URBAN LIVESTOCK PRODUCTION SYSTEMS AND FOOD SECURITY IN THE "ZONE DENSE" KHOROGO AREA OF COTE D'IVOIRE

By

MODY BAKAR BARRY

Bachelor of Science
University of Abidjan
Abidjan, Cote D'Ivoire
1973

Master of Science
Universite de Montpillier
Montpellier, France
1979

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
August, 2001

URBAN LIVESTOCK PRODUCTION SYSTEMS

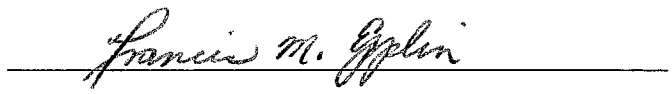
AND FOOD SECURITY IN THE "ZONE

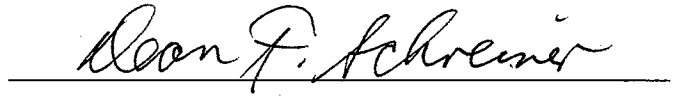
DENSE" KHOROGO AREA OF

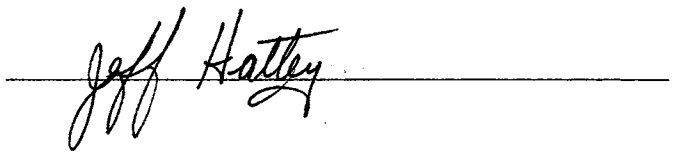
COTE D'IVOIRE

Thesis Approved:

Thesis Advisor







Dean of the Graduate College

ACKNOWLEDGMENTS

First, I would like to express my profound gratitude to my Principal Advisor, Dr. A. Stoecker for the guidance and multiform support he has generously provided me during my entire program. When he visited me during my field research, I was like a motherless child, in trying to define and implement an adequate sampling method for the survey.

I would like to take this opportunity to thank Professor Dean Schreiner for his sincere support, especially for the way he scrutinized the dissertation, but before that, for the formidable recommendation letters he sent to the funding agencies which helped to secure the grant for the field research. I would like also to thank my other committee members, Dr. Epplin, and Dr. Hattey for their guidance and support.

I am indebted to Dr. Ehui Simeon from the International Livestock Research Institute in Addis Ababa. As I used to say, dear brother, you have been the Alpha and Omega of this project. I will remember. Thanks also to your colleague Dr. Mohamed Ahmed, for his contribution.

I would like to take this opportunity to thank all my colleagues and friends from OSU, who not only helped me, but also enriched my intellectual life. Gelson Tembo, was one of them. During five years he patiently helped me and provided me a family atmosphere. Thanks also to Mohamed Assim, Abdulbaki Bilgic, Cumhur Buguk and many others friends for your kindness and availability.

This project could not be undertaken without the support of many institutions. First of all, AGROPOLIS, which provided the financial support. I would like to thank all the staff for supporting research in developing countries. I hope that the Urban Agriculture Network will blossom world wide to help improve nutrition among urban poor.

I would like to thank also my academic and non-academic institutions: the Ivoirian Center for Social and Economic Research (CIRES) and the International Livestock Research Institute (ILRI) I owe a particular debt to the Director of CIRES Pr. Tche-Tche N'Guessan for his personal support to this project. To my collegues and friends from CIRES, I would like to say, thanks guys, in particular, Dr.Tano Kouadio, Pr,Affou Yapi Simplice, Joseph YAO YAO, Diomande KAVALLY for their support and academic guidance.

Last but not least, I would like to thank my wife Hadja BARRY TOURE, for her support, patience and love. She went through so many things during this four years, stress anxiety, and hope. She supported our four kids alone with courage and dignity. Maman, I owe you everything, thank you for your support. Masseni, Nene Amy, Habiba, Yayou, I am sorry for having been away from you, for so long time, I love you.

TABLE OF CONTENTS

Chapter Page

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Sub-Saharan Africa is the only region of the world where per capita food production has fallen during the past decades (World Bank 1986). Between 1979-81 and 1981-91, per-capita food production declined by 20% and the real GDP per capita contracted by 1% (Ehui 1997). A 3.1% population growth rate, combined with the effects of urbanization, makes it very difficult for the region to maintain the present level of consumption (Sanders, Shapiro and Ramaswany 1996), using the same low input technology. Traditional production systems, based on shifting cultivation, low input use, and low productivity, are no longer able to satisfy food demand.. Population growth and urbanization, and the limited potential for increasing production through the expansion of cultivated area (especially in the highly populated zones) imply that, for food needs to be met in the future, yields have to increase. As far as protein supply is concerned, the deficit facing the country is expected to grow, despite the efforts undertaken by the parastatal agencies during the last two decades. Under the Structural Adjustment programs livestock production activities will be gradually privatized. However policy makers are still interested in knowing the potential contribution of urban livestock production systems and the constraints facing small ruminant owners, in order to provide adequate services (equipment, veterinary services, information, incentive prices). Policy makers are also interested in the socio-economic characteristics of the producers,

especially their gender. It is often assumed that when women own the small ruminants, or have control on income, the food security of the household and the nutritional status of the children is improved.

The general objective of this research is to determine the impact of urban livestock on meat supply and households food security in the city of Korhogo

Specific objectives include:

1. Determine of the number of livestock owned by urban households in selected neighborhoods of Korhogo, Cote d'Ivorie.
2. Estimation of the input-output relationships of the urban livestock production systems.
3. Quantification of the factors that most influenced the adoption of small ruminants by urban households.

Background and Justification

Problem Setting

During the last two decades, rapid economic growth, and political stability have characterized the Ivory Coast. As a result, the country attracted many immigrants from neighboring countries, especially in the cities. The conjugate effects of immigration, urbanization and population growth have increased the pressure exerted on the food supply, especially that for meat and other livestock products. More recently, civil wars in Liberia and Sierra-Leone, and the drought in neighboring Sahelian countries have exacerbated the phenomenon. Moreover, the recent devaluation of the local currency (franc C.F.A) in January 1995 has restricted the access to imported foods. Even the low-grade meat ("caparacon") imported from the EC has become unaffordable. Therefore,

food security (especially the meat supply) is a critical challenge for both households and policy makers.

Traditional production systems, based on long fallow periods, a low level of investment and input use, and low productivity are no longer able to provide enough food to urban consumers. These systems have also proven to be environmentally detrimental. Moreover, inadequate land tenure systems and inappropriate agricultural and macroeconomic policies, have led to inefficiencies and inertia of the production systems (frozen agricultural prices, cost of transportation, etc.). Urban agriculture is one possible alternative, which can make more intensive use of existing non-forest space and contribute to environment protection. As Ninez (1983) pointed out, Urban Agriculture represents the most universal of subsistence strategies for urban families. Despite its critical role in producing food for city dwellers around the world, urban food production has been largely ignored by scholars and agricultural planners (Tinker 1994). Little is understood about the forces behind urban farming or its impact at the household level. Intra-household dynamics, gender relations, and declining wages are all important to an understanding of urban farming (Maxwell 1995). This in part relates to the scant attention directed to the issue of unpaid and unrecognized labor, of marginalized and vulnerable groups including women of all ages and the elderly, of unemployed and low-income males. These are the groups who most often perform the tasks necessary for self-sufficiency of the local population (Bellows 1997).

Problem Statement

The Cote d'Ivoire is a traditional net importer of meat. It relies mainly on neighboring countries for live animals, and on the European Community for meat and

milk. Since the devaluation of the C.F.A currency these imports have become very expensive for low and middle-income urban workers. The meat supply from neighboring countries is becoming more and more uncertain due to weather fluctuations and to the emergence of more attractive markets in Ghana, Nigeria and the Magrheb. An alternative is to focus on promoting domestic production, by intensifying traditional production systems and/or by developing and supporting urban production system. These two alternatives are not mutually exclusive.

Several attempts by extension agencies at intensification of traditional production systems have been undertaken in the study area. The proposed models were all based on macroeconomic consideration. The major objective was to increase the number of cattle in order to reduce the beef deficit. However the carrying capacity of the zone and the dynamics that underlay the cattle production systems were ignored. As a result none of the proposed schemes have succeeded. For instance the public development project "Noyaux d'elevage" was based on a loan of 20 cattle to selected farmers to help promote domestic meat and milk production. Farmers were supposed to reimburse the government (in terms of live animals), so new loans could be provided to other farmers. Unfortunately, it was not a successful program. It failed because many farmers failed to respect the contract, because management was not appropriate, because herd production was extremely low and many animals were simply lost. Another project, the introduction of the "Stylosanthes Gracilis" as a fodder crop in cotton plantations, was aimed at encouraging farmers implement mixed crop-livestock farming systems.

After years of unsuccessful attempts to improve domestic production, the government decided to enter the production process. As a result, many public extension

agencies were created, with the objective to offset meat imports and improve the balance of payments. The results were also disappointing. These public programs failed mainly, because the traditional production systems in the region do not integrate cattle with over productive activities in the farm household (Barry 1979).

As Powell and Williams (1996) point out, crop and livestock production are functionally linked but are operationally separated. Farmers use their income to buy cattle, but they view cattle production as an investment to offset the uncertainty of crop production under fluctuating climatic conditions (Frankenberger, Reeves, and Coughenour, 1984). As a result, farmers are reluctant to integrate cattle in their exploitations. Therefore, cattle and crops are technically dissociated as there is no positive interaction between the two activities. Cattle production occurs outside the cropping zone. Human population rather than the carrying capacity of the pasture determines the stocking rate (Chataigner, 1983).

