individually. Instead, farmers face choice decisions in which goods are seen as having several characteristics and they are forced to make tradeoffs with some levels of characteristics in order to gain other levels of other characteristics. Conjoint analysis is one method that incorporates product trade-offs in preference studies.

In addition, current farming systems and breeding practices may only exhibit slight variation in some important managerial and behavioural variables. As a result, observing actual choices by farmers might not identify preferences for specific traits in cases where there are minimal variations in observed data. Conjoint analysis is an experimental-based tool allowing some control over the type of information by including a relatively wider variation in relevant variables than might be observed in field data. Thus, it can be used to study preferences about actual products in existing markets or hypothetical products that currently are not available in the markets.

The use of conjoint analysis to estimate the preferences that cattle owners attach to each trait of cattle included in the study will primarily provide estimates based on the levels of traits. They represent the marginal values of the specified levels of traits, with the sign of each marginal value reflecting the nature of the impact of the levels on cattle owners preferences. A negative coefficient means that cattle owners dislike the specified level and they would discount an animal having this level of characteristic. Since the marginal values indicate the preferences, the magnitude of the estimated coefficients also reflects the importance of the traits.

The marginal values provided for levels of traits included in the study can also be used to generate the overall utility to producers of existing or hypothetical products that are described in terms of the levels of traits. Total utility of a specific profile is obtained by adding up the estimated coefficients of the levels of traits that make up the profiles. This capacity of conjoint analysis is particularly relevant for assessing the potential and overall utility of genetically improved breeds. It was shown in an earlier chapter that the roles of cattle in southern Burkina Faso go beyond the provision of income (milk and meat) to include draught power, store of wealth and social events (dowry and sacrifices). In such a context, the benefits resulting from a genetic improvement calculated on the basis of milk and meat might not provide good guidelines for determining breeding programs (Faminow, 1996). In such circumstances, conjoint analysis would be a good complement to the traditional production-based selection indexes (e.g., Amer et al., 1994).

Conjoint analysis also allows the identification of differences in preferences between sub-groups of respondents (Faminow, 1996). In the multi-purpose production systems of southern Burkina Faso, conjoint analysis can be used to test whether some cattle owners have similar preferences, and hence can be considered as a separate group. Test for the heterogeneity in cattle production is done in conjoint analysis by including, in the estimation, variables representing the interaction between the levels of traits and survey respondents background information. The existence of significant differences in preferences among cattle producers would indicate that cattle development and breeding programs have to be more specific and focused.

4.2 Theoretical models of valuing cattle traits

The conceptual foundation of conjoint analysis arises from the consumer theory developed by Lancaster (1966) which assumes that consumers' utility for an economic good is derived from the properties or characteristics of the goods (Ratchford, 1975). A major implication of this theory is that the overall utility for a good could be decomposed into separate utilities for its constituent characteristics or benefits (Louviere, 1994). In terms of the utility function, this translates into using the characteristics of goods, not their physical quantities as the arguments of the function. Thus an individual's utility function on characteristics can be written as in equation (4.1):

$$U(X) = U(X_1(S_1,S_2,\ldots,S_n),X_2(S_1,S_2,\ldots,S_n),X_n(S_1,S_2,\ldots,S_n)) \qquad (4.1)$$

where U (X) represents the utility, Xs are the goods, and S_i are the characteristics.

Lancaster's approach is the basis for a broad empirical models of differentiated products studied by Rosen (1974) and Griliches (1971). Applications of this approach to the agricultural sector have developed along two related lines of thought (Espinosa and Goodwin, 1991). One method considers a production function in a profit maximizing framework and derive the marginal value product for a set of product characteristics (Ladd and Martin, 1976; Ladd and Gibson, 1976; Espinosa and Goodwin, 1991). The alternative approach considers product characteristics to be utility-providing attributes in a consumer's utility maximization framework. As both approaches are similar, a brief exposition of their basic models is necessary to sustain the choice of the appropriate tool for this study.

4.2.1 Hedonic price analysis models

The following is a summary of the derivation of the basic model of the demand for cattle characteristics by Ladd and Martin (1976) assuming a perfectly competitive market situation where a profit function of input characteristics is maximized. The profit function is written as follows:

$$\Pi = \sum_{h=1}^{H} P_h F_h \, (X_{1.h}, X_{2.h}, \ldots, X_{m.h}) - \sum_{h=1}^{H} \sum_{i=1}^{n} P_i S_{ih} \qquad (4.2)$$

where P_h is the price of the h^{th} output, P_i is the price paid for the i^{th} input, S_{ih} is the quantity of the i^{th} input used in the production of the product h, $F_h(X_{1.h}, X_{2.h}, \ldots, X_{m.h})$ is the production function and $X_{1.h}$, $X_{2.h}, \ldots, X_{m.h}$ are the amounts of characteristic j entering the production of product h. Ignoring summation signs, equation (4.2) has two main parts. The first, $P_h F_h(X_{1.h}, X_{2.h}, \ldots, X_{m.h})$, represents total revenue and the second, $P_i S_{ih}$, is total cost.

The first-order conditions for profit maximization are derived by differentiating equation (4.2) with respect to S_{ih}, which yields equation (4.3).

$$P_h \sum_{h=1}^{m} (\partial F_h / \partial X_{j,h})(\partial X_{j,h} / \partial S_{j,h}) - P_i = 0 \qquad (4.3)$$

Solving equation (4.3) for P_i yields equation (4.4).

$$P_i = P_h \sum_{h=1}^{m} \frac{\partial F_h}{\partial X_{j.h}} \frac{\partial X_{j.h}}{\partial S_{ih}} \qquad (4.4)$$

where P_i, P_h, $X_{j.h}$ and S_{ih} are defined above. Equation (4.4) can be simplified by letting the value of the marginal product of the j^{th} characteristic used in producing output h be equal to A_j as indicated in equation (4.5) and the yield of characteristic j by input i be equal to Z_{ijh} as indicated in equation (4.6). Both A_j and Z_{ijh} are assumed to be constant, which would imply that, within a certain period of time and given the level of technology, the product yields of characteristics can be treated as fixed or exogenous because they are beyond the control of the user of the inputs.

$$P_h \frac{\partial F_h}{\partial X_{j.h}} = A_j \qquad (4.5)$$

$$Z_{ijh} = \frac{\partial X_{j.h}}{\partial S_{ih}} \qquad (4.6)$$

With this assumption equation (4.4) becomes:

$$P_i = \sum_{j=1}^{m} A_j Z_{ijh} \qquad (4.7)$$

where A_j is the marginal implicit value of the characteristic j and Z_{ijh} is the marginal yield of the i^{th} characteristic by the j^{th} input. Equation (4.7) shows the typical form of function that is used to estimate characteristic values with hedonic price analysis. In the context of cattle production, it can be interpreted as follows: the price, P_i, that a producer will pay (or receive) for an animal can be expressed as the sum of the marginal yield of the different characteristics of the animal weighted by their implicit prices. In other words, the overall price of an animal can be decomposed into implicit prices for the characteristics that embodied in the animal.

The hedonic price technique has been widely used to estimate marginal values for animal characteristics (Faminow and Gum, 1986; Lambert et al., 1989; Schroeder et al., 1988). Most models use variants of the basic model represented in equation (4.7) to account for various factors affecting cattle price determination (Faminow, 1996):

$$P_i = f(C_{it}, GM_{it}, LM_{it}, e_{it}) \qquad (4.8)$$

where P is the price, C a vector of animal and sale lot characteristics, GM a vector of general market characteristics, LM a vector local market characteristics and e is the error term.

Using a hedonic price analysis to estimate cattle owners' preferences for the traits in rural Africa has one major limitation. Most cattle transactions do not take place in formal physical markets where cattle owners would go and buy cattle. Transactions usually take the form of a private treaty - agreement between buyers and sellers of cattle in cash or barter or exchange. In such circumstances collection of price data requires an intensive price survey effort that is complicated, time consuming and expensive. Thus, conjoint analysis provides an alternative to the hedonic methods commonly used in developed countries.

4.2.2 Conjoint analysis models

As Louviere (1994) has noted, there is always some proportion of the variation in choice behaviour that cannot be explained from the standpoint of the analyst. For example, it is difficult to include important factors such as managerial skill into an analysis using the production function framework. The random utility theory of the consumer utility framework "provides a logical way to link observed choices to actions, and develop choice models that explain the observed choices conditional on the managerial actions" and conjoint analysis provides a practical methodological tool for doing so (Louviere, 1994 p.226).

Most conjoint analysis models follow a decompositional approach which is based on the assumption that the overall preference that an individual would express for a particular product can be decomposed into implicit and marginal preferences for the product characteristics. The decompositional approach is quite appealing in the assumptions about the process of consumer's utility formation. As Louviere (1994) has noted, when facing choice decisions, individuals usually examine the descriptions of the alternatives and, using their own decision criteria, they react by expressing a certain preference level. The role of the analysis is to find a set of part-worth for the main characteristics of the alternatives that are more consistent with the individuals' overall preferences (Green and Srinivasan, 1978).

The following summarizes the derivation of the model for estimating the values of cattle characteristics (Sy et al., 1997). In the model, the utility that an individual will derive from choosing a given cattle breed is hypothesized to be a function of the characteristics of the breeds, S, the individuals' socio-economic background, Z, the interaction between the individuals' background and the characteristics of the breed and an error term. The utility model can be written as follows:

$$U_j = f(S_{1j}, S_{2j}, \ldots, S_{gj};\ Z_1, Z_2, \ldots, Z_i;\ \mu_1, \mu_2, \ldots, \mu_g, e_j | \Theta_g) + e \qquad (4.9)$$
$$j = 1, 2, \ldots, m; \qquad g, i = 1, 2, \ldots, n.$$

The partial derivative of the utility with respect to the g[th] level of characteristic indicated in equation (4.10) represents the partworth of the g[th] characteristic level. It has two main parts. The first part, represented by equation (4.11) and hereafter referred to as V_g, measures the changes in utility resulting from changes only in characteristic levels. It is the marginal value of the g[th] characteristic level. The second part of equation (4.10) is the product of two partials, hereafter referred to as b_g (equation 4.12) and Z_i (equation 4.13) respectively. They represent the marginal impact of the interaction between the levels of traits and the individuals' background information. Derivation is as follows:

$$\frac{\partial U(s^*)}{\partial S_g} = \frac{\partial f(^*)}{\partial S_g} + \frac{\partial f(s^*)}{\partial \mu_g} * \frac{\partial \mu_g}{\partial S_g} \quad \textit{where,} \qquad (4.10)$$

$$V_g = \frac{\partial f(^*)}{\partial S_g}, \qquad (4.11)$$

$$b_g = \frac{\partial f(s^*)}{\partial \mu_g}, \textit{ and} \qquad (4.12)$$

$$Z_i = \frac{\partial \mu_g}{\partial S_g}, \qquad (4.13)$$

which can be summarized by

$$\frac{\partial U(s^{*})}{\partial S_g} = V_g + Z_i b_g \ . \qquad (4.14)$$

Equation (4.14) provides the basis for the models to estimate marginal utilities of cattle characteristics. The basic model hypothesizes are that the utility is a function of various levels of characteristics and the interaction between the levels of characteristics and individuals' socio-economic background. The model can written as (Sy et al., 1997):

$$U = \alpha + Sv + \mu b + e \qquad (4.15)$$

$$e \sim N(0,1)$$

Since utility is not observable, a choice variable representing ratings or rankings of animals is used in empirical works. The choice variable is related to utility as follows:

$$R = 0 \quad if \quad U < 0$$

$$R = 1 \quad if \quad 0 < U < \gamma_1$$

$$R = 2 \quad if \quad \gamma_1 < U < \gamma_2$$

$$.$$

$$.$$

$$R = \omega \quad if \quad U > \gamma_{\omega-2}$$

where U are the unobservable utility levels, Rs are preference ratings and γs are the threshold variables or cut-off points which provide a link between the respondents' actual preferences and the ratings.