Competition between men and animals has confined cattle in marginal and fragile areas, with severe degradation of soil and biodiversity. On the other hand, small ruminants are effectively integrated in the production systems. Goats and sheep are part of the production unit, and sometimes part of the residential units in the cities. There is no taboo in managing and taking care of the small stock, which is an important source of protein and income for the households. However, no studies have been conducted in the area to understand how the system operates in order to help implement appropriate policies and promote crop mixed –small ruminant systems.

Since the venue of the Structural Adjustment Programs, the funding agencies like the World Bank and the IMF no longer allow governments to be directly involved in the

production process. So the government is no longer a meat or dairy producer. However, it still intervenes by providing incentives to farmers by supplying subsidized inputs. As a result it is interested in knowing the characteristics, of potential producers, as well as their motivations and production constraints. Hypotheses to be addressed include:

1. Adopting small ruminants contributes significantly to incomes of the relatively poor households in urban system and improves their food security.
2. Households with farming experience and primary farming occupation are most likely to invest in livestock activities as an alternative source of income.

Organization of the Study.

After the introductory chapter, a literature review presents the recent developments of urban agriculture, which are related to food security and gender. Household decision-making models are also presented, as well as the demand systems for food and categorical data analysis framework. In part three the study area, is described and the findings and results of the survey are presented. In part four the econometric methods used and the factors affecting livestock adoption as a food security strategy and the estimate a household demand system are identified. Finally part five presents the conclusion and the policy implications of the study.

CHAPTER II

LITERATURE REVIEW

Production Systems

Production systems are part of farming systems. According to the definition of the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIR),

> "A farming system is not simply a collection of crops and animals, to which one can apply various inputs, and expect immediate returns. Rather it is a complicated interwoven mesh, of soils, plants, animals, implements, workers, other inputs, and environmental influences, with the strands held and manipulated by a person called the farmer who, given his aspiration and preferences, attempts to produce output from the input and technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socioeconomic, that results in his farming system".

In other words, the farming system includes the whole farm and its activities Mademba (1984).

The Urban Agriculture Concept

Urban agriculture's overall nature makes the concept difficult to define. Taken literally, urban agriculture means, "to establish and perform an agricultural practice in or near an urban or city-like setting". Often considered as supplementary to conventional agriculture, urban agriculture is also a viable adaptive response to urbanization. It may

promote food security and generate income to the poorer small holders. International studies share the conclusion that urban food production is an important component of household survival strategies Cockram et al. (1998).

Gender and Urban Agriculture

Many studies (Lele, 1986; Due, 1986; Gladwin and McMillan, 1989; Due and Magayane, 1989; Poats, 1991) have shown that a gender approach of economic development may be essential to the household's nutritional status and overall welfare in developing countries. In the early 1980's, Henn (1983) argued that increased attention to the problems of women farmers could help solve both rural and urban food supply problems. Based on the farming system of the Beti people of Southern Cameroon, his research showed that woman significantly increased food production when they had good access to large urban markets. More recently Dennery (1995), in her study in Kibera Kenya, added a qualitative dimension to Urban Agriculture research in East Africa, by providing empirical evidence on gender relations, labor relations, and the multiple use of the produce at the individual, households and community level.

In a survey conducted during 1992 and 1993, Drescher (1998) explores the role of household gardens in the context of household food security in Zambia. He found that women were much more involved in the food supply of the household than were men through their productive labor, and through their decisions on the production, consumption and division of food. He also developed a gardening model to enable a better understanding of urban gardening activities in the social and environmental context. Scrutinizing the motivations of urban farmers, Freeman (1993) found out that the main objective of women cultivators was to avert hunger, and provide home-grown

food to free-up the scare cash earned by family members. In a follow-up study Krieger (1995) describes survival strategies adopted by rural women in Cameroon during an economic crisis. He details the processes, activities and issues related to women's involvement in the subsistence and income generating food production for household consumption and for sale in urban areas.

Analyzing the characteristics of urban agriculture in Kenya, Lee-Smith and Pyar (1993) focus on the significance of incorporating food components such as crops and livestock into the urban household and raise policy questions about sustainable urban development. In his work, Lourrenco-Lindell (1995) addresses the role of urban food supply for the urban food security and attempts to uncover the diversity and the complexity of the urban food system, through an integrated study of the production, distribution and consumption of two foodstuffs. The study reveals that each foodstuff contributes differently to food security and is integrated in the urban food system in different ways. Each foodstuff has a distinct production, marketing and consumption structure.

As far as natural resources and the environment are concerned, urban agriculture plays also a major role. Maptela et al. (1994), showed how the use of wild vegetables in Lesotho contributes to providing a balanced diet to poor households. It is also argued that gardens with urban housing sites are agriculturally more productive than fields in rural areas. Maxwell, in emphasizing the role of women, argues that farming in the cities is the deliberate effort of urban women to provide a source of food that does not depend on cash income and fluctuating markets. He characterizes farming in the city as "household strategy". Focusing on the concepts of "household" and "strategy", Rakodi

(1991), pointed out that households and individuals formulate and adjust strategies according to their own circumstances in terms of opportunities available to them. Strategies are linked to decision making of the household and may take the form of income-generating activities.

Livestock are a major component of urban agriculture, which contribute directly and indirectly to food security and sustainable development (Sancoucy et al.1994). The urban livestock production systems are developed in response to market demands and population growth. They emerge as alternative mechanisms by which urban food insecurity can be alleviated and rural income can be enhanced according to the Association of Institutions of Tropical Veterinary Medicine (AITVM 1996). However, the concept of peri-urban agriculture needs to be clarified. Participants of the AITVM workshop agreed that it is not possible to provide a clear-cut definition. Instead, the group identified some characteristics of this type of livestock production. One characteristic was easy access to a market from which needed inputs could be secured and in which products could be sold. Another characteristic was relative closeness to a population center, which creates the demand for livestock products.

Ehui, Shapiro and Yapi (1994) reviewed the constraints to, and the opportunities for peri-urban livestock development in Sub-Saharan Africa. Following McIntire et al. (1992), they describe the four stages in the process of agriculture intensification and the role of livestock at each stage. They noted that peri-urban livestock tend to flourish in the fourth stage where human population pressure is high and where the livestock system is intensive and specialized. Peri-urban livestock systems in Cote d'Ivoire were also briefly reviewed in the study. It was found that the ultimate goal of these systems was

fattening for sale. Despite their rapid emergence, none of these systems is actually integrated in a crop-livestock production system. Major feed sources consist of agricultural by-products and household wastes. In a study conducted in the same agro-ecological zone, (25 km around the city of Bobo-Dioulasso), Thiombiano and Mattoni (1996) reported that 41 percent of small ruminants were raised for home consumption and 52 percent were raised for sale. A similar study, in Dakar by Missohou et al. (1996), noted the importance producing of small ruminants for religious purposes and for household food security. Many previous studies had emphasized the role and importance of backyard animals with increasing human population. As human population increases, small scale limited resource farmers tend to place more effort on backyard animal production (Bishop 1984).

The Food Security Concept

The recent economic development history has accustomized us to slogans or nicknames attached to each year. Under the auspices of the United Nations, international funding agencies, governments and the NGO's, we have witnessed, among others, the venue of the "Decade of the Environment"(after the Rio summit); the "Decade of Woman" (after the Beijing summit). Sometimes after a scientist or politician or philosopher has expressed concern about a specific challenge in the century, one specific year or decade has been correspondingly labeled the decade of "Structural Adjustments", of "Economic Integration" of AIDS etc...These names have nourished debates in the past twenty years. So did the "Food Security" concept.

However, contrary to the former concepts, food security has been a major concern for human beings since the very outset of his appearance on earth. When the *Homo*

Sapiens learned how to grow crops and domesticate animals in the Neolithic period, he was very concerned with food security. Since then mankind is, and will be always concerned with food security across history. The concept has recently redefined by Maxwell and Frankberger (1992), as the "secure access at all times to sufficient food for a healthy life". The definition includes the related concepts of access, sufficiency, security (or vulnerability), and sustainability all the times. We still will always be facing the challenge of food security in one form or another. As far as livestock are concerned, they contribute directly to the sustainability of the farming systems by supporting farm households, especially during periods of food shortage or financial stress (Omitti, et al. 1992).

The traditional production systems in the Northern Ivory Coast are generally differentiated by gender and ethnical background. Livestock activities are considered as minor occupations reserved to children, women, and foreigners. In that context, the role of women has often been underestimated and their work in agriculture has long been invisible. While policy makers have targeted population, health, and nutrition programs to women in their reproductive role, they have neglected them as productive agents (Quisumbing et al.1995). However since the fourth World Conference on Women in Beijing China in September 1995, this attitude has been changing, and the role of women in achieving food security has been stressed by many studies such as Quisumbing et al. (1995), and Haddad and Reardon (1992). According to the International Food Policy Research Institute (IFPRI), sustainable production of food is the first pillar of food security, and the gender approach to the issue is critical to understanding the concept in the urban production systems.

In every region of developing world, but perhaps most in Africa, millions of women work as farmers, farm workers, and natural resource managers. In doing so, they contribute to national agricultural output, maintenance of the environment, and family food security. Cassman and Harwood (1995) pointed out the role and importance of research and technology in improving productivity, and hence in protecting the environment, for a sustained food security. Even though food insecurity is present everywhere in developing countries, it has different shapes in different contexts. Food insecurity has certainly a different meaning in the highlands of Ethiopia than it has in our study area. The Ethiopian farmer has no choice but to produce, otherwise he has no chance to get access to food, because there are no markets, and no job opportunities to get income to purchase food, if any were available. This is not the case in the study area. One can either produce food or work to buy it. So in the household context, labor supply is an important factor.

Household Decision Models

The concept of the household varies widely across cultures. It ranges from the western nuclear household to the African extended family system. In the latter several generations can share the same residential compound and the same consumption unit. As de Janvry and Sadoulet (1996) pointed out, the key element in defining the household is to identify the decision-making unit, which sets the strategy concerning the generation of income and the use of this income for consumption and reproduction.

In the African households there is usually a single decision unit. It is the husband (or the patriarch) who decides on behalf of other members. In this consensual household,

a unique strategy is followed in which resources are pooled and consumption is shared, though not necessarily equally between household members.

The construction of household models started with the work of Chaynov in the 1920s as part of the debate between populists and Bolcheviks in Russia, where households faced no labor market and no flexible access to land. This lead to the concept of demographic differentiation as the optimum work effort changed through the life cycle (Harisson, 1975).

Decision making by individuals, families, and households in developing countries has long been the focus of studies by anthropologists and other social scientists. Since Baker's (1965) contribution to home economics, research on household decision making processes has grown tremendously in recent years. This effort has been stimulated by advances in economic models, econometric techniques, and the quantity and quality of household and individual level data (Strauss and Thomas 1995).

As Singh, Squire, and Strauss (1986) mentioned, agricultural households are the main forms of organization in developing countries. Consequently, it is important to understand and account for their behavior, when analyzing the impact of development projects and government policies. Quisumbing et al. (1996) have also stressed the importance of a good understanding of the intra-household process. Kinsey (1986) made a major contribution to modeling of household production and leisure time behavior of subsistence farmers.

Two types of models have been used in the literature: unitary models and collective models Unitary models are sometimes called the "Common Preferences Model", or the "Altruism Model", or "Benevolent Dictator Models". Unitary models

assume that the household acts as a single unit with a single preference function. The model has been criticized, because of its weak microeconomic foundations. Among the few theoretical attempts to reconcile the single utility framework with the existence of several individuals in the household, one must cite Samuelson's (1956) household welfare index, and Baker's (1981) rotten kid theorem

Collective Models, which are sometimes called bargaining models, have two common features. First, they allow different decision makers to have different preferences, and second, they do not require a unique household index to be interpreted as a utility function, (Chiappori 1992). The basic idea is to place the household decision problem into a bargaining framework, and then use some cooperative equilibrium concept (e.g. Nash bargaining). In a follow-up, Browing, Bourguignon, Chiappori, and Lechene (1994), developed and estimated a collective model to show how final outcomes depend on the income each person brings into the households.

Quisumbing, Brown et al. (1994) subdivided the collective models into two broad categories. There are cooperative models where individuals have a choice of remaining single or forming a household or other grouping, and the non-cooperative models which rely on the assumption that individuals cannot enter into binding and enforceable contracts with each other. In the latter, an individual action is conditional on the actions of others, implying that not all non-cooperative models are Pareto optimal. McElroy (1990) proposed a cooperative Nash bargaining model of household behavior, where each household member has a utility function and a threat point. A key issue that separates bargaining from neoclassical models is the treatment of income. In neoclassical models, only pooled family income matters, whereas in the bargaining approach, who has control

over the various incomes sources matters. De Janvry and Sadoulet (1996) discussed when and how to use a Household Model. If there are no market failures, and we are interested only in the production side of the farm household, the separability condition eliminates the need for a household approach. If there are no market failures and we are interested in the consumption side of the household, a household approach my be useful to link the consumption side to the production side ex-post through income effects. If there are market failures, which are common in developing countries, a household approach is necessary due to breakdown in separability condition between production and consumption decisions.

In economic theory, the problems of production decisions, consumption decisions and labor supply decisions are usually analyzed separately through the behavior of the three classes of agents. These are producers, consumers, and workers. Producers maximize net revenues subject to constraints determined by market prices, fixed factors and technology. Consumers maximize utility with respect to the quantity of good consumed, subject to constraints determined by market prices, disposable income, household characteristics and tastes. Workers maximize utility with respect to income and home time and the constraints determined by the market wage, total time available, and worker characteristics. In the case of the household, the decision-maker is simultaneously engaged in production, consumption and work decisions. So these three problems must be integrated into one single household problem de Janvry, and Sadoulet (1996).

Whole Farm Models

Household decision making models can also be captured in the framework of mathematical programming. As producers, households operate in risky conditions, and they have to make decisions on what type of activities they should undertake, and how they should allocate their time in order to maximize the total household expected utility. Many risk-programming methods have been developed to address risk in decision-making. The most commonly used risk return-model is the mean variance (E-V), in which risk is measured as the variance, and return by the mean of the probability distribution over outcomes (Holtausen 1983). The Motad (Minimum of Total Absolute Deviations) by Hazel (1971) is also widely used in the literature. However, these two methods have been criticized for their shortcomings. The E-V approach is consistent with Second Degree Stochastic Dominance (SSD) only under specific restrictions of decision-maker's preferences (risk aversion), and normality of the probability distribution, or a quadratic utility function. To overcome these shortcomings, Tauer (1983) proposed an alternative-programming model, the Target Motad, which generates a subset of feasible SSD solutions. In the model, returns are measured as the sum of the expected returns of activities, multiplied by their individual activity level. Risk is measured as the expected sum of the negative deviations of the solution results from a target return level. Risk is varied parametrically, so that a risk return frontier is traced out.

Investing in livestock is a common practice in the region. However, the substantive investment has to be clarified in the context of the study area. According to the authors experience, after a good harvest farmers usually buy a cow. It is not clear

whether this is an investment, a saving, or source of social prestige. Cows are not milked and is manure used in the traditional fields. Even though draft power is becoming more and more popular, there is no real integration between cattle and the cropping system to their mutual advantage. The cattle do not receive any supplements, and the ranchers have no direct action on the herd. Animals are collectively managed at the village level, but the objective of the owner is not to make a profit from his "investment". Sheep and goats are almost treated the same way in the traditional rural areas. However, in the cities it seems to be a different story. The presence of the private grazing area and a market orientation of the herd would likely generate an improved production system in terms of labor and input use.

The Demand Systems

One of the most commonly employed demand systems is Stone's Linear Expenditure system (LES). Like the Almost Ideal Demand System (AIDS), the Translog or the Rotterdam model, the LES, involves a system of equations rather than to a single equation. An advantage of a demand system over the single equation is that it allows for testing restrictions of demand theory, such as symmetry, or homogeneity conditions (Deaton and Mullbauer, 1980).

The first demand system consistent with the assumptions of neoclassical theory was developed by Stone (1954). Following Stone, many other authors such as Brown and Deaton (1972) and Pollak et al. (1969), have worked on the estimation of the LES. Also, Abott (1977) used LES to estimate commodity demand and labor supply functions, based on explicit direct and indirect utility functions. Lundberg (1988) presented a new approach to estimating family labor supply, using standard simultaneous equations.

Bianciforti and Green (1983) used the AIDS model to estimate a demand system of four food groups (meats, fruits and vegetables, cereals and bakery products, and miscellaneous foods), and compared the estimates with those from the LES.

CHAPTER III

THE SURVEY DESIGN, DATA COLLECTION, AND ADOPTION DECISIONS

The Study Area

The Cote d'Ivoire is located in the Gulf of Guinea in West Africa, between the Equator and the Tropic of Cancer. It is bordered by Ghana on the East, Liberia and Guinea on the west, Mali and Burkina-Faso on the North. It covers an area of 322,000 km^2. As a whole the relief belongs to the old African base. One can distinguish three major land types. These are the southern area with a relief of plains and the central and northern areas with terraced plateaus, and the western and northwestern areas with mixed relief.

There are four climatic regions characterized by total rainfall and intensity. The South has with four seasons, a long rainy season from April to July, a short dry season from July to September, a short rainy season from September to November, and a long dry season from season from November to March. The center has a dry season from July to September and in which maximum rainfalls occur from October to May. The North has a very long dry season and a fairly short rainy season (June to September). The central- west with its mountainous relief is distinguishable with by a very long rainy season and a short-lived dry season. The average rainfall ranges 900 mm in the North to 2,300 mm in the south. Table1 shows the actual and average rainfall in the Korhogo study area.

TABLE 1

HISTORIAL RAINFALL AT KORHOGO, COTE d'IVOIRE

	Average**	1988	1989	1990	1991	1992	1993	1994	1995
January	9	0	0	0	0	0	0	40	0
February	19	0	0	5	1	11	1	15	0
March	65	75	23	19	77	38	103	45	76
April	96	26	110	58	98	118	152	60	109
May	157	86	153	128	193	265	125	97	113
June	173	86	88	107	110	112	139	85	201
July	199	255	334	193	227	366	7	207	246
August	325	308	238	220	291	217	9	229	215
September	271	317	253	146	116	102	9	224	213
October	162	51	31	81	88	123	5	190	132
November	29	53	1	3	-	42	5	6	9
December	6	0	10	0	-	0	0	0	40
Total	1511	1257	1241	960	1201	1394	555	1202	1354

*Average for 30 years
Source: ANAM

In 1999, the estimated total population of the country was around 15 million, with an average density of 20.5 habitants per square Km Gidis (1994). The study area is located in the North, in the Savannah region in a relatively highly populated zone, called the "Zone Dense" of Korhogo, where the population density is around 80 habitants per square km, which is higher than the national average.

The Agricultural Sector. The main crops grown in the area are yam, rice, corn, cotton, sorghum-millet, peanuts and vegetables. In the cities only vegetables (carrots, lettuce, cucumbers, a local vegetable (comparable to beans, with high protein content), and irrigated rice are grown, due to land constraints. Crops are used for home consumption and are also sold in the market. Usually, yam is grown first, then corn is grown for one or two years, then follows cotton, sorghum-millet, and peanuts at the end of the rotation. The peanut plot usually belongs to the women. The product is sold and is also used as source of protein in meal preparation. Rice and vegetables are grown in specific areas near rivers or lakes. Major activities involved are: finding the plot, cleaning, ploughing, weeding, transplanting, irrigating and watering, fertilizing and pest-control, harvesting, processing, storing, and marketing. Most of these activities are shared by both men and women, except ploughing which men with the use of hired labor generally do. After 6 to 7 years, the plot is abandoned to fallow for several years, depending on land scarcity.