With the choice variable, the basic model becomes:

$$R = \alpha + X\beta + Y\lambda + e \qquad (4.16)$$

where R is a vector of preference ratings (0, 1 ,2 ,....n), X is a vector of non-stochastic variables capturing the levels of traits, Y is a vector of non- stochastic variables capturing the interaction between the levels of traits and farmers' background, β is a vector of marginal utilities for the levels of traits, λ represent the vector of marginal impacts of the interaction between the levels of traits and individuals' background and e is a disturbance term. The marginal values β and λ are estimated from observations on R, X and Y.

The λ vector measures the variability in preferences due to the interaction between farmers' background and the levels of traits. Farmers with the same estimated λ have similar preferences, and would make up one particular segment of the market. Thus, estimates of λ can be used to assess the existence of market segments.

It is common in conjoint analysis to use an effect-coding procedure for categorical independent variables. In an effect-coding the usual (0-1) dummy system is replaced by a (-1, 0, 1) system or a (-1, 1) system where -1 is used for the variables that are normally left out in order to avoid the dummy trap during the estimation. The use of effect-coding generates estimates that measure the marginal change in the dependent variable as a result of a unit change in the independent variable (Pedhazur, 1982). Thus the use of effect-coding in conjoint studies leads to marginal coefficients being partworths, which is very interesting as it helps assess the actual impact of the traits and their interaction with farmers' background on the ratings of the profiles.

Using effect-coding also implies that the sum of the estimated coefficients of a group of variables, for example all the levels of a given trait, is constrained to be equal zero (Jain et al., 1979; Pedhazur, 1982). This, in turn, implies that the estimates of the variables that were not used in the regression can be computed as the negative of the sum of the estimated coefficients of the level of trait that were used in the estimation.

Multiple regression has been the most common technique to estimate the parameters of equation (4.16). The choice of the appropriate tool among alternative methods is mainly determined by the nature of the dependent variable. If the dependent variable is of a discrete nature like ratings, a discrete choice model is more appropriate than the Ordinary Least Squares (OLS) procedure (Greene, 1990). Using the OLS procedure to analyze discrete dependent variables can produce non-efficient estimates because of the potential heteroscedasticity (Kmenta, 1986; Mckelvey and Zavoina, 1975; Mackenzie, 1993). Among the discrete choice models, the Ordered Probit framework using a Maximum Likelihood Estimation (MLE) will be used for three main reasons. First, because the dependent variable represented by the ratings is discrete and ordinally scaled, and Ordered Logit or Ordered Probit procedure is more appropriate than the multinomial Logit or Probit. Second, under general conditions, the MLE gives estimates that are consistent, asymptotically efficient and normal (Judge et al., 1985; Davidson and Mackinon, 1993). Third, the use of the Ordered Logit procedure involves the property of Independence of Irrelevant Alternatives, which may not produce reasonable results when two or more alternatives among the alternatives being studied are close substitutes (Judge et al., 1985; Davidson and Mackinon, 1993).

4.3 Methodological innovations

The majority of the studies that utilized conjoint analysis to estimate preferences have been conducted in developed countries where language barriers are minimized. In contrast, generalized illiteracy and the existence of various languages make the situation of southern Burkina Faso complex. The study design needs a strategy different from that used by Sy et al. (1997) in their study of cattle characteristics.

There are two aspects of this study that are unique in comparison to other agricultural economic studies using conjoint analysis: (a) cards with graphical representations of the differences in the levels of traits were used to demonstrate each cattle profile to survey respondents instead of using the standard procedure of written questionnaire and (b) the set of important traits to be investigated was broken down into two subsets for the questionnaire design and for estimation, but the estimated preferences were later combined into one index to provide an overall evaluation of the relative importance of the complete list of traits.

In conjoint studies, stimuli can be presented to respondents in one of the following three ways: verbal descriptions, paragraph descriptions, and pictorial representations (Weiner, 1993; Cattin and Wittink, 1982). Verbal descriptions use cards in which each level of traits is described in a brief line item fashion while paragraph descriptions give a more detailed description of each level (Weiner, 1993). Pictorial representations use some graphical images to present the levels of traits. A survey of the commercial use of conjoint analysis in USA indicated that verbal and paragraph descriptions of profiles were used by 70% of the surveyed practitioners (Catting and Wittink, 1982). About 19% of them used pictorial representations in combination with verbal descriptions.

Verbal and paragraph descriptions are convenient, straightforward and inexpensive when there is high literacy in the study population. High illiteracy levels and language differences in the population make data collection more complex and pictorial representations can be an easier, more convenient and less potentially ambiguous way to present the differences in levels of traits (Green, and Srinivasan, 1990). Moreover, survey respondents need to remember each profile in order to give a rating which accurately reflects their preferences. Visual materials can help the information processing, thereby facilitating the interpretation and the rating of the profile (Holbrook and Moore, 1981).

The necessity of using pictorial representations and the information processing problem limited the number of traits in each profile. When there is information overload, survey respondents tend to simplify the evaluation process by ignoring less important characteristics or by ignoring the levels themselves, especially when they have to evaluate profiles with a large number of levels (Green and Srinivasan, 1990). Empirical studies have shown that respondents have difficulty evaluating profiles defined on more than six characteristics (Green and Srinivasan, 1990). Thus, including all the seven traits identified for this study in a single design would have made the survey design quite impractical. The size of the design is also affected by the number of levels for each trait because the profiles are the combination of the levels of traits. In order to use a survey design with a manageable size, the number of traits as well as the number of levels for each trait must be limited. The research team decided to use four traits in each design, each with two levels of trait. Limiting the number of levels to two was primarily intended to make clear differences between levels. In some cases, this may provide too gross a distinction between levels of cattle traits for the area (Faminow, 1996).

Given that only four of the seven traits will be used in each profile, it was necessary to devise a way to overcome the loss of information that would result from limiting the range of traits. This was done by splitting the questionnaire design into two parts for data collection and estimation of the models and then combining the estimated results into a single index showing the overall relative importance of the traits. A statistical analysis of the ranking data discussed below was performed in order to get the order of preference of each trait. The first four traits of bulls or cows were used to define the first design of bulls or cows; one trait among the highest ranked traits (disease resistance) was added to the lowest ranked three traits to make up a second design of bulls or cows.

Thus, the study of cattle preferences in southern Burkina Faso used two profiles of bulls and two profiles of cows. For bulls as well as cows, the two profiles have disease resistance in common. The purpose of the second set of profiles is to indicate the relative importance of the other three traits and to confirm the importance of disease resistance. Moreover, having a common trait in the two set of profiles provides a good opportunity to see how realistic is the idea of combining all estimated parameters per type of animal (cows and bulls) and construct a composite index showing the overall picture about the relative importance of the complete list of traits.

4.4 Experimental design, empirical model and data collection

Once the number of traits and the number levels for each trait have been chosen the implementation of conjoint studies requires four additional steps: construction of the profiles, evaluation of the profiles, estimation of coefficients of the levels of the traits and the use of the estimated parameters to determine the relative preference and relative importance of the traits.

Cattle profiles are cattle presented in a trait format. They are constructed by combining the levels of traits included in the study. The number of profiles depends on the number of traits and the number of levels. The seven traits of bulls and seven traits of cows considered in this study and their respective levels are indicated in table 4.1.

To decide on which traits to use in the first and second designs, a statistical analysis of the ranking data provided by the farmers survey (Table 4.2) was performed. A crude ranking of the traits showing the relative importance of the traits was established using the mean rank values. The first trait is the trait with the lowest rank value, the second trait is the one with the second lowest value, and son on. This procedure only produces a first approximation of the relative importance of the traits.

The final assessment of the relative importance of the traits was provided by a statistical analysis using the Wilcoxon nonparametric matched-pair signed-ranks test, a nonparametric equivalent of the paired-t-test that is usually needed to see whether or not two dependent samples have equal means. As we were dealing with ranking data a nonparametric procedure was more appropriate than a parametric one. The test was performed in this case because for several traits the average ranks were so close that it was difficult to state their relative importance only on the basis of the mean rank (Tables 4.3a and 4.3b). Results of this test were used to establish the statistical rankings also given in Tables 4.4. These statistical rankings indicated that the first four traits of bulls were fitness to traction, weight gain, disease resistance and feeding ease. These were used to construct the profiles of bulls in the first design, while fertility, temperament and size were added to disease resistance to construct the profiles in the second design for bulls. The first design of cows used fecundity, milk yield, weight gain and disease resistance while feeding ease, temperament, size and disease resistance were used in the second design.

Given that each trait has two levels, there would be $2^4 = 16$ possible cattle profiles for each experimental design in a full factorial design, which will make data collection in the area quite an impractical process. The general solution to this common problem in the conjoint analysis literature is to reduce the number of profiles to a manageable size using an orthogonal or fractional factorial design which treats all attributes as independent and precludes collinearity between them in an empirical model (Mackenzie, 1993). In conjoint studies, it is a common remedy to the problem of having respondents to evaluate too many profiles (a burdensome task) should all the traits be included in one single experimental design. In this study the use of a fractional factorial design resulted in eight profiles in each experimental design.

In each design, the eight profiles were produced with a special algorithm of SPSS for Windows (SPSS, 1994). Each profile is shown in the form of a card representing an hypothetical cattle breed that was described in terms of the levels of traits included in the experimental design. An example of profile in the first experimental design of a bull is represented by a card describing a bull that is feed selective (grass and water), resistant to disease, with a rapid weight gain and a poor fitness to traction. The eight profiles of bulls used in the first experimental design are shown in Table 4.5.

The evaluation of the profiles was carried out during a survey in January and February 1996 which involved the sample of 299 cattle owners who participated in the matrix rating. The evaluation was organized over personal interviews in which cattle owners were asked to consider eight profiles of bulls (cows) and give a rating to each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent' s cattle operations, 1 the least desirable animal and ratings 2 to 4 represented desirability between the two extremes. Five wooden sticks with variable and increasing lengths were used to represent the preference scale, with the longest stick used for the highest preference (5), the shortest stick for the least desirable profile (1). Half of the sample rated the profiles in the first experimental designs and the other half rated the profiles in the second experimental design.

The actual evaluation process started with the enumerator explaining the meaning of the levels of traits represented by special drawings. Then the cattle owner is asked to explain his (her) understanding of the levels of traits. This usually took 30 to 45 minutes and was repeated as necessary. These preliminary explanations were provided in order to make sure that the drawings were providing the information that was intended in the survey. After considering all eight profiles, cattle owners evaluate each profile by assigning a stick reflecting his (her) preference. Ratings of profiles were recorded using a pre-prepared questionnaire shown in appendix 4 along with an example of drawings showing a profile of bulls used in the first experimental design. Despite the time taken by the rating and the cost of making the drawings, the approach was advantageous. It helped data collection by making the profiles more realistic and by reducing the heterogeneity among farmers in their perceptions of the profiles. The rating process also held farmers' interest.