Land ownership. Land is usually held as common property. The "land chief" *(tarafolo)* allocates it to heads of extended families. The same amount of land is allocated to each unit. It is the responsibility of each family head to organize production activities and plot allocation within his group. Usually there are two types of plots in a family perimeter: a family plot (*foroba*) in which every family member is required to work, and some individual plots (*torolongo*) allocated by the head of the family to spouses, young men. Garden land allocations proceed in a similar way. However, due to the market orientation of the products, the property regime is becoming more and more individualistic. Still the plots cannot be sold, even though they can be rented. Men

usually make decisions on crop rotations and labor allocation, because they are the ones who are responsible for the family food security. Children between 7 and 15 years of age help in the field but they are not paid. Instead, they get food, shelter and education independently of the amount of labor they provide. If the city is nearby, there may be job opportunities. Women can also make handicrafts for the local market.

Gardening Activities. These activities take place near rivers and lakes. The major vegetable crops grown are lettuce, carrots, cucumbers and green leaves (*"dah")* with high protein content. Vegetables are grown both in wet and dry season, are generally done by women and are market oriented. They also contribute to balancing the family diet.

The Livestock System. Overall, the livestock sub-sector is weak, compared to the agricultural sector. The major constraints to animal husbandry are pathological and sociological.

Animal Diseases. The region is almost entirely infested by the tsetse fly and other disease vectors. Animal diseases like rinderpest, brucelloses, trypanosomiasis, are very common in the region despite eradication measures undertaken by the government and extension agencies. This disease constraint jeopardizes most the available grazing area in the region. As far as the "zone dense" is concerned, due to the high rate of land occupation by crops, only marginal lands remain for livestock. As a result, there is no correlation between the herd size and the carrying capacity of zone. Animals are not given supplementary feed. They are just kept away from the cropping area.

Sociological Constraints. Sociological constraints hamper livestock development. This is a region where the author has observed that production systems are overwhelmed by "physiocratic" traditions. From the local farmer's view, only crop agriculture

generates net surplus, while cattle husbandry is considered as a minor activity reserved to women, kids or the "Fulani" (an ethnical herding group from neighboring countries). On the other hand, raising small ruminants is accepted by the society, and the animals are very often integrated in the cropping system, or in housing unit.

These traditional conceptions make livestock activities paradoxical. The cattle herd has no specific orientation, the objective is not to provide milk or meat; animals are kept as a live savings account, and the owner does not interact with the herd. In most of the farms, cattle are individually owned but managed as a collective herd at the village level. The herds graze in common grazing area under the responsibility of a hired herdsman or sometimes children. During the dry season, animals are abandoned and must scavenge by themselves. Cattle are generally owned by men and are mostly used for social celebrations. The owners do not milk cows. Milk is part of the salary of the herdsman. Little time is allocated to animals. Technically, cattle and crop activities are dissociated. From this general picture however, urban farmers are emerging in or near the city, with market-oriented activities, especially with small ruminants.

Survey Design

Several handbooks treat data collection and sample surveys in developing countries (Casley and Lury 1981 and 1982, Casley and Kumar 1988). While providing very useful information on basic techniques, the technical level does not exceed that of an introductory statistic course (De Grote 1993). The same holds true for common handbooks on agricultural statistics in developing countries (Idaikkadar 1979, FAO 1982). There are on the other hand several advanced textbooks written from an explicit agricultural background (Cochran 1977, Yates 1981, Sukatme et al. 1970). These books

are, unfortunately written in a very technical language, largely inaccessible to non-statisticians. Consequently, other professionals such as economists and sociologists have trouble using statistics as a guide for determining the optimal survey design. Recently there has been some renewed interest in the methodology of sample surveys. Some authors write explicitly about different methods of measuring crop production, although they do not provide a quantifiable evaluation of those methods (Poate 1988, Poate and Casley 1985). Loker (1988) also describes problems encountered in measuring agricultural production but he does not offer any quantification either. As far as livestock are concerned, some isolated ad-hoc techniques have been used. For instance, Peden (1980) describes a systematic allocation sampling resources for a nation-wide aerial survey of livestock in Kenya. He calculated the trade off between precision and flying time.

Survey Objectives. The Objectives of the Survey were to:

1. Estimate the numbers of livestock and poultry in selected neighborhoods of Korhogo.
2. To determine factors which influence the decision to produce small ruminants in an urban setting and which influence the number of animals produced.

Survey 1: Inventory Survey to Estimate Numbers of Livestock and Poultry in Korhogo. The survey took place by following strip transects through the streets and alleys of selected neighborhoods of Korhogo. The survey design is outlined in Table 2. The 1999 city map shown in Figure 1 shows the city divided into 25 neighborhoods. Eleven of the neighborhoods in the center of the city were selected for a "street" survey.

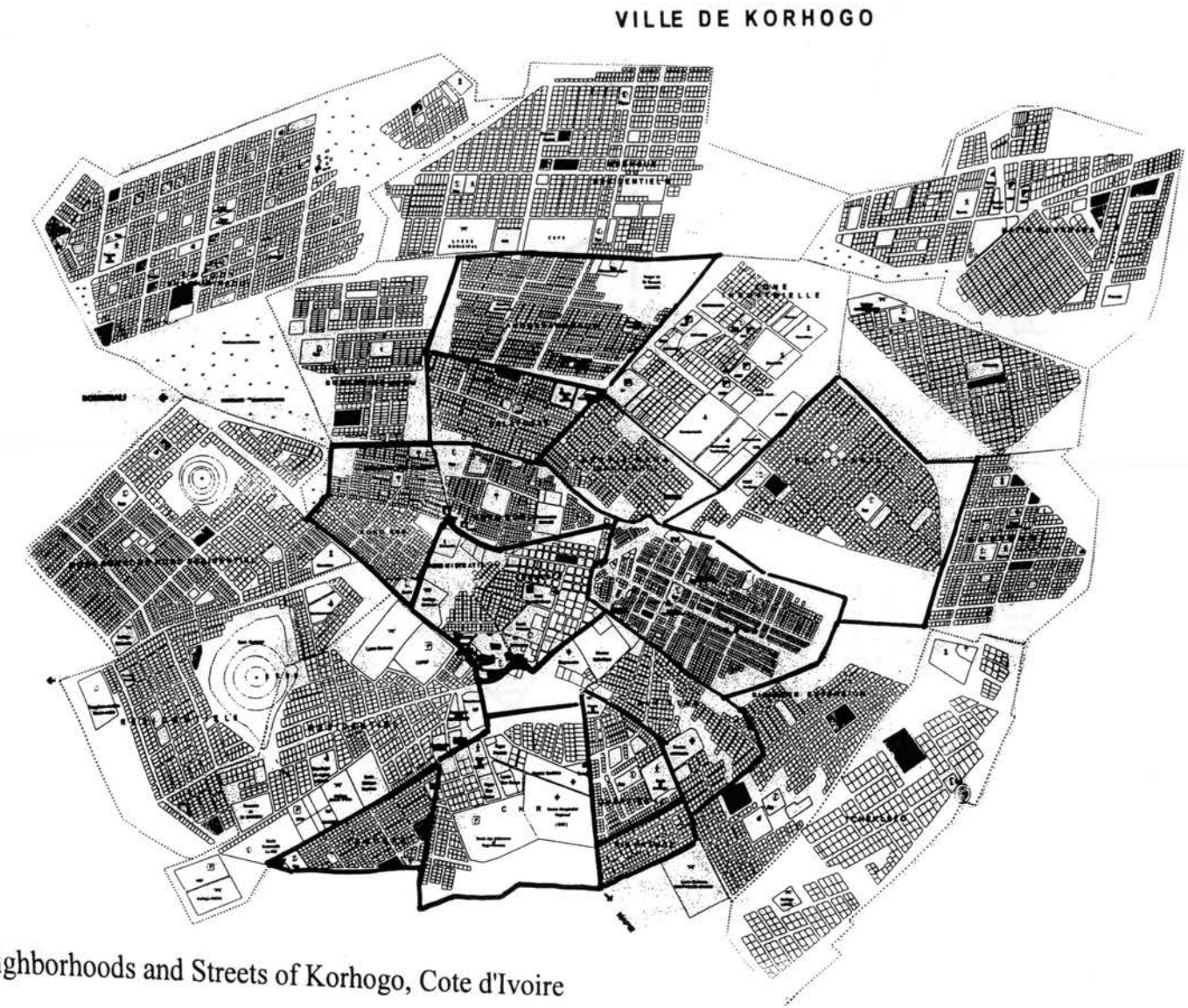


Figure 1: Neighborhoods and Streets of Korhogo, Cote d'Ivoire

These are outlined on the map in Figure 1 and listed in Table 2. The Administrative and the Commercial neighborhoods were combined and treated as one neighborhood.

TABLE 2

RESIDENTIAL AREA OF KORHOGO COVERED

BY THE INVENTORY SURVEY.