4.5 Results and discussions

The analysis of conjoint survey data was conducted with the iterative maximum likelihood procedure for Ordered Probit in Limdep (Greene, 1995). Four models including two models of bulls and two models of cows were estimated. Since all the traits considered in this study have two levels, during the estimation one level was left out. The levels of traits that were used in the estimation are also indicated in Table 4.1. Recall that for each trait, the estimate of the variable that was left out is the negative of the estimate of the level that was included in the regression.

In all models the ratings that farmers gave to the profiles to express their overall preference serve as the dependent variable and the independent variables consisted of the specified levels of traits and selected interactions between the traits and producers' background. An estimation of models with and without interactions indicated all the four variables representing the traits were statistically significant at the 1% level with the expected signs. Only models involving the interaction terms are presented here.

Three main interaction variables were considered for use in the models: production system (subsistence, milk and beef, mixed crop), location (Pays Lobi and Kourouma) and farmer's origin (indigenous and migrant). The production systems variable was selected for final estimation. Recall from chapter 2 that choice of production systems is related to both location and farmer origin. Based on all possible combinations of the variables representing the traits and the interaction terms, seven models were estimated for each experiment of bulls and cows. Only those with statistically significant parameters and the expected signs will be discussed here.

4.5.1 Estimated models and statistical significance

Model 1 of bulls is fitted to data collected with the first design of bulls (4 highest rated traits) and is used to estimate partworths for disease resistance, rapid weight gain, poor fitness to traction and selective grazing habit. Model 2 of bulls is fitted to data collected with the second design of bulls (disease resistance and 3 lowest rated traits) and is used to estimate partworths for disease resistance, small size, high fertility and difficult temperament. Model 1 of cows is fitted to data collected with the first design of cows (4 highest rated traits) and is used to estimate partworth values for disease resistance, rapid weight gain, low fecundity and low milk yield. Model 2 of cows is fitted to data collected with the second design of cows (disease resistance and 3 lowest rated traits) and is used to estimate part worth values for disease resistance, selective grazing habit, difficult temperament and small size.

The estimated results for bulls are indicated in Table 4.6 and the results for cows are indicated in Table 4.7. The overall significance of the models is assessed using the likelihood ratio statistic which is the relevant criteria for assessing the goodness of fit in Maximum Likelihood Estimation. Its value is given by the following relationship

$$L_R = -2\ln\frac{L_\omega}{L_\Omega} \qquad (4.17)$$

where L_R is the likelihood ratio statistic, L_ω and L_Ω are the unrestricted and restricted likelihood respectively. The likelihood ratio is distributed as a χ^2. The estimation procedure of Limdep (Greene, 1995) provided these statistics along with the degrees of freedom and significance levels. The critical statistics for 12 and 16 degrees of freedom at the 0.01% level of significance are respectively 39.1433 and 45.9249. As indicated at the bottom of tables 4.6 and 4.7, the computed likelihood ratios for all the models were larger than the critical values at 0.01% with the appropriate number of degrees of freedom. This means that the estimated models were statistically significant at the 0.01% level, implying that all the traits of cattle included in the models and their interactions with selected producers' background are relevant determinants of farmers preferences.

The significance of the individual parameters was assessed using the p-value which is an alternative way to assess individual significance of estimates in Maximum Likelihood Estimation. The p-value is the lowest significance level at which a null hypothesis can be rejected (Mirer, 1988; Gujarati, 1992). Under the null hypothesis, the p-value represents the probability that the computed statistic is larger than it actually is; and a small p-value would mean that the result is quite unlikely and would lead to rejecting the null hypothesis, thereby failing to reject that the estimated coefficient is statistically significant. We will first consider the main effects which consist of the levels of the traits, the case of the interaction variables will be examined later.

Results of the main effects shown on Table 4.6 indicated that all four levels of traits considered in both models of bulls were statistically significant at 0.01%. They all have the expected sign. For example, selective grazing habit has a negative sign, indicating that respondents disliked cattle which are selective in the type of grass they will eat or the type of water they will drink. Selectivity in the type of grass would require that cattle have to walk longer distances in order to get their feed supply. Poor ability in traction of bulls is also disliked (negative sign) because it reduces the workload the animal can bear. In contrast, high fertility, disease resistance and rapid weight gain have positive signs. High fertility has a direct positive impact on the size of the herd. Rapid weight gain is a measure of beef production, indicating that animals arrive at mature size in a relatively short time period. Disease resistance would mean lower cost of disease control, higher survivability and potential success of the whole cattle operation.

In a similar way, results of the models of cows shown in Table 4.7 indicated that all four levels of traits were statistical significant with both models having a good fit. As for bulls, selective grazing habit has the expected negative sign. Low fecundity reflects a reduced breeding capability, negatively impacting herd size, so a negative sign is expected. As small sized animals do not yield high market value, the negative sign is also expected. Disease resistance and rapid weight gain have the expected positive signs, as in the models of bulls.

4.5.2 Relative preference for the levels of traits

A strength of conjoint analysis is to decompose the overall rating that survey respondents gave to a given cattle profile into partworth values for the levels of traits that were used to describe the profile. These partworths represent the preferences that respondents attached to the specified levels.

The main effects presented in Tables 4.6 represent partworth values of an average farmer for the levels of traits included in the designs for bulls. The magnitudes and the signs of the coefficients reflect the level of the preference and the direction of the preference (positive or negative). For example, rapid weight gain in a bull (Table 4.6) has a partworth value of 0.306 while disease resistance has a partworth value of 0.918 to an average farmer in the study area. This means that rapid weight gain is less preferred than disease resistance. However, a bull with no ability to graze some types of grass is less disliked than one with a poor ability for traction. Other partworth values in Tables 4.6 are interpreted in the same way.

Results for the main traits reveal that disease resistance, rapid weight gain and fertility positively affect farmers' preference for bulls. On the other hand, selective grazing habit, poor traction performance, small size and difficult temperament have a negative impact on farmers' preferences for bulls. The result about disease resistance is consistent with expectations in a area of trypanosomosis risk. Results about poor fitness to traction, small size and difficult temperament were also expected given that mixed crop farming is an important production system using large sized animals for traction. High fertility and rapid weight gain may be important for milk and beef producers.

Given that large partworth absolute values associated with a level of trait indicate a high preference, the results show that farmers have a high positive preference for bulls that are resistant to disease and a high, but negative, preference for bulls with a poor fitness to traction.

It is important to note that estimated coefficients of the omitted variables like low weight gain, disease susceptibility, non selective grazing habit and good fitness to traction in model 1 for bulls (Table 4.6) would be the negative of the values of the variables included in the model. For example, good fitness to traction would have an estimated value of 1.12 which represents the negative of -1.12. Similarly disease susceptibility, low weight gain in bulls would have estimates of -0.92 and -0.306 respectively (Table 4.6). On this basis, the study results show that farmers have a high preference for high fertile bulls that are disease resistant with good performance in traction. However, they will discount disease susceptible bulls with a poor traction ability and are relatively less interested in a rapid weight gain as a trait.

The previous discussion can also be made for the models of cows indicated in Table 4.7. Numerically, fecundity and disease resistance are important traits for cows. For example, in model 1 their partworth are 0.984 and -1.185 respectively (Table 4.7). Put in another way, the results show that farmers have a high preference for cows that are disease resistant and with a high fecundity. Selective gazing habit of cows is much more disliked than small size, difficult temperament or low milk yield. Since most cattle owners would rely on common grazing land, this may reflect the high pressure on these lands. The analysis of preferences for selected groups of farmers carried below will provide insights onto the reasons for these relative preferences for the levels of traits.

Another important result is that disease resistance, the common trait to the two parts of the designs of both cows and bulls, has almost identical estimated values in the models for bulls and slightly divergent values in the models for cows. This result is important as it reassures that conjoint analysis is working in the hypothesized manner stated in the theoretical discussion given earlier. Given that conjoint analysis is a way to empirically reveal the underlying utility function, it is reassuring that the separate equations for bulls and cows are producing coefficient values for disease resistance that are consistent and similar across models and animal types. This result also increase confidence in using disease resistance to construct a composite index showing the relative importance of the complete list of traits for bulls and cows.

4.5.3 Preferences of producer groups

One important issue is the existence of differences in preferences among producers. Are producers preferences homogeneous or can they be segmented? For that purpose, interaction variables representing the main farming systems were used to test the impact of the levels of traits and the farming systems. Table 4.8 shows the preferences for the main farming systems described in chapter two.

The partworths for each farming system were computed by adding up partworths of the average farmer indicated in Tables 4.6 and 4.7 and the incremental partworths due to the interaction variables for the different farming systems. Only the coefficients of the interactions that were statistically significant are duscussed. Non-significance of the interaction variables mean that preferences of the given producer group for the specified levels were not different from the preferences of an average farmer.

Table 4.8 indicates that no segmentation of producers groups can be identified on the basis of disease resistance and rapid weight gain of bulls because the interaction variables for these two levels of traits were not statistically significant. For disease resistance, this result confirms its importance as perceived by all cattle owners in the study area, i.e they do not perceive it differently. Assuming that cattle owners use different disease management strategies, this implies that disease resistance is a general concern. In contrast, rapid weight gain in bulls is equally less preferred by all cattle owners. This general low preference for rapid weight gain may indicate that rapid weight gain in bulls was not perceived as contributing as much as traits such as disease resistance, fitness to traction or fertility to the cattle production, although it is among the main traits for breed choice.

Data also show variable partworths for selectivity in feed. Mixed crop farmers have the lowest preference for this trait. Mixed crop farmers are usually crop producers who feed their animals using some of the crop residues, so selectivity to grass is less of a problem for them. Some farmers may be less directly concerned by the issue because most of their cattle are managed by hired herders who did not participate in the interviews. Alternatively, milk and beef producers and subsistence farmers do not usually have substantial amount of crop residues and or manage their own cattle. They have more negative preferences for feed selectivity.

Traction ability also shows significant differences in the preferences. Subsistence farmers do not use cattle for traction and have less preference for fitness to traction than milk and beef producers who use some traction for food production. In fact, most milk and beef producers are Fulani who live far from any market and produce their own food. Given that they raise the most suitable cattle for traction (Zebu), they tend to use draught power to grow sorghum, millet and maize. Mixed crop farmers produce food crops for home consumption but they also grow cash crop. The use of traction for cash production has been an extensively promoted agricultural technology in most cotton growing zones in West Africa. It is one of the key elements of extension programs. This is probably why mixed crop farmers are the group of farmers who disliked poor fitness to traction the most.

The differences in preferences for difficult temperament are related to the use of herders in the management of the herds. Mixed crop farmers and milk and beef producers use specialized herders for their animals. For milk and beef producers the herder is usually a member of the cattle owning family while mixed crop farmers generally use a hired herder. Even though they dislike difficult temperament, both types of producers have less concern for this trait than subsistence farmers who use the younger members of the family and are themselves more intimately familiar to animal behaviour.

The differences in preferences for size of animals can be explained either by the needs for draught purposes (mixed crop farmers) or the market value of the animals (milk and beef producers). Subsistence farmers who do not use cattle for traction seem less concerned by this trait.

Low fecundity in cows displays significant differences in preferences that can be attributed to differences in the role of livestock in farming systems. Mixed crop farmers who are less interested in off-take (beef and milk) dislike low fecundity the least. On the contrary, in a subsistence farming system, cattle play various and complex roles (social events, dowry, store of wealth). The permanent need for cattle in this system is also illustrated by the fact that cattle are usually the only available item that can be quickly converted into income when the need arises. Thus, a trait like low fecundity has a potential negative effect on the herd size and, therefore, would be very much disliked. Milk and beef producers are more interested in off-take than mixed crop farmers, but they are specialized cattle producers who may have alternative management ways of overcoming low fecundity.

Low milk yield is less of a problem for mixed crop farmers as they use herders whose salary usually includes milk off-take. Herders would therefore be much more concerned by milk yield; but they were not interviewed as they were not cattle owners. On the contrary, subsistence farmers herd their own cattle and use any milk they can get for consumption or sale. The fact that milk and beef producers have a moderate preference, but lower than subsistence for milk yield was not expected.

Like in the case of bulls, small size in cows is disliked because it has a potential negative impact on the market value of the animals. Milk and beef producers who are much more interested in off-take seemed to be affected than mixed crop farmers.

4.5.4 Relative importance of traits derived from the estimated models

Since partworth utilities for the traits included in each model are measured on a relative basis, traits used in each model can be compared. In conjoint studies, this comparison is achieved by computing the relative importance score for each trait. The relative importance score for a given trait is the ratio of the partworth range for that particular trait (difference between highest and lowest partworth values) and the sum of all the part worth ranges. This ratio is an indication of which trait survey respondents valued the most. Results about the relative importance of traits are presented in Table 4.9 for the traits of bulls and Table 4.10 for the traits of cows.

When model 1 of bulls is considered, fitness to traction and disease resistance were the most important traits. Feeding ease and weight gain were less preferred. When model 2 of bulls is considered, disease resistance and fertility were the most important traits followed by temperament and size which were less important. These results show that the most preferred traits of bulls were disease resistance, fitness to traction and fertility. Traits like temperament, size, feeding ease and weight gain were less preferred. The importance of fitness to traction reflects the intensive use of traction in the area. The most preferred traits were those with potential direct impact on production activities. Fitness to traction has a direct link to crop production, one of the main purposes for raising cattle. Fitness to traction may also have impacts on income that could be generated by renting out animals for draught. With a potential impact on the herd size, low fertility negatively affects cattle as an effective store of wealth.

When model 1 of cows is considered, fecundity and disease resistance were the most important traits followed by weight gain and milk yield. When model 2 of cows is examined, disease resistance and feeding ease were the most important traits followed by temperament and size. For cows, traits that farmers preferred most were fecundity, disease resistance and feeding ease. Like fertility of bulls, fecundity has a significant impact on the herd size and on off-take. Feeding ease in cows (specially in dry season) has a significant impact on the reproductive performance of the herd, which may have further impacts on various income generation activities. Again, as in the case of bulls, farmers seemed to have high preferences for traits related to production activities.

It is important to note that traits such as milk yield and weight gain, which are usually the key elements of genetic improvement programs, did not seem to be equally favoured by cattle owners whose preferences seemed to be more determined by other objectives than measurable direct output.

4.5.5 Overall relative importance of the traits

The above discussion showed the relative importance of the traits as they were used in the survey designs. Given that both designs of bulls and cows had one trait in common, it is possible to combine all partworths of the levels of traits included in each case (bulls or cows) and compute a unique index showing the relative importance of the complete list of traits. This provides a way to overcome the limitations created by the need to limit choices in the survey construction to 4 traits, each at 2 levels.

It is worth noting that this overall relative importance may not reflect what would have resulted from an evaluation by respondents of a single design including all the seven traits. As noted earlier, estimates of disease resistance in both models of bulls and cows were quite close, which gives support to the construction of a common index reflecting a preference ordering based on the entire set of traits. In constructing the overall index, the average of the two estimates of coefficients in each case (bulls and cows) was used. The overall index of relative importance of the traits is shown in Tables 4.9 (bulls) and 4.10 (cows).

On the basis of the overall index, the relative importance of the traits for bulls can be established as follows: fitness to traction, disease resistance, fertility, temperament, feeding ease, size and weight gain. In the same way, the most important traits of cows were found to be in the following order of preference: fecundity, disease resistance, feeding ease, weight gain, temperament, milk yield and size. These results show that when all the seven traits are considered, fitness to traction, disease resistance and fertility were the most preferred traits of bulls while most preferred traits of cows were fecundity, disease resistance and feeding ease. The importance of disease resistance, fertility and fitness to traction for bulls is confirmed. More than 60% of the rating of a bull defined over these seven traits would be due to these three traits. The most preferred traits of cows were fecundity, disease resistance and feeding ease which account for 60% of the rating that would be given to a cow having all the seven traits. These results also indicate that, in general, farmers have relatively less preference for weight gain, feeding ease, temperament and size of bulls.

In order to see how these results compare with farmers' explicit ranking of the traits, Table 4.11 was constructed. Data in this table combine the conjoint and statistical rankings. They indicate some differences between the two methods, the relative importance of milk yield and feeding ease for cows. Milk yield was ranked second by farmers but the conjoint process found it less important. For bulls, differences in the two methods concern feeding ease and weight gain. For the other traits, both methods yield fairly similar results.

To measure the extent of agreement among the ranks of the traits for the two methods, Kendall's coefficient of concordance was computed. Kendall's concordance coefficient normally ranges from 0, indicating no agreement or independence to 1 which indicates perfect agreement among the rankings (Kendall, 1970; Daniel, 1990). The computed coefficient is 0.55 for bulls and 0.52 for cows. Both coefficients were statistically significant at the 10% level. These results provide confirmation about the similarities and differences in the rankings resulting from using the two methods. This suggest that simply asking farmers their preferences for traits of cattle may result in different rankings than when faced with a choice among cattle with different traits. This is an empirical test of the assertion that cattle owners trade-off cattle traits in their breed choice. When they were asked to rate the profiles, cattle owners apparently traded-off some of their least preferred traits for the most preferred traits. In contrast, the ranking process involved no trade-off because the choice concerned individual traits. The results provided by the conjoint study are stronger than the explicit rankings because the trade-offs involved in conjoint studies mimic actual choice situations more closely than a ranking procedure.

4.6 Conclusion

The method of conjoint analysis was used to estimate preferences of cattle in southern Burkina Faso for seven important traits of bulls and cows identified from a survey of cattle owners in Pays Lobi (Poni province) and in Kourouma (Kenedougou province). The conjoint analysis technique was used with the purpose of confirming findings of a ranking procedure about the relative importance of the traits. In addition, conjoint analysis will provide farmers' preferences for levels of the traits and test for potential differences in preferences among cattle owners.

Practical considerations of the survey field conditions (illiteracy and language differences) dictated two major innovations in the survey design: (1) pictorial materials were needed to describe the profiles to avoid ambiguity about the levels of traits and the purpose of the research, and (2) a limited number of traits had to be considered in the survey design in order to limit the number of profiles that each respondents would need to evaluate.

The use of the Ordered Probit procedure to analyze the survey data yielded two main results:

First, concerning the estimates of the levels of traits included in the models, the main effects of the levels of traits on the ratings given by farmers to the profiles represent marginal preferences of an average farmer for the levels of traits. The estimated models indicate that all main effects were statistically significant with the expected signs. An important feature of the conjoint analysis technique is to use the estimated main effects to compute the relative importance of the traits and show which traits survey respondents preferred more. Fitness to traction and disease resistance in the first bull design and disease resistance and fertility in the second design were found to be the most preferred traits of bulls. Weight gain and feeding ease in the first design and size and temperament in the second design were less preferred. Most preferred traits for cows were fecundity and disease resistance in the first design and disease resistance and feeding ease in the second design. Milk yield and weight gain in the first design, and temperament and size were the least preferred traits of cows. A strategy to combine the two sets of results for both bulls and cows confirmed these results.

Second, significant differences in preferences among cattle producers for the levels of traits were: (a) subsistence farmers have the lowest preference for fitness to traction and small size and high preference for easy temperament, (b) milk and beef producers have the highest preferences for non selective bulls and large size cows and a moderate preference for fitness to traction, and (c) mixed crop farmers have the lowest preference for non selectiveness, high fecundity, high milk yield and the highest preference for fitness to traction. However, the fact that there was no detectable differences among cattle producers based on disease resistance confirms the importance of disease resistance as perceived by cattle owners in the study area.

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Table 4.1 Traits and levels of traits used in the experiments

Traits	Levels	Bulls/Cows
Feeding ease [1, (2)**]	1. Non selective	Bulls and cows
Weight gain [1]	1. Rapid*	Bulls and cows
Disease resistance [1, 2]	1. Resistant*	Bulls and cows
Fecundity [1]	1.High (1 calf/year)	Cows
Milk Yield [1]	1. High	Cows
Size [2]	1. Large	Bulls and cows
Temperament [2]	1. Easy to handle	Bulls and cows
Fitness to traction [1]	1. Good	Bulls
Fertility [2]	1. High	Bulls

Note: (1): Used in the first experiment

(2): Used in the second experiment

*: Levels with the asterisk were used in the estimated equation; the other levels were left out to avoid the dummy variable trap

**: Feeding ease was used in the first design of bulls and in the second design of cows.

Table 4.2 Mean rank values of traits of bulls and cows, southern Burkina Faso

Traits	Bulls	Cows
Fitness to traction	2.79 (1.89)	
Feeding ease	3.77 (1.65)	4.25 (1.61)
Temperament	4.19 (1.92)	4.85 (1.75)
Disease resistance	3.65 (1.73)	3.79 (1.59)
Weight gain	3.64 (1.95)	3.87 (1.89)
Fertility	4.42 (1.95)	
Fecundity		1.80 (1.23)
Milk yield		3.36 (1.67)
Size	5.24 (1.80)	5.63 (1.61)

Source: Survey data, August 1995

Values in parentheses are standard errors

Table 4.3a Wilcoxon test results for bulls, southern Burkina Faso

	Fitness to traction	Feeding ease	Temperament	Disease resistance	Weight gain	Fertility	Size
Fitness to traction							
Feeding ease	-10.00*						
Temperament	-11.99*	-4.26*					
Disease resistance	-7.93*	-1.80***	-4.97*				
Weight gain	-6.95*	-1.12	-4.55*	-0.01			
Fertility	-12.52*	-5.92*	-1.98**	-7.14*	-7.39*		
Size	-17.00*	-12.70*	-9.24*	-13.21*	-13.79*	-7.11*	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 4.3b Wilcoxon test results for cows, southern Burkina Faso

	Milk yield	Feeding ease	Temperament	Disease resistance	Weight gain	Fecundity	Size
Milk yield							
Feeding ease	-7.96*						
Temperament	-11.58*	-5.33*					
Disease resistance	-3.26*	-4.94*	-9.16*				
Weight gain	-3.95*	-3.30*	-7.55*	-1.73***			
Fecundity	-14.30*	-17.35*	-18.62*	-15.89*	-15.16*		
Size	-16.17*	-11.72*	-6.89*	-14.16*	-13.20*	-19.26*	

Source: Analysis of survey data

* Statistically significant at 1% level

** Statistically significant at 5% level

*** Statistically significant at 10% level

Table 4.4 Crude and statistical rankings of bulls and cows, southern Burkina Faso

Crude and statistical rankings of bulls			Crude and statistical rankings of cows		
Crude rankings	Traits	Statistical rankings	crude rankings	traits	statistical rankings
1	Fitness to traction	1	1	Fecundity	1
2	Weight gain	2	2	Milk yield	2
3	Disease resistance	2	3	Disease resistance	3
4	Feeding ease	2	4	Weight gain	4
5	Temperament	3	5	Feeding ease	5
6	Fertility	4	6	Temperament	6
7	Size	5	7	Size	7

Source: Analysis of survey data

The crude rankings are based on the mean ranks of traits computed from the survey data and prior to the test of equality of means

The statistical rankings are based on the crude rankings and the results of the Wilcoxon test of equality of mean ranks of pairs of traits.