Neighborhood	Residential Area	Number of Transects	Area in Transects	Percent of area
	ha.	n	ha.	Surveyed
Air France	27.3	5	9.4	34.3%
Koko	149.2	9	48.4	32.4%
Delafosse	75.1	7	27.6	36.7%
Teguere	45.9	3	19.2	41.8%
Petit Paris	128.9	7	59.1	45.9%
Banaforo	62.9	6	32.6	51.8%
Soba	127.0	6	36.6	28.8%
Sinistre	77.6	4	17.4	22.4%
Ahoussadoughou	130.7	6	47.7	36.5%
Administrative and Commercial	36.7	3	25.6	69.9%
CHR	147.3	4	46.7	31.7%
Total	1008.6	60	370.3	36.7%

The major objective was to estimate the number of livestock in the city center so it was decided to cover approximately one-third of each neighborhood. The method was to select streets at random and count the livestock observed within a prescribed transects width. Urban livestock are associated with residential family compounds. Thus the area of the transect occupied by single family compounds was also recorded.

The livestock population for each neighborhood was then estimated by using a ratio estimate from a series of strip transects in each neighborhood. The ratio is the density or the number of livestock observed per unit of area surveyed. The relevant formulas and notation are based on Cochran (1977, pp 164-168). In the formulas;

N is the total number of neighborhoods or strata,

M_i is the number of possible strip transects in neighborhood i,

m_i is the number of strip transects taken in neighborhood i,

X_i is the total area of the neighborhood i occupied by single-family housing and compounds,

x_{ij} is the area covered in neighborhood i by strip transect j, and

y_{ij} is the observed number of livestock observed in neighborhood i on transect j.

The ratio estimator for neighborhood or strata i, is given as

$$\hat{R}_i = \Sigma_j y_{ij} / \Sigma_j x_{ij}$$

The respective neighbor population and overall population totals is estimated as

$$Y_i = X_i R_i, \text{ and } \hat{Y} = \Sigma_j X_j \hat{R}_i$$

The actual area covered by transect x_{ij} is variable because the neighborhoods are irregularly shaped and because streets do run parallel to each other. If j transects (If j = 1 to m_i), are taken in neighborhood i, the total area covered is $\Sigma_j x_{ij}$. The area covered by the average transect is $x_{ij} = \Sigma_j x_{ij}/m_i$. Then M_i, the number of possible of non-overlapping transects becomes, $M_i = X_i/x_{ij}$. Mi is not likely to be an integer and it depends on the random selection of transects.

The approximate variance of the estimated population total in strata i or neighborhood i, is

$$Var(Y_i) = M_i^2(1-m_i/M_i)/[m_i(m_i-1)] \; \Sigma j \; (y_{ij} - R_i x_{id})^2 .$$

Since all strata of interest are sampled, the variance of the population total is the sum of the variances for the individual neighborhoods or strata,

$$\mathrm{Var}(Y) = \Sigma i \, \mathrm{Var}(Y_i).$$

The objective was to survey approximately 1/3 of the area in each neighborhood. The approach was to randomly select the first street to be surveyed. If the random start is on street number 2 (see diagram to the left above), then surveyors walked streets 2, 5, and 8 and counted the numbers of livestock (cattle, sheep, goats, and chickens). The surveyors observed livestock that likely belong to owners in house rows 2, 3, 8, 9, 14 and 15. Note that when the surveyor comes to an intersection, only those livestock, which are

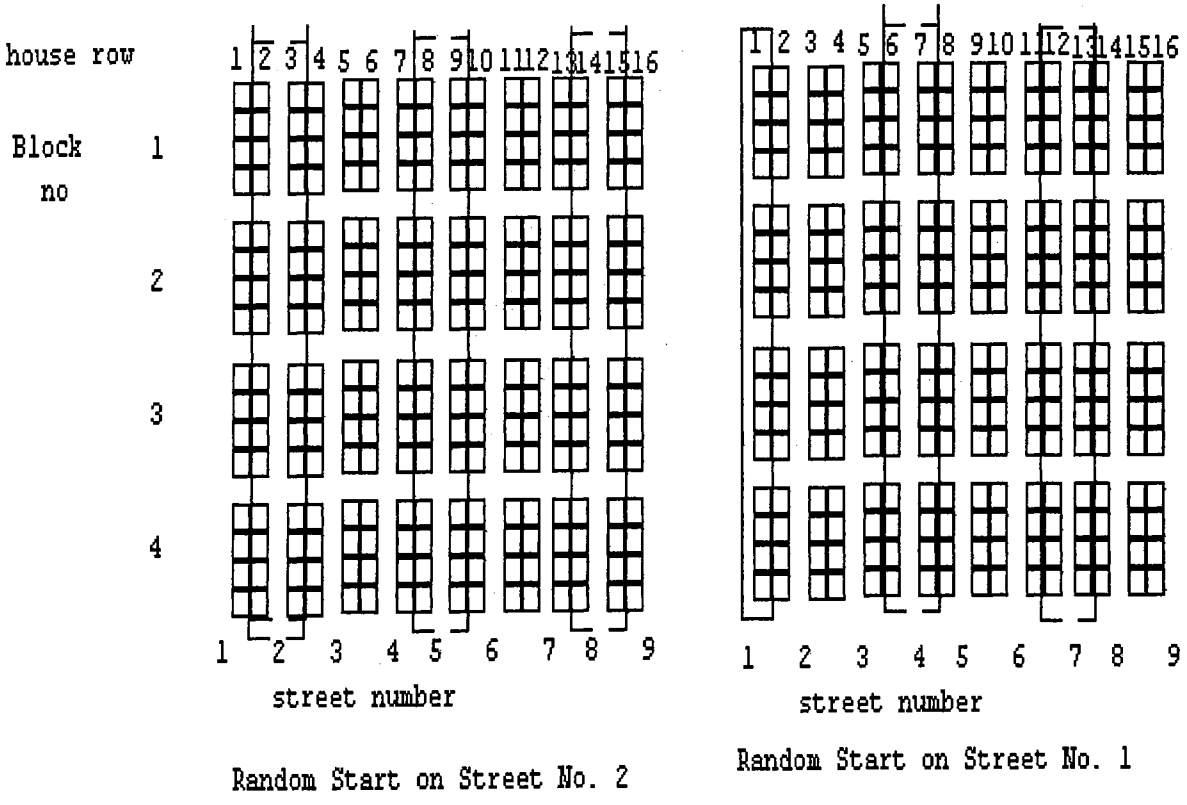


Figure 2. Transect for Estimating Number of Livestock

located halfway to the next parallel street on either side, were counted. If there are 16 rows of houses in the neighborhood, the surveyors would cover 6/16 or 37.5% of the area.

Survey 2. Survey of Individual Households Concerning the Adoption of Small Ruminants. The purpose of the second survey was to determine the relationship between major sociological variables such as gender, age of household, primary occupation, family size and the number of small ruminants (if any) owned by the household. This survey was conducted by randomly selecting households from the 10 streets found to have the greatest number of livestock in the first survey. An in-depth survey was administered to head of each cooperating household. Some 90 useable surveys were obtained. This survey was summarized and presented as a simple random survey of urban households from streets in Korhogo having large numbers of small ruminants. The study is analyzed with respect to means and relationships between observed variables. No attempt is made to extent the results to any larger population.

The Decision to Adopt

The adoption of technology is an economic decision based on expected marginal benefits and costs. Most empirical specifications deal with a variety of models of farmer or household optimization: maximizing profits, expected utility of profits, or expected utility of consumption and leisure subject to production function and time Mekuria (1996).

The economic analysis of the behavior of individual decision-makers often leads to models that are of a limited dependent or qualitative variable nature. In the recent years, econometrics has embraced the use of limited dependent and qualitative variable models in applied work.

Very often farmers (and other economic agents) are faced with a choice between two alternatives. They have to make a decision vis-à-vis a given situation: whether or not adopt a technology (improved seeds, tillage type, food security strategy etc...). The decision they make is of binary type: 1 (if the answer is yes or if the technology is present) and 0 (if the answer is no or the technology is absent). The decision will depend on each farmer's own characteristics, beliefs and objectives. The dichotomous nature of the response in that framework will require specific econometric approach, namely the use of qualitative response models. These models are found in surveys by Amemiya (1981), McFaden (1984) and Dhrymes (1984). To simplify the discussion around these models, some authors assume that the probability of an individual making a given choice is a linear function of individual attributes. Four types of models have been commonly used in the literature: the linear probabilistic model, the probit, the Logit and the Tobit models.

The regression form of the linear probability model is

$$Y_i = \alpha + \beta X + \varepsilon_i$$

Where X_I = value of individual characteristics, like age, income level and ε_i a random error, with mean zero.

The dependent variable is binary. Y is commonly entered as

$$Y = \begin{cases} 1 \text{ ifyes} \\ 0 \text{ ifno} \end{cases}$$

The Prob (Y=1) = F(x,B) and the Prob (Y=0) = 1- F(x,B). The variance, V(Σ/X) $= \beta^t X (1-\beta^t X)$

This is heteroscedastic, which violates one of the assumptions of the classical linear regression model. One-way to overcome heteroscedasticity is to use weighted least squares. However, the weighted least square method does not guarantee that the estimated probabilities will lie between the interval (0,1).

The Probit Model. Given the shortcomings of the linear probability model, the usual approach to overcome the difficulties is to transform the original model, in such a way that, the predictions will lie in the (0,1) interval for all X. The requirement of such a process is that it translates the values of the characteristics X, which range in value over the entire real line, to a probability that ranges in value from 0 to 1. (Pindiyck and Robinfeld 1995). The probit model is associated with the normal distribution. The resulting probability distribution is represented as:

$$P_i = F(\alpha + \beta X) = F(Z)$$

Where Z is an index determined by an explanatory variable X and

$$Z = \alpha + \beta X_i$$

Probit analysis solves the problem of how to estimate the parameters α and β while at the same time obtaining information about the underlying index Z. Let Y represent a dummy variable that equals 1 if a given household adopts small ruminants as a food security strategy, and 0 otherwise. Individuals may adopt livestock according to their own characteristics for instance if their farming experience or income bracket is higher than a certain level $(Z_i > Z_i^*)$ and they will not adopt the it ($Zi < Z_i^*$).

The probit model assumes that the Zi* is a normally distributed random variable, so that the probability of Zi* can be computed from the cumulative normal probability

function. The normal distribution has been used in many types of analysis, giving the probit model.

$$\Pr ob(y=1) = \int_{\infty}^{\beta' x} \phi(t)dt = \phi(\beta' x)$$

Where $\phi(t)$ is a standard normal distribution. However, the assumption of the error term is normally distributed results in exceedingly complex calculations for the probability of selecting one alternative from three or more possibilities (Anas, 1982; Amemiya, 1985; Greene, 1993).

The Logit Model. Logistic regression like ordinary regression extends to models incorporating multiple explanatory variables. Moreover, some of those explanatory variables can be qualitative rather than quantitative. The logistic model is based on the cumulative logistic probability function and is specified as:

$$P_i = P(Z_i) = F(\alpha + \beta X_i) = \frac{1}{1+e^{-Z_i}} = \frac{1}{1+e^{-(\alpha+\beta X_i)}}$$

By some appropriate transformation this model can be specified as:

$$\log \frac{P_i}{1-P} = Z_i = \alpha + \beta X_i$$

where the dependent variable is the logarithm of the odds that a particular choice will be made or a technology adopted.

The Tobit Model. Tobit analysis is seeing increasing use in econometrics. One of the reasons is because the coefficients obtained from using Tobit provide more information than is commonly realized. In particular, McDonald and Moffitt (1999) show that the Tobit can be used to determine both changes in the probability of being

above the limit and the changes in the values of the dependent variable when it is already above the limit. The general formulation of the model is given in terms of an index function, Greene (1999).

(latent regression) $y^* = \mathrm{x}'\beta + \sigma\varepsilon, \mathrm{E}[\varepsilon] = 0,$

(observation) $y = \max(0, y^*),$

(disturbance distribution) $\mathrm{Prob}[\varepsilon \le a] = F(a), -\infty < \varepsilon < +\infty,$ independent of $\mathrm{x}_i,$

(density) $f(\varepsilon) = \mathrm{F}'(\varepsilon) = \mathrm{dF}(\varepsilon)/\mathrm{d}\varepsilon.$

Where ε is a scale parameter in the distribution used to normalize the underlying variable such that the density of the structural disturbance is free of the model variables. Y_i is the dependent variable; $\boldsymbol{X_i}$ is a vector of independent variables, β is a vector of unknown coefficients and ε is an independently distributed error term assumed to be normal with mean zero and variance σ^2. Because of its ability to estimate both the probability to adopt and the intensity of adoption, the Tobit model will be used in this study.

CHAPTER IV

SURVEY RESULTS

Survey One: Number of Livestock in Korhogo

Analysis of the Survey Area. The area used in the denominator of the ratio estimate, (animals per area), was the area occupied by family compounds and the adjacent streets. This definition was used because animals commonly return to the family compound at night and because this area could readily be calculated from the enlarged version of the recent city maps shown above in Figure 1. In each neighborhood, the total residential area was measured. The area occupied by open spaces, public buildings, parks, and commercial buildings was not included. The residential area was measured in hectares. These areas were shown above in Table 2.

The total residential area was measured to be slightly more than 1,000 hectares. The sixty transects made by the survey team covered 370 hectares or nearly 37 percent of the area. The survey team averaged 5 individuals. The inventory survey required one week to complete. The numbers of adult female, adult male, and young sheep and goats that were observed either in the streets on in the residential compounds were recorded. The total number of cattle and chickens were also counted. The inventory survey was summarized using separate ratio estimators for each class of livestock in each neighborhood. The various total and variances were summed over the neighborhoods.

Estimated Livestock Density and Total Livestock Inventory. The estimated density or number of sheep, goats, cattle, and chickens per residential hectare for each neighborhood are shown below in Table 3. The individual street counts are listed in Appendix 2. The total number of small ruminants per unit area varied from a low of 9.8 hd ha^{-1} in Petite Paris to a maximum of 40.5 hd ha^{-1} in Delafosse. The area weighted average density for small ruminants for all surveyed neighborhoods was 25.8 hd ha^{-1}. As expected, cattle numbers were low, .5 hd ha^{-1}. The density of poultry, 12.3 hd ha^{-1}, was lower than for small ruminants.

The projected total numbers of livestock and poultry for the surveyed neighborhoods are presented in Table 4. The results in Table 4 indicate there are more than 14,500 goats, 11,800 sheep, 500 cattle, and 12,500 poultry in the surveyed neighborhoods. This is in a residential area of 1000 hectares. The livestock densities per total area are much lower as more than 50 percent of some neighborhoods is not in residential areas. Thus there are a significant number of animals that can contribute to the food security of the urban population both as a potential source of protein and as a store of wealth.

The standard errors of the estimated total are low which reflects that on the average more than 36 percent of the area was covered by the survey. (The standard errors in Table 3 would be zero if a complete census had been conducted). This indicates that acceptable estimates of urban livestock could have been obtained with fewer transects in the selected neighborhoods and that more neighborhoods could have been reliably surveyed with the same resources.

TABLE 3

ESTIMATED DENSITY OF GOATS, SHEEP, CATTLE, AND POULTRY IN THE SURVEYED NEIGHBORHOODS OF KORHOGO.

Neighborhood	Population	Sheep				Goats				Total Small Rum.	Cattle all	Poultry all
		Female	Male	Kids	Total	Female	Male	Lambs	Total			
Air France	no./ha	29.1	6.0	9.0	44.0	25.7	6.1	7.3	39.1	83.1	0.7	33.3
Koko	no./ha	11.9	2.2	2.4	16.5	9.6	2.4	2.6	14.7	31.2	0.3	14.0
Delafosse	no./ha	16.5	1.2	3.0	20.7	15.4	1.9	2.5	19.8	40.5	0.2	19.3
Teguere	no./ha	6.9	1.3	1.9	10.1	6.8	1.4	1.5	9.6	19.7	0.0	9.7
Petit Paris	no./ha	4.3	0.6	1.4	6.3	1.3	0.5	0.7	3.5	9.8	0.4	5.5
Banaforo	no./ha	14.7	2.4	3.7	20.7	12.9	2.5	3.3	18.6	39.3	1.2	15.9
Soba	no./ha	7.2	1.0	1.7	9.9	5.3	0.9	1.7	8.0	17.8	0.0	8.0
Sinistre	no./ha	13.9	1.9	3.3	19.2	11.3	1.8	3.2	16.2	35.4	0.6	14.3
Ahoussadoughou	no./ha	15.4	1.7	3.1	20.2	9.6	1.4	2.3	13.3	33.6	1.6	20.8
Administrative and Commercial	no./ha	7.9	1.2	1.8	10.9	5.8	1.2	1.4	8.4	19.3	0.4	8.2
CHR	no./ha	4.7	0.9	1.2	6.8	3.3	0.8	1.0	5.2	12.0	0.1	5.2
Area Weighted Average	no./ha	10.4	1.5	2.4	14.3	7.9	1.5	2.0	11.6	25.8	0.5	12.3

TABLE 4

ESTIMIATED TOTAL NUMBER OF GOATS, SHEEP, CATTLE AND POULTRY

IN THE SURVEYED NEIGHBORHOODS OF KORHOGO.

Neighborhood	Population	Sheep				Goats				Cattle	Poultry
	Value	Female	Male	Kids	Total	Female	Male	Lambs	Total	all	all
Air France	Est. Total	792	163	245	1200	702	166	198	1066	20	909
	Std.Er.	0.52	0.24	0.29	0.64	0.49	0.24	0.26	0.61	0.08	0.56
Koko	Est. Total	1780	321	361	2462	1437	361	389	2187	49	2085
	Std.Er.	0.33	0.08	0.30	0.46	0.59	0.27	0.23	0.76	0.21	0.70
Delafosse	Est. Total	1240	93	223	1556	1158	142	188	1488	14	1447
	Std.Er.	0.85	0.16	0.53	1.25	0.64	0.26	0.56	1.03	0.10	0.93
Teguere	Est. Total	316	60	86	462	313	62	67	442	0	445
	Std.Er.	0.66	0.04	0.25	0.74	0.60	0.08	0.59	0.97	0.00	0.25
Petit Paris	Est. Total	560	81	177	817	166	59	87	451	52	713
	Std.Er.	0.74	0.11	0.15	0.83	0.34	0.11	0.19	0.39	0.16	0.69
Banaforo	Est. Total	925	149	230	1303	809	156	205	1170	77	1000
	Std.Er.	1.05	0.29	0.55	1.33	1.33	0.40	0.37	1.32	0.39	1.09
Soba	Est. Total	912	121	219	1252	673	118	219	1010	0	1010
	Std.Er.	0.27	0.08	0.17	0.41	0.15	0.13	0.11	0.24	0.00	1.33
Sinistre	Est. Total	1082	148	259	1488	876	139	246	1260	45	1113
	Std.Er.	0.81	0.68	0.64	1.15	0.80	0.29	0.36	0.99	0.51	0.91
Ahoussadoughou	Est. Total	2015	222	405	2641	1259	181	304	1744	211	2721
	Std.Er.	1.81	0.27	0.33	2.09	0.86	0.24	0.30	1.03	0.37	2.09
Admin. + Comm.	Est. Total	289	46	66	400	212	44	51	307	13	302
	Std.Er.	1.45	0.22	0.20	1.85	1.09	0.15	0.15	1.36	0.19	0.89
CHR	Est. Total	687	136	180	1003	489	117	155	760	19	766
	Std.Er.	0.51	0.16	0.16	0.70	0.36	0.16	0.19	0.66	0.10	0.53
All Neighborhoods	Est. Total	10597	1538	2450	14585	8094	1544	2108	11885	500	12510
	Std.Er.	3.09	0.90	1.21	3.87	2.44	0.76	1.12	3.03	0.83	3.38

The relationship between the number of mature female sheep and goats and the number of adult males and young animals are shown below in Table 5. These values are directly calculated from the means shown above in Table 3.