Table 4.5 Sample of profiles used in the first experiment of bulls

N°1	N° 2
Diseases: *Resistant*	Disease: *Resistant*
Weight: *Rapid*	Weight gain: *Rapid*
Feeding ease: *Selective*	Feeding ease: *Selective*
Fitness for traction: *Good*	Fitness for traction: *Poor*
Rating ..../ 5	Rating ..../ 5
N°3	N°4
Diseases: *Susceptible*	Diseases: *Susceptible*
Weight: *Low*	Weight: *Rapid*
Feeding ease: *Selective*	Feeding ease: *Non Selective*
Fitness for traction: *Poor*	Fitness for traction: *Good*
Rating ..../ 5	Rating ..../ 5
N°5	N°6
Diseases: *Resistant*	Diseases: *Resistant*
Weight: *Low*	Weight: *Low*
Feeding ease: *Non Selective*	Feeding ease: *Non Selective*
Fitness for traction: *Poor*	Fitness for traction: *Good*
Rating ..../ 5	Rating ..../ 5
N°7	N°8
Diseases: *Susceptible*	Diseases: *Susceptible*
Weight: *Low*	Weight: *Rapid*
Feeding ease: *Selective*	Feeding ease: *Non Selective*
Fitness for traction: *Good*	Fitness for traction: *Poor*
Rating ..../ 5	Rating ..../ 5

N. B: Survey respondents were asked to evaluate each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent's cattle operations, 1 the least desirable cattle and ratings 2 to 4 represented desirability between the two extremes.

Table 4.6: Main effects of levels of traits of bulls on ratings, Southern Burkina Faso

Variables	Model 1	Model 2
Constant	1.191(0.1029)*	0.973 (0.119)*
Rapid weight gain	0.306(0.0451)*	
Selective grazing habit	-0.437(0.0452)*	
Poor fitness to traction	-1.115(0.0517)*	
Resistant to disease	0.918(0.0377)*	0.905 (0.0505)*
High fertility		0.831 (0.0515)*
Small size		-0.407 (0.0496)*
Difficult temperament		-0.500 (0.0460)*
Coefficients of threshold variables		
μ^1	0.939 (0.0521)*	0.939 (0.0517)*
μ^2	2.0720 (0.0691)*	1.999 (0.0678)*
μ^3	3.133 (0.0887)*	3.050 (0.1127)*
Log likelihood ($L\omega$)	-1311.763	-1275.581
Restricted (slopes=0) log-likelihood (L_Ω)	-1912.752	-1826.218
Likelihood ratio (L_R)	1201.978	1100.873
Significance level	0	0
Degrees of freedom	12	16

Statistically significant at * 1% level,

The likelihood ratio is computed as: $L_R = -2\ (L_\Omega - L\omega)$

The threshold variables represent a link between the utility of cattle profiles to the respondents and the numerical ratings given to the profiles

Table 4.7 : Main effects of levels of traits of cows on ratings, Southern Burkina Faso

Variables	Model 1	Model 2
Constant	1.22 (0.0802)*	0.9092 (0.104)8*
Low fecundity	-1.185 (0.0468)*	
Rapid weight gain	0.632 (0.0432)*	
Low milk yield	-0.436 (0.0476)*	
Resistant to disease	0.984 (0.0424)*	0.884 (0.04778)*
Selective grazing habit		-0.743 (0.0466)*
Small size		-0.313 (0.0483)*
Difficult temperament		-0.518 (0.0470)*
Coefficients of the thresholds		
μ^1	0.9859 (0.0538)*	0.9580 (0.0533)*
μ^2	2.0308 (0.0710)*	1.9027 (0.0651)*
μ^3	3.3959 (0.1069)*	2.7749 (0.0811)*
Log likelihood ($L\omega$)	-1218.621	-1380.395
Restricted (slopes=0) log-likelihood	-1912.685	-1837.868
Likelihood ratio (L_R)	1388.128	914.647
Significance level	0	0
Degrees of freedom	12	12

Statistically significant at * 1% level,

The likelihood ratio is computed as: $L_R = -2\,(L_\Omega - L\omega)$

The threshold variables represent a link between the utility of cattle profiles to the respondents and the numerical ratings given to the profiles

Table 4.8 Impact of interaction between levels of traits and farming systems on ratings of bulls and cows, southern Burkina Faso

		Traits of bulls		
Levels of traits	Subsistence system	Milk and beef system	Mixed crop system	Average farmer
Resistance to disease	0.918	0.918	0.918	0.918
Rapid weight gain	0.306	0.306	0.306	0.306
Selective grazing habits	-0.555***	-0.666*	-0.089*	-0.437
Poor fitness to traction	-0.868*	-0.908**	-1.569**	-1.115
High fertility	0.634***	831	1.028**	0.831
Small size	-0.170**	-0.407	-0.644*	-0.407
Difficult temperament	-0.680***	-0.5	-0.320**	-0.5
		Traits of cows		
Resistance to disease	1.460***	0.963	0.780**	0.963
Rapid weight gain	0.614	0.614	0.614	0.614
Low milk yield	-0.727*	-0.432	-0.138**	-0.432
Low fecundity	-1.414**	-1.185	-0.956*	-1.185
Selective grazing habit	-0.743	-0.743	-0.743	-0.743
Small size	-0.313	-0.478 **	-0.148*	-0.313
Difficult temperament	-0.518	-0.275 *	-0.762*	-0.518

*, **, *** Statistically significant at the 1, 5 and 10% levels respectively

Table 4.9 Relative importance of the main traits of bulls, Southern Burkina Faso

Traits	Model 1	Model 2	Overall
Fitness to traction	40.2		24.7
Weight gain	11.0		6.7
Feeding ease	15.8		9.7
Disease resistance	33.0	34.2	20.2
Fertility		31.5	18.6
Size		15.4	9.0
Temperament		18.9	11.0
Total	100.0	100.0	100.0

Source: Computed from estimates data of Tables 4.6 and 4.7

The overall importance of the traits is obtained by combining estimates of both designs as if they were coming from a single design using then following formula:

$$\psi_a = \frac{[max(v_{ga}) - min(v_{ga})]}{\Sigma\, \omega_a}$$

where v_{ga} is the marginal value of the g^{th} level of the a^{th} trait; ψ_a represents the relative importance for the a^{th} trait; $\Sigma\omega_a$ is the sum of the ranges, $\left[\max(v_{ga}) - \min(v_{ga}) \right]$, across all traits.

Table 4.10 Relative importance of the main of cows, Southern Burkina Faso

Traits	Model 1	Model 2	Overall
Fecundity	36.6		24.9
Weight gain	19.5		13.3
Milk yield	13.5		9.2
Disease resistance	30.4	35.9	19.6
Feeding ease		30.3	15.6
Size		12.8	6.6
Temperament		21.0	10.8
Total	100.0	100.0	100.0

Source: Computed from estimates data of Tables 4.6 and 4.7

The overall importance of the traits is obtained by combining estimates of both designs as if they were coming from a single design using the following formula:.

$$\psi_a = \frac{[max(v_{ga}) - min(v_{ga})]}{\Sigma \omega_a}$$

where v_{ga} is the marginal value of the g^{th} level of the a^{th} trait; ψ_a represents the relative importance for the a^{th} trait; $\Sigma\omega_a$ is the sum of the ranges, $\left[\max(v_{ga}) - \min(v_{ga}) \right]$, across all traits.

Table 4.11 Comparison of the relative importance of the traits of bulls and cows: conjoint versus ranking, southern Burkina Faso

	Bulls		Cows	
Traits	conjoint	ranking	conjoint	ranking
Fitness to traction	24.7 (1)	1	-	-
Fertility	18.6 (3)	4	-	-
Feeding ease	9.7 (5)	2	15.6 (3)	5
Disease resistance	20.2 (2)	2	19.6 (2)	3
Weight gain	6.8 (7)	4	13.3 (4)	4
Size	9.0 (6)	5	6.6 (7)	7
Temperament	11.0 (4)	3	10.8 (5)	6
Fecundity	-	-	24.9 (1)	1
Milk yield	-	-	9.2 (6)	2

Source: Statistical rankings from Table 4.4

Conjoint index from Tables 4.9 and 4.10

Number in parentheses indicate the rank of the trait based on the index value.

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International Livestock Research Institute

Collaborative Program on Trypanosomosis

Trypanotolerant Livestock in West Africa

Breeding Practices and Breed Preferences

in southern du Burkina Faso

Questionnaire for the evaluation of cattle profiles

in Kourouma and Pays Lobi

Kouadio Tano,

Graduate Fellow, ILRI

Village:.............................. Focus village:......................

Name of respondent:.. N°/______/

January 1996

FIRST EXPERIMENTAL DESIGN

Village.............................. Focus village........................

Name of respondents.. N°/_____/

BULLS

N°1 Diseases: Resistant Weight: Rapid Feeding ease: Selective Fitness for traction: Good Rating ..../ 5	N° 2 Disease: Resistant Weight gain: Rapid Feeding ease: Selective Fitness for traction: Poor Rating ..../ 5
N°3 Diseases: Susceptible Weight: Low Feeding ease: Selective Fitness for traction: Poor Rating ..../ 5	N°4 Diseases: Susceptible Weight: Rapid Feeding ease: Non Selective Fitness for traction: Good Rating ..../ 5
N°5 Diseases: Resistant Weight: Low Feeding ease: Non Selective Fitness for traction: Poor Rating ..../ 5	N°6 Diseases: Resistant Weight: Low Feeding ease: Non Selective Fitness for traction: Good Rating ..../ 5
N°7 Diseases: Susceptible Weight: Low Feeding ease: Selective Fitness for traction: Good Rating ..../ 5	N°8 Diseases: Susceptible Weight: Rapid Feeding ease: Non Selective Fitness for traction: Poor Rating ..../ 5

N. B: Survey respondents were asked to evaluate each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent's cattle operations, 1 the least desirable cattle and ratings 2 to 4 represented desirability between the two extremes.

Profiles were presented in the pictorial format enclosed.

COWS

1 Disease : Resistant Weight gain : Rapid Fecundity : Low Milk yield : Low Rating............./ 5	2 Disease : Susceptible Weight gain : Low Fecundity : High Milk yield : Low Rating............./ 5
3 Disease : Resistant Weight gain : Low Fecundity : Low Milk yield : Low Rating................./ 5	4 Disease : Susceptible Weight gain : Rapid Fecundity : High Milk yield : High Rating............./ 5
5 Disease : Resistant Weight gain : Rapid Fecundity : High Milk yield : Low Rating................/ 5	6 Disease : Susceptible Weight gain : Low Fecundity : Low Milk yield :High Rating............./ 5
7 Disease : Resistant Weight gain: Low Fecundity : High Milk yield : High Rating................/ 5	8 Disease : Susceptible Weight gain : Rapid Fecundity : Low Milk yield : Low Rating................./ 5

N. B: Survey respondents were asked to evaluate each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent's cattle operations, 1 the least desirable cattle and ratings 2 to 4 represented desirability between the two extremes.

Profiles were presented in the pictorial format enclosed.

SECOND EXPERIMENTAL DESIGN

Village.............................. Focus village.......................

Name of respondents... N°/_____/

BULLS

1	2
Disease : Resistant Fertility : High Temperament : Easy Size : Large Rating................................/ 5	Disease : Resistant Fertility : Low Temperament: Difficult Size : Small Rating................................/ 5
3 Disease : Resistant Fertility : Low Temperament : Easy Size: Large Rating................................/ 5	**4** Disease : Susceptible Fertility : High Temperament: Easy Size: Small Rating................................/ 5
5 Disease : Susceptible Fertility : High Temperament : Difficult Size: Large Rating................./ 5	**6** Disease : Susceptible Fertility : Low Temperament: Difficult Size: Large Rating................./ 5
7 Disease : Resistant Fertility : High Temperament: Difficult Size: Small Rating................./ 5	**8** Disease : Susceptible Fertility : Low Temperament: Easy Size: Small Rating................./ 5

N.B: Survey respondents were asked to evaluate each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent's cattle operations, 1 the least desirable cattle and ratings 2 to 4 represented desirability between the two extremes.

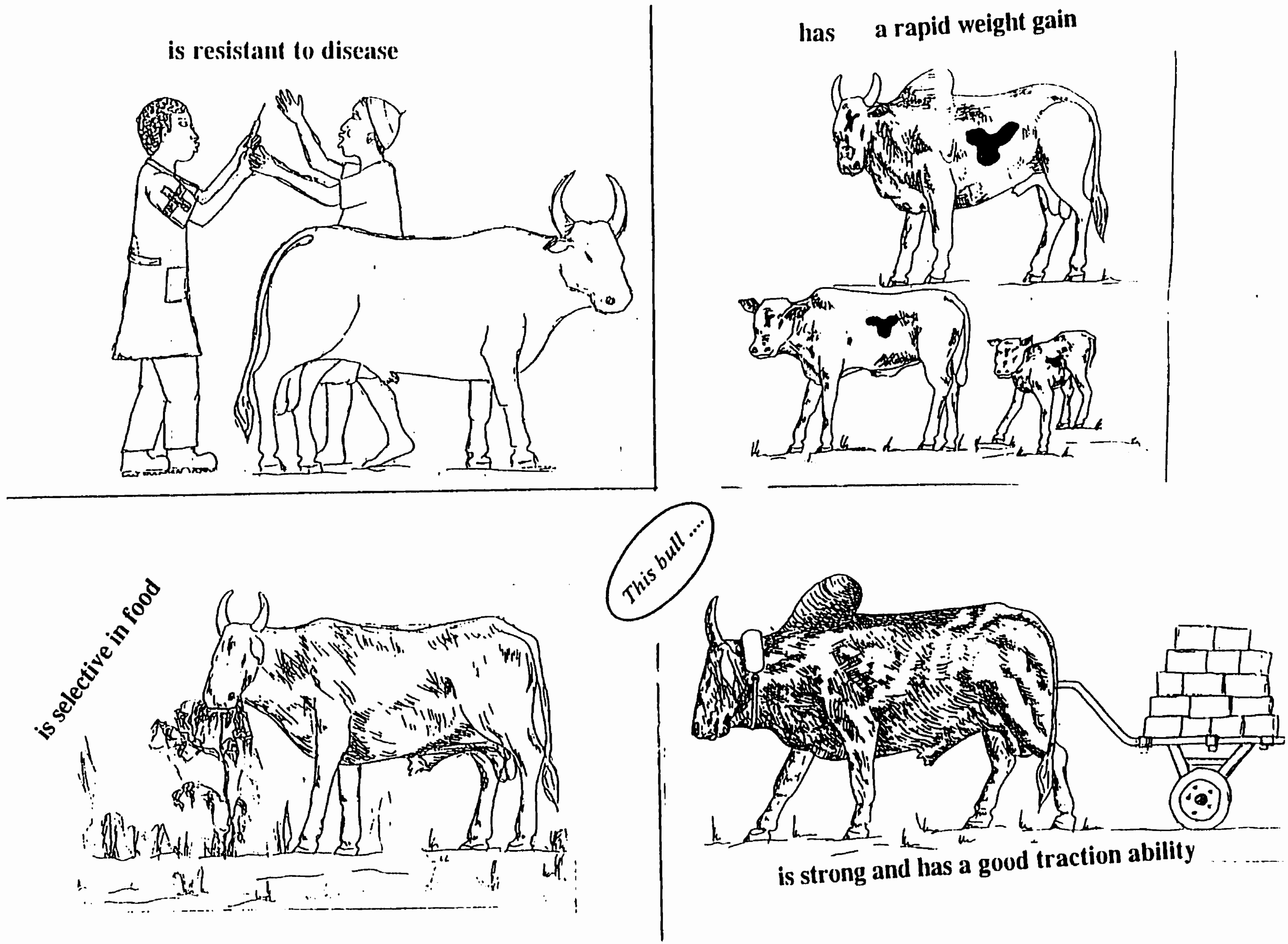
Profiles were presented in the pictorial format enclosed.

COWS

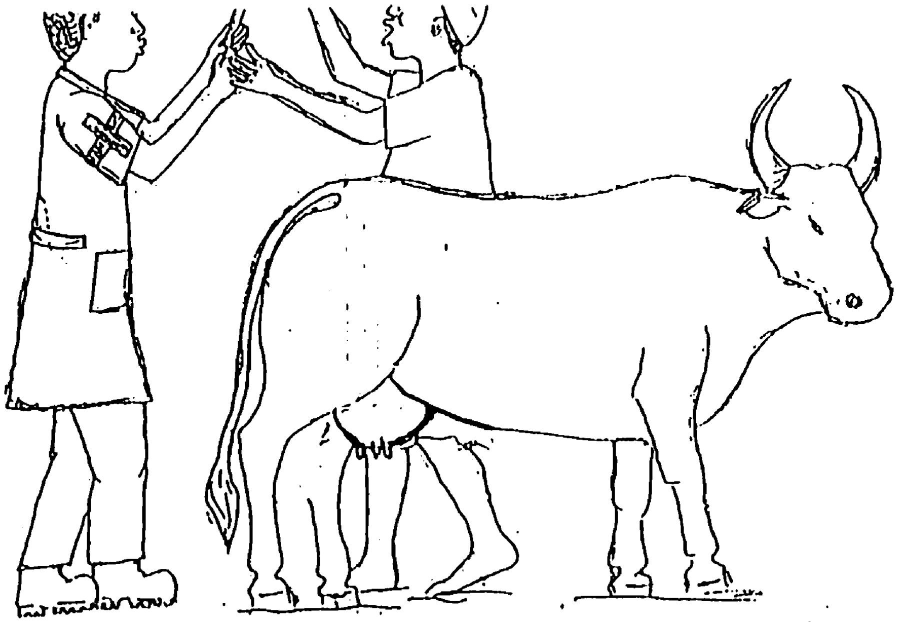
1	2
Disease : Resistant Size : Small Feeding ease : Selective Temperament : Difficult Rating............./ 5	Disease : Susceptible Size : Large Feeding ease : Selective Temperament : Easy Rating............../ 5
3	**4**
Disease : Resistant Size : Large Feeding ease : Non selective Temperament : Difficult Rating................./ 5	Disease : Susceptible Size : Small Feeding ease : Non selective Temperament : Easy Rating............../ 5
5	**6**
Disease : Resistant Size : Large Feeding ease : Selective Temperament : Easy Rating................/ 5	Disease : Susceptible Size : Small Feeding ease : Selective Temperament : Difficult Rating............./ 5
7	**8**
Disease : Susceptible Size : Large Feeding ease : Non selective Temperament : Difficult Rating................./ 5	Disease : Resistant Size : Small Feeding ease : Non selective Temperament : Easy Rating................./ 5

N. B: Survey respondents were asked to evaluate each profile using a five-point (1-5) preference scale, where 5 means the most desirable animal for the respondent's cattle operations, 1 the least desirable cattle and ratings 2 to 4 represented desirability between the two extremes.

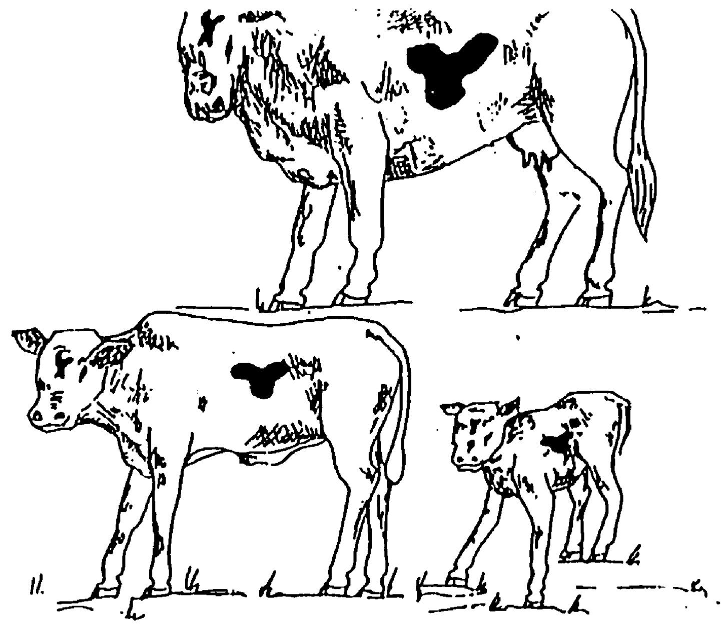
Profiles were presented in the pictorial format enclosed.


This bull ....
is resistant to disease
has a rapid weight gain
is selective in food
is strong and has a good traction ability

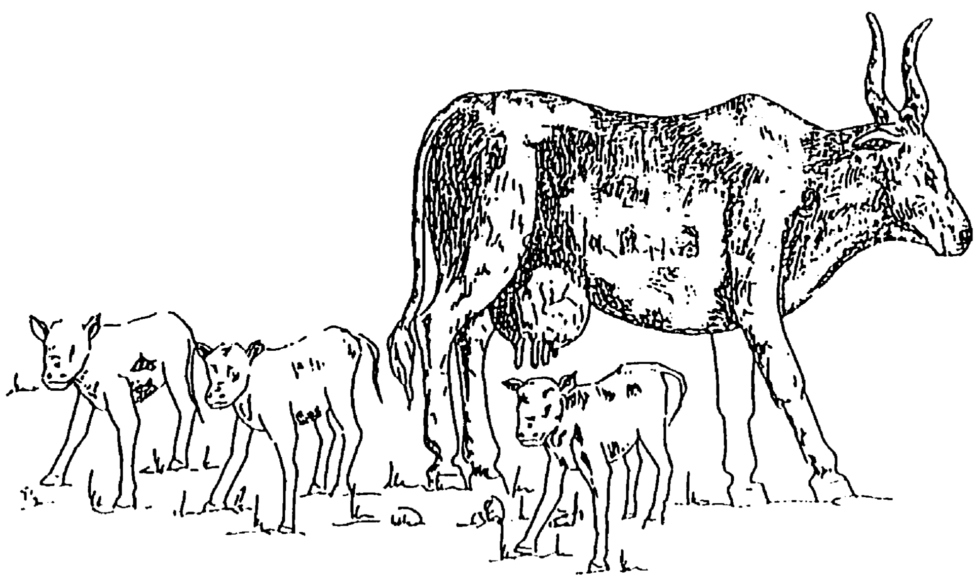
This cow....