TABLE 5

NUMBER OF OBSERVED ADULT MALES AND YOUNG ANIMALS PER ADULT FEMALE SHEEP AND GOAT IN KORHOGO.

Neighborhood	Goats		Sheep	
	Adult Males per Female	Kids per Female	Adult Males per Female	Lambs Per Female
Air France	0.2	0.3	0.2	0.3
Koko	0.2	0.2	0.3	0.3
Delafosse	0.1	0.2	0.1	0.2
Teguere	0.2	0.3	0.2	0.2
Petit Paris	0.1	0.3	0.4	0.5
Banaforo	0.2	0.2	0.2	0.3
Soba	0.1	0.2	0.2	0.3
Sinistre	0.1	0.2	0.2	0.3
Ahoussadoughou	0.1	0.2	0.1	0.2
Admin. + Comm.	0.2	0.2	0.2	0.2
CHR	0.2	0.3	0.2	0.3
Wt. Ave	0.1	0.2	0.2	0.3

The values in Table 5 are reasonably consistent from one neighborhood to the next. The number of male animals on the street might be lower than expected if people tend to hold animals until ages 2 or 3 for sale. If such males were held in a compound for

feeding, such animals might not be observed in the survey. The number of young animals seems low but might be explained by sale or consumption or from the use of free-range production methods with few feed inputs.

The survey bias is expected to tend toward under-estimation. The degree of undercounting because of unseen livestock in compounds along the streets is unknown. The likelihood of double counting within a given neighborhood is thought to be low as the survey members walked roughly parallel transects. However it is possible that livestock counted in one neighborhood one could be counted again in an adjacent neighborhood the next day. Problems occurred where transects encountered open spaces. It could be hypothesized that larger amounts of open areas in a neighborhood would increase the likelihood of small ruminant adoption. In future surveys, the amount of open in a neighborhood should be recorded as second ratio variable.

Survey Two: Characteristics of Households with Small Ruminants In Urban Areas

Selection of Households. The objective of this survey was to identify the factors that significantly affect or influence the urban household's decision to adopt small ruminants and then to determine the level of production. The need was to survey households which did and households which did not produce small ruminants. The households were selected from the streets that had been identified as having the largest number of small ruminants in the inventory survey. Households on these streets were selected at random. Cooperating households were administered in depth survey about age, gender, family size, ethnic origin, income, and primary occupation. If the family did produce small ruminants, further questions were asked concerning whether they were owned by women,

the number of animals, purchased inputs, the amount of labor by men and by women. This survey is first summarized by traditional methods. These results are presented in graphs and tables. In the final analysis, Tobit econometric methods are used simultaneously to identify factors which influence the decision to adopt and the amount of production if adoption does occur.

Socio-Economic Characteristics

In most African countries, the social system is of the gerontocratic type, and men generally head households. In the sample, 83 percent of the household heads were men, despite the fact that the matrilineal system prevails in the study area. Some selected household characteristics are presented in Table 6. The average age found for the head of households is 48 years, which is pretty close to the average of 50 given by the Cote d'Ivoire Standard Living Survey Ahuja (1996). Family size is eight, with two adult males and two adult females.

Occupation of Household Head. The household heads' primary occupations were extremely diverse. Urban farmers represent about 31% of the respondents. They grow vegetables and sometimes they have fields outside the city, where they grow crops, for home consumption and marketing. They often raise small stock for home consumption and as source of cash income. As shown in Figure 2, the category "other occupation" represents almost 59% of the total. This is simply a characteristic of the cosmopolitan urban job opportunities. The merchants and civil servants represent the remaining categories. Households in all of these categories however might own small ruminants for different purposes.

TABLE 6

SUMMARY STATISTICS BY GENDER OF HOUSEHOLDS HEAD

FROM THE HOUSEHOLD SURVEY.

		Gender of Household Head						All Households			T value for Male – Female
		Male			Female						
	Unit	Number	Mean	Std. Error. of Mean	Number	Mean	Std. Error. of Mean	Number	Mean	Std. Error. of Mean	
Size of Household	Persons	74	8.1	6.4	16	6.7	5.3	90	7.856	6.3	0.94
Age of Head	Years	74	48.1	13.88	16	46.1	9.7	90	47.77	13.3	0.71
All Households	Income	73	441.3	424.3	15	284.5	404	88	414.5	427.4	1.36
Farmer	Income	26	304.3	417.2	7	96.1	60	33	260.2	381.0	2.45*
Civil Servant	Income	3	748.3	482.9	0			3	748.3	482.9	
Merchant	Income	5	371.8	237	3	208.0	78	8	325	217.5	1.42
Other	Income	40	517.9	411.8	6	529.7	546	46	519.4	432.1	-0.05
Own Livestock	Number	24	0.3	0.468	4	0.3	0.4	28	7.856	6.3	0.31
Herd Size	Number	24	69.8	158.9	4	28.3	38	28	63.89	148.1	1.11
Experience	Years	73	8.3	11.32	16	8.8	11	89	8.416	11.3	-0.13

* Difference significant at 10 percent level

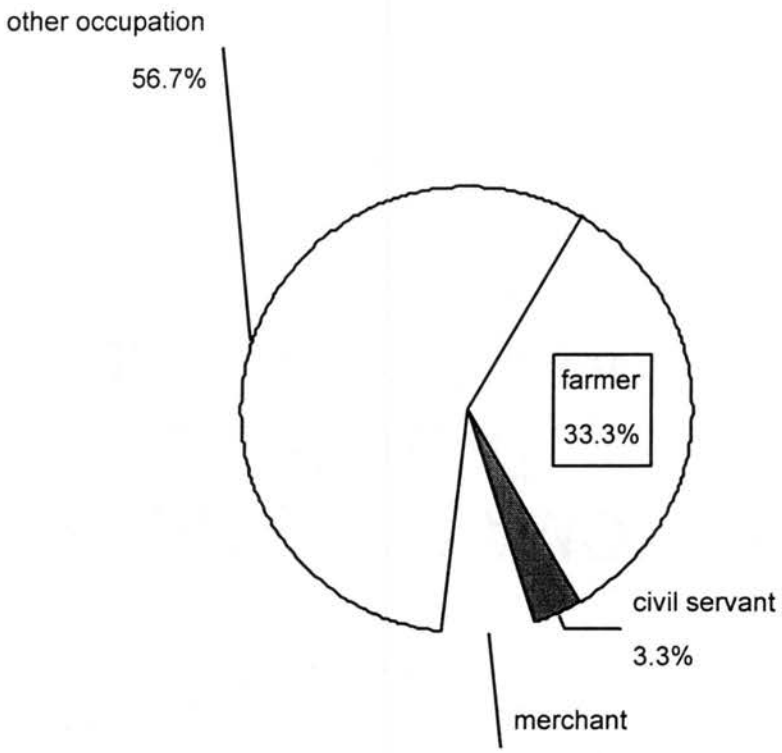


Figure 3. Head of Household Primary Occupation

Gender and Age. Fifteen of the 90 households surveyed were headed by women. As shown in Figure 4 there is a wide range in the ages of female household heads but most female household heads fell in the 40 to 50 age range. Usually in the traditional rural society, only widow females are heads of household, and they are generally old. These data indicate a wide range in urban female households heads and indicate that a not insignificant number were headed by women under the age of 50. However, the small number of household headed by women make any final conclusions difficult.

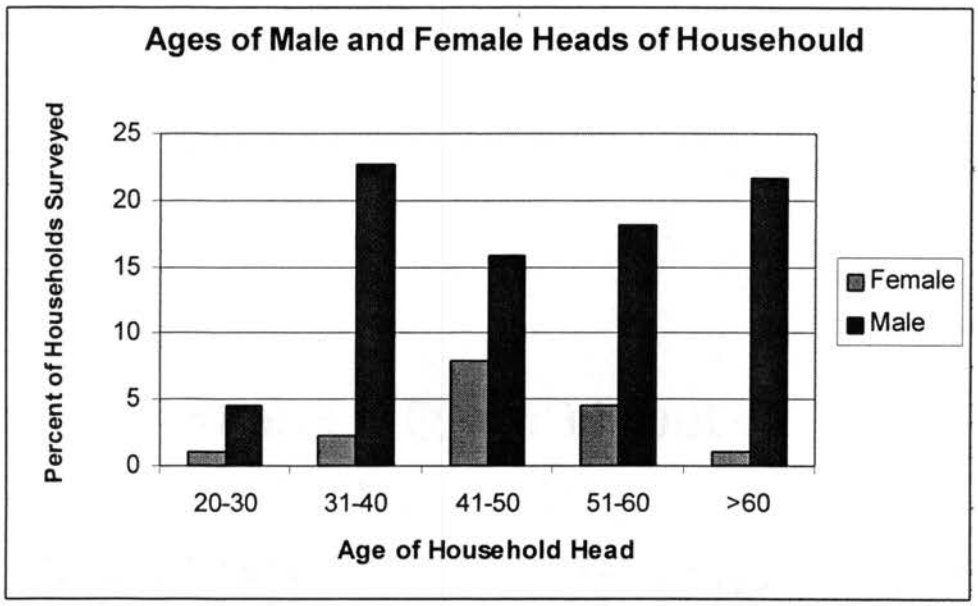


Figure 4. Gender and Age of Household Head

Gender and Family Size. Men, in a context of polygamy generally head larger families. They head eighty percent of families with more than 20 people. The patrilenear system prevails more often in the cities, so extended families live together under the responsibility of the husband who controls both the resources and the labor supply. As shown in Figure 5, females head mostly small size households except for one outlier heading a family with more than 20 persons.