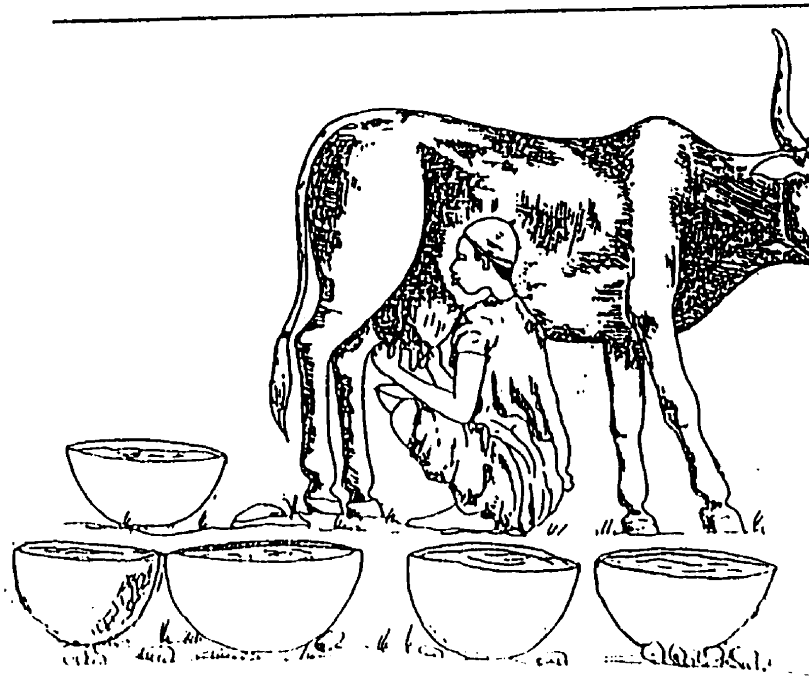
..... is resistant to diseases



...... has a rapid weight gain



.... has a high fecundity



has a high milking ability

Chapter 5

Summary and Conclusions

5.1 Introduction

This chapter summarizes the primary results of this study, along with a review of the methods used to achieve the specific objectives. The overview of results is followed by a summary of the policy implications. Finally, the limitations of the research and suggestions for future research in the area are discussed.

The study was conducted in southern Burkina Faso with the primary objective of assessing livestock owners preferences for the main breeds of cattle. The study was conducted in a tsetse-infested area where three breeds of cattle, Baoulé, Zebu and Méré, are raised under different production and management systems. Baoulé is an indigenous trypanotolerant breed also found in pockets across West Africa and known for their ability to survive and produce in areas of low to moderate tsetse challenge without the aid of drugs (Rege 1994; Jabbar et al., 1997). Formerly Zebu were primarily raised outside the tsetse-infested area, but herders who raise Zebu have increasingly been forced to settle in the humid, tsetse-infested zones by prolonged droughts and the deterioration of range in their traditional grazing areas. Méré is a stabilized cross resulting from crossbreeding Zebu with Baoulé in order to reduce risk of mortality due to trypanosomosis (Bassett, 1986) and / or to produce larger animals for draught purposes.

General guidelines in field surveys regarding the most important animal traits, farmers' preferences and strategies in livestock production were developed using a range of techniques. Focus group interviews were particularly helpful in linking key theoretical concepts to the actual perceptions and behaviour of livestock owners, and in the establishment of a restricted list of most important traits of cattle. The underlying hypothesis is that livestock owners' preferences for breeds are based on various traits contained in each breed. A producer survey (299 households) to elicit livestock owners' preferences for the main traits of cattle and their perceptions of the advantages and disadvantages of each breed was used as a way to test this hypothesis. The impacts of cattle production and breeding practices on breed preferences were also examined.

Farmers' preferences for the indigenous Baoulé were also assessed using a more rigorous method involving a stochastic discrete choice model. The main purpose was to identify potential factors likely to explain the adoption of Baoulé, given the serious risk of extinction of Baoulé cattle due to many livestock owners relative preference for good traction ability and high reproductive ability, traits in which Baoulé cattle perform poorly.

Finally, A survey-based method called conjoint analysis was used to estimate cattle owners' preferences for various levels of the traits. The use of conjoint analysis provides measurements of the relative preferences for the levels of traits considered in the study and the overall importance of the traits. The capacity of conjoint analysis to carry out preference studies using levels of traits is a way of testing different possible shapes of the utility function along each trait (Green and Srinivasan, 1990). For example, some traits may be inferior in the sense that their only presence reduces the preference for the breed while other traits may be preferred up to a point and not preferred after that point (Ladd and Martin, 1976). Conjoint analysis allows the testing of differences in relative preferences among cattle owners, which can help design more effective strategies and reorient livestock breeding policies to be more inclined with farmers' aspirations.

5.2 Main results and policy implications

The focus group interviews and a producer survey led to the identification of the seven most important traits for cattle breed choice. For bulls, these are weight gain, disease resistance, selectivity in feed, fitness to traction, temperament, fertility, and animal size for bull. For cows they are disease resistance, weight gain, selectivity in feed, fecundity, milk yield, temperament, and animal size. Of this list of traits, only three (trypanotolerance, milk yield and traction) were regarded as being "of larger importance" in a breeding scheme recently proposed for a genetic improvement of trypanotolerant cattle developed by an FAO consultation team (Dempfle, 1992 p.77). If some of this longer list of potential candidates are found to be more highly preferred by cattle producers, then a reasonable case can be made to reconsider the narrow list of traits for breed improvement.

Analysis of producer survey data indicated three main production systems and various herd structures ranging from specialized herds with only one breed of cattle to more composite herds combining Zebu, Baoulé and Méré. Direct questioning of farmers about the advantages and disadvantages they perceived in each breed indicated that Baoulé cattle were preferred to Zebu and Méré only in disease resistance and grazing habits while Zebu were preferred to Baoulé in several traits such as milk yield, size, fecundity, weight gain and traction ability. These results were confirmed by the use of the matrix rating technique to assess farmers' preferences for the breeds.

There is another important result related to the importance of farmers' knowledge in cattle production. The fact that some important traits identified with the producer survey were regarded as important in a genetic improvement program is an indication that the survey methods used can be an effective way to integrate producer preferences into genetic research programs (Faminow, 1996). The fact that active breeding between Zebu and Baoulé has been carried out by cattle producers in the region also shows that farmers are not ignorant of the genetic process, similar to findings in North America (Kerr, 1984). This would imply that there is a potential role for genetic research for livestock development in the area, but this role should be participatory. In other words, breed improvement programs could be integrated with preferences and breeding programs of farmers.

Given the general advantages of Zebu over Baoulé and farmers' preference for Zebu, Logit models were used to identify factors that are likely to explain the adoption of Baoulé. These factors are important inputs for breed improvement schemes as well as breed preservation programs aiming at reducing the risk of extinction of Baoulé in the study area. If key factors that trigger the adoption of Baoulé in commercial and subsistence herds can be identified, then programs to help maintain a viable breeding stock of Baoulé in herds can be developed. This is particularly important in countries like Burkina Faso where regional isolation, illiteracy and limited interactions with technical breeding programs at experiment stations limit the effectiveness of non-participatory forms of breed preservation and improvement research.

Sigué and Kamuanga (1997) found no evidence of a clearly established policy by the Government of Burkina Faso to promote the development of trypanotolerant livestock, despite the fact these breeds represent about 25% of the national stock.

Results of the logit models showed that the type of production system and farmers' origin (migrant vs indigenous) and their subjective evaluation of the breeds were significant determinants of the adoption of Baoulé. For example, the fact that some subsistence farmers regarded Baoulé as having an "overall desirability" relative to Zebu and Méré provides an opportunity to increase the probability of adoption of Baoulé in some herds. In contrast, mixed crop farmers were less likely to keep Baoulé. These results confirm the findings of previous adoption studies about the significant role of farmers' perceptions of the technology characteristics on their adoption decisions (Jabbar et al., 1997; Feder and al.,1985; Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995). However, in this study, the high ratings of disease resistance and feeding ease of Baoulé did not make these traits major determinants of the probability of adoption of Baoulé, in contrast to what has been observed in southern Nigeria (Jabbar et al., 1997).

The fact that a high perceived overall advantage of Baoulé to the other breeds positively affects the odds of having a Baoulé breed in the herd and confirms the potential role of subsistence farming systems in the design of breed preservation strategy. The significant impact of farmers' perceptions on their adoption decisions imply that extension programs may have some role in adoption decisions. The target for such a strategy could be indigenous farmers using the subsistence farming system (i.e., most farmers in areas like Pays Lobi) who have a high probability of adopting Baoulé.

As Jabbar et al., (1997) have noted with the increasing adoption of Zebu, perhaps breed improvement schemes should focus on ways of improving the adaptation of traits of Zebu through within-breed selection or crossbreeding with trypanotolerant breed such as Baoulé.

Conjoint analysis was used to assess preferences of cattle owners for the seven traits of bulls and cows and their levels with the purposes of confirming findings of the ranking procedure about the relative importance of the traits and testing the hypothesis about the existence of potential differences in preferences among cattle owners. High illiteracy and language differences in the survey population required the use of a simple survey instrument displaying a limited range of profiles. In addition, pictorial materials were needed to describe the profiles to the respondents so that ambiguity about the levels of traits and the purpose of the research would be reduced. Limiting the number of profiles was achieved by limiting both the number of traits in each design and the number of levels for each trait. Information loss was minimized by splitting the questionnaire, in designs of both bulls and cows, into two parts with disease resistance being common to both parts, and the remaining six traits evenly split between the two parts.

The estimates of the levels of traits represent marginal preferences of an average farmer for the levels of traits. Results of the estimated models indicate that all main effects were statistically significant with the expected signs. For bulls, small size, selective grazing habits, poor fitness to traction and difficult temperament of bulls had negative signs, indicating that respondents disliked these levels of traits. For cows, levels of traits that respondents disliked were low fecundity, low milk yield, selective grazing habits, small size and difficult temperament. In contrast, disease resistance, rapid weight gain and high fertility of bulls were preferred. The preferred levels of cows were rapid weight gain, and disease resistance.

The estimated main effects can be used to compute the relative importance of the traits and show which traits survey respondents preferred more. Fitness to traction and disease resistance in the first design and disease resistance and fertility in the second design had high partworths for bulls. For cows, fecundity and disease resistance in the first design and disease resistance and feeding ease in the second design had high partworths. It is important to note that disease resistance, the common trait in both designs had consistent estimated values across and between the models of bulls and cows. This increases our confidence that conjoint analysis is working as hypothesized in the theoretical framework of preference ordering.

Since both designs of bulls and cows had disease resistance in common, the relative importance of all the traits were computed by combining results of the two parts of the survey. This provides, in an ad hoc way, an overall evaluation of the complete list of traits as if they were jointly considered by the respondents. Notice that this overall relative importance may not necessarily reflect what would have resulted from an evaluation by respondents of a single design including all the seven traits. However, estimates of disease resistance in both models of bulls or cows were so close to give support to a common index reflecting a preference ordering based on the entire set of traits.

On the basis of the overall index, the relative importance of the traits for bulls can be established as follows: fitness to traction, disease resistance, fertility, temperament, feeding ease, size and weight gain. In the same way, the most important traits of cows were found to be in the following order of preference: fecundity, disease resistance, feeding ease, weight gain, temperament, milk yield and size. These results show that when all the seven traits are considered, fitness to traction, disease resistance and fertility were the most preferred traits of bulls while most preferred traits of cows were fecundity, disease resistance and feeding ease. It is important to note that traits such as weight gain and milk yield which are usually key elements of breed improvement programs were among the least important traits as assessed by farmers in Burkina Faso.

Conjoint analysis also provided significant differences in preferences among classes of cattle producers for traits such as fitness to traction, feeding ease, temperament, size of animal and low fecundity. The differences in fitness to traction can be explained by a difference in the use of animal traction across the different classes of farmers. For example, subsistence farmers do not use cattle for traction and have less preference for fitness to traction than mixed crop farmers who use animal traction to grow food crops and cash crops.

The differential preferences for feeding ease can be attributed to differences in the amount of crop residues available to each producer. For example, mixed crop farmers are usually crop producers who feed their animals using some of the crop residues, so selectivity to grass is less of a problem for them. Alternatively, milk and beef producers and subsistence farmers do not usually have substantial amount of crop residues and or manage their own cattle. They have stronger negative preferences for feed selectivity. Some farmers may be less directly concerned by the issue because most of their cattle are managed by hired herders who did not participate in the interviews.

Differences in preferences for temperament can be attributed to the use of herders in the management of the herds. Mixed crop farmers and milk and beef producers using specialized herders for their animals have less concern for this trait than subsistence farmers who use the younger members of the family and are themselves more intimately familiar with animal behaviour. The differences in preferences for size of animals can be explained either by the needs for draught purposes (mixed crop farmers) or the market value of the animals (milk and beef producers). Subsistence farmers who do not use cattle for traction seemed less concerned by this trait. For low fecundity the differences in preferences were mainly due to differences in the role of livestock in farming systems. Mixed crop farmers who are less interested in off-take (beef and milk) dislike low fecundity the least. On the contrary, in a subsistence farming system, cattle play various and complex roles (social events, dowry, store of wealth). Low fecundity has a potential negative effect on the herd size and, therefore, would be very much disliked. Milk and beef producers are more interested in off-take than mixed crop farmers, but they are specialized cattle producers who may have alternative management ways of overcoming low fecundity. The fact that there was no detectable differences among cattle producers based on disease resistance confirms the importance of disease resistance as perceived by cattle owners in the study area.

A comparison of these results with farmers' explicit ranking of the traits indicated similarities and differences. The relative importance of milk yield and feeding ease for cows, and feeding ease and weight gain for bulls were different in the two approaches. For the other traits, both methods yield fairly similar results about the relative importance of the traits. Kendall's coefficient of concordance computed for bulls and cows confirmed the similarities and differences in the rankings resulting from using the two methods. Despite the similarities, results provided by the conjoint study are much stronger than the explicit rankings because the trade-offs involved in conjoint studies mimic actual choice situations more closely than a ranking procedure. In addition, using conjoint provides average and producer specific partworths for the traits considered in the study. However, it should be noted that conjoint analysis and traditional methods to assess economic weights of cattle characteristics are complementary approaches.

5.4 Use and Limitations of the study

The general purpose of this study was to assess the preferences of cattle owners in southern Burkina Faso towards the main breeds of cattle raised in the area. The relative preferences provided reflect the relative importance of the traits to cattle owners. The potential economic benefits to producers from genetic improvement of the traits were not provided by the analysis. The economic benefits, usually derived using production-based approaches (e.g. Amer et al., 1994) are important as they link the change in production that results from genetic improvement directly to the revenues and costs of that change (Faminow, 1996). However, the conjoint approach supplements the information provided by production-based selection indexes.

Animal traction is a good example of how combining results from both approaches can be beneficial to livestock production. Despite the fact that traction was considered an important trait, it was ignored in a genetic improvement program because of difficulties in the "definition of the trait, the derivation of economic values, the testing for the trait and the feeling that the economic importance of a genetic improvement of the trait is not so high" (Dempfle, 1991, p.82). The last reason for not including traction in the program which may be valid for other parts of sub-Saharan Africa did not reflect what was shown in this study and the fact that traction is the most preferred trait of bulls provides some indication that traction should be included in a genetic improvement program in the study area. The traction case is also important as it shows how the relative importance to producers of traits that are relatively difficult to measure in trial tests can be assessed.

The speed of replacement of Baoulé by Zebu or Méré in the herds is another limitation of this study. Although the trend away from Baoulé was observed for most cattle owners in Kourouma, there was no systematic information about the speed of the introduction of Zebu in indigenous farmers herds. The information would help identify the current status and the future trend of the risk of extinction of Baoulé.

In this study, conjoint analysis was used in an exploratory way to assess cattle preferences through an alternative method. Specific conditions of the survey population and the lack of conjoint studies conducted in the African context, required some degree of pragmatism in the design of the survey instrument (Karugia, 1997). The questionnaire was split into two parts, and estimated results were later combined to produce a single index showing the relative importance of the traits which may differ from a results of a single design involving all seven traits. In addition, polar opposite levels were defined for the traits and in some cases the pictorial representations showed level differences in a exaggerated manner. This may have provided a wider distinction between the levels of traits than it, actually, is. For example, the levels used for disease resistance did not incorporate an intermediary case represented by Méré.

5.5 Suggestions for further research

As mentioned above, the risk of extinction of Baoulé in the region needs to be investigated. This could be done by expanding the issues covered by the ongoing works assessing the relative performances of Baoulé, Zebu and Méré.

Another important study would be the analysis of farmers' transactions about cattle (purchases and sales) to identify the factors that determine prices. The absence of markets where farmers buy and sell cattle may be an important constraint for the study. Along with this study, it would be interesting to investigate the demand for cattle use for traction given the importance of fitness to traction. Results would help assess the potential inclusion of fitness to traction in a breeding program.

Finally, the study reported traits that were regarded as being important. The actual definition of the trait and the derivation of the relative economic weights need to be carried out before inclusion in a breeding scheme.

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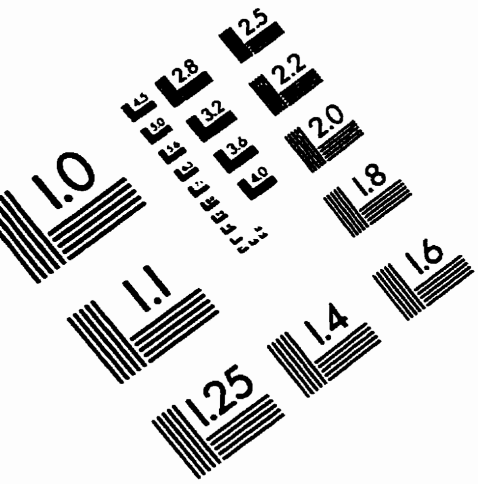
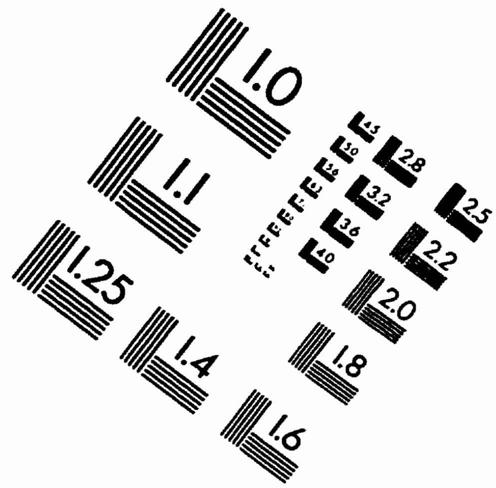
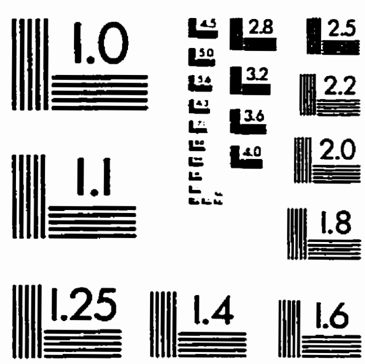
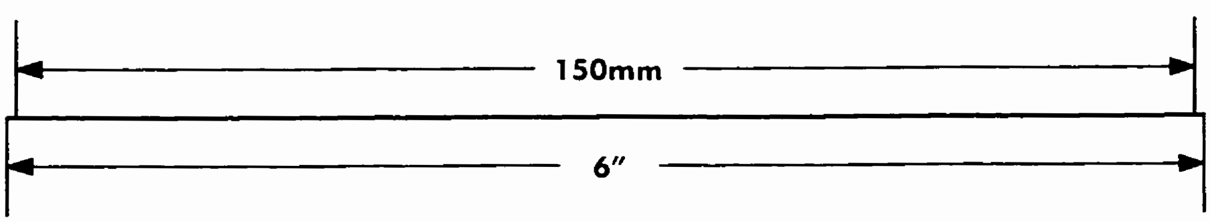
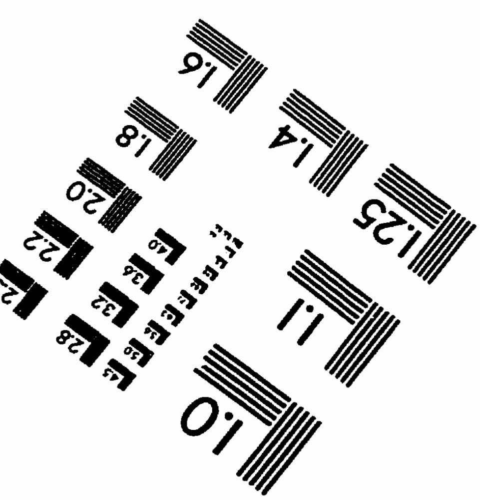
IMAGE EVALUATION TEST TARGET (QA-3)

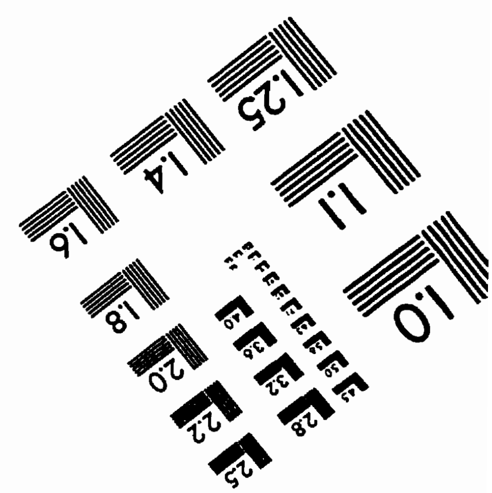












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