Gender and Income Level and Primary Occupation. Figure 6a shows that women share approximately the same proportion of income at each level, except the level of 201 to 400. The author's observation is that in urban households, income is usually not pooled, especially among civil servants. The wife controls her own income, and spends its mostly on food and for childcare, and sometimes on her own needs. Men are generally in charge of non-food expenses, equipment, and housing.

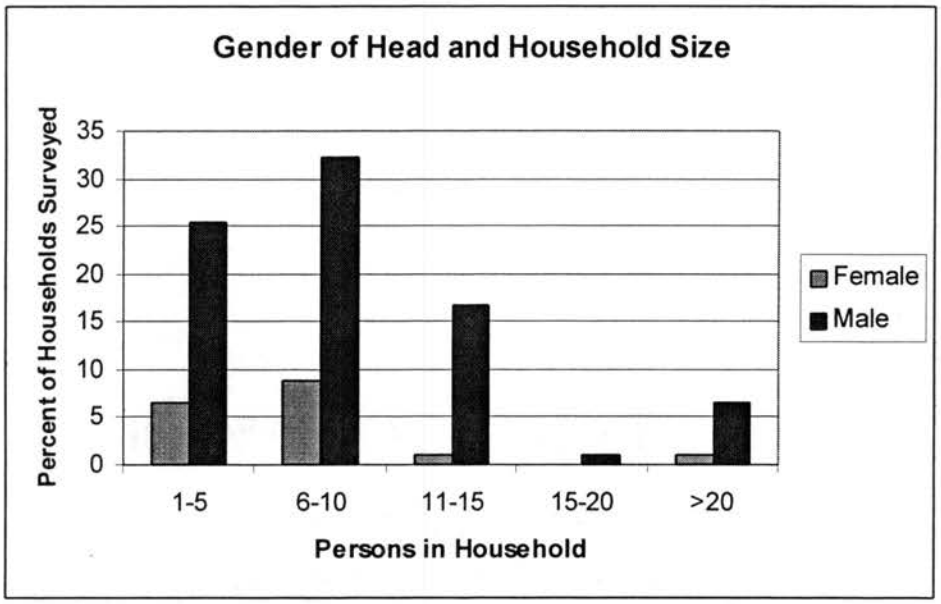
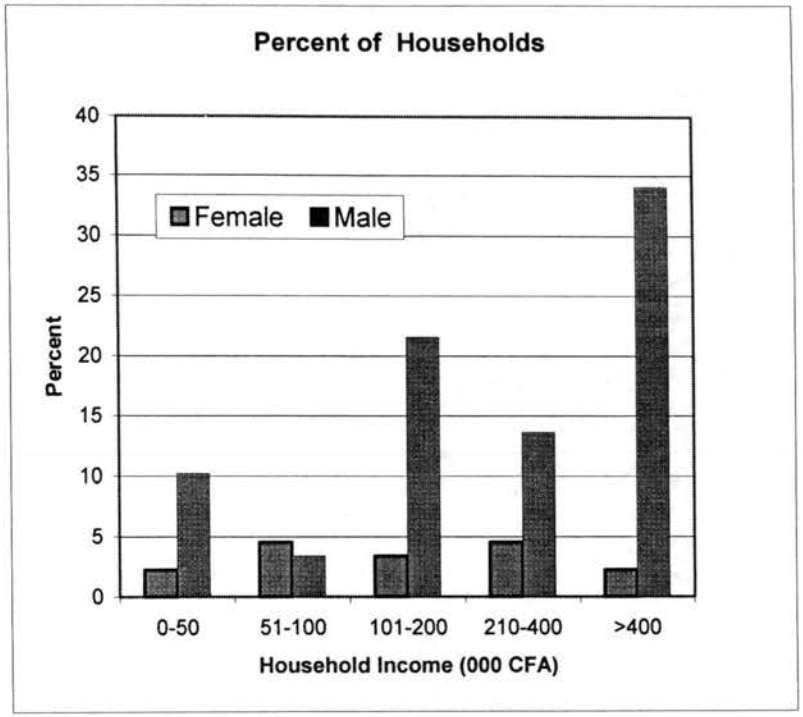


Figure 5. Gender and Family Size

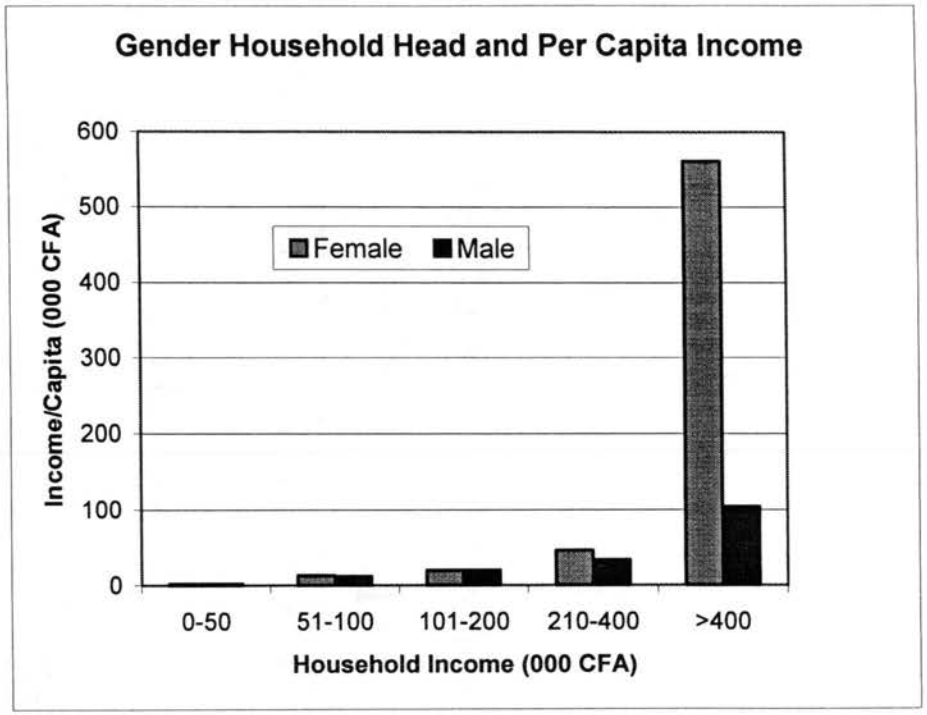
The average household income is higher in households headed by men as shown above in Figure 6. However, the average size of household headed by men is larger. Figure 6b shows there is very little difference in per capita income in households headed by men or women.

Gender and Primary Occupation. Primary occupation is often considered as an important factor in technology adoption. In the context of African economies, primary occupation is also gender and ethnical background differentiated.

Figure 7 shows that both men and women in the sample are mostly involved in agriculture or wage related activities. Men are more involved in government activities, due to higher education. The mean income levels by occupation were shown previously



6a



6b

Figure 6. Gender and Income Level

in Table 2 indicates that households headed by men earn more in each occupation and significantly more in agricultural households than households headed by women.

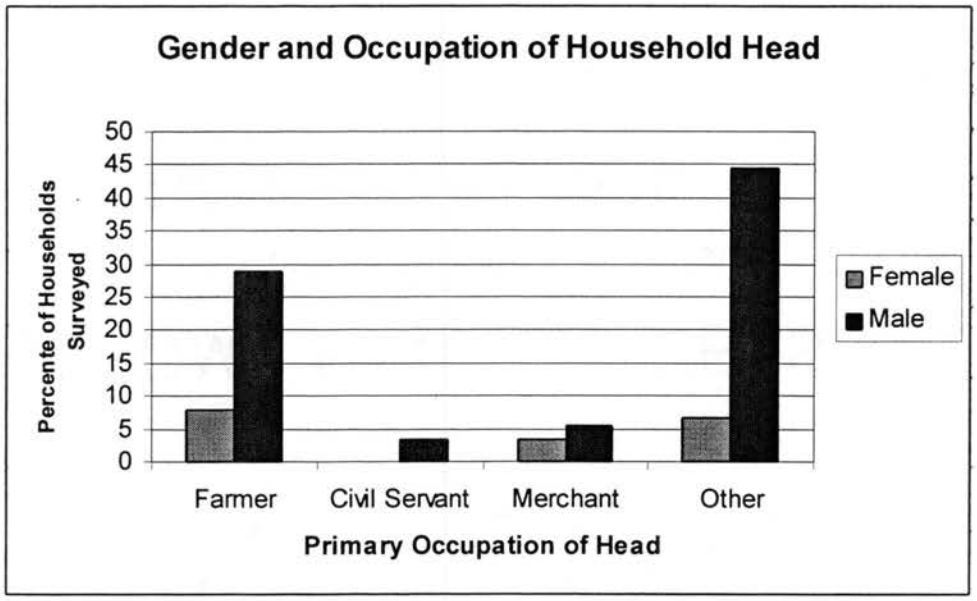


Figure 7. Gender and Primary Occupation

Gender and Farming Experience. Nearly 50 percent of all household heads surveyed reported no experience in agriculture (Figure 8). Figure 8 shows that a higher proportion of the female household heads in the sample had more experience in farming than did male heads. The number of years of experience exhibits a bimodal distribution. Only five percent of households have 1 – 5 years of experience. In many technology adoption programs, in agriculture, the number of years of experience of farmers has been shown to be crucial.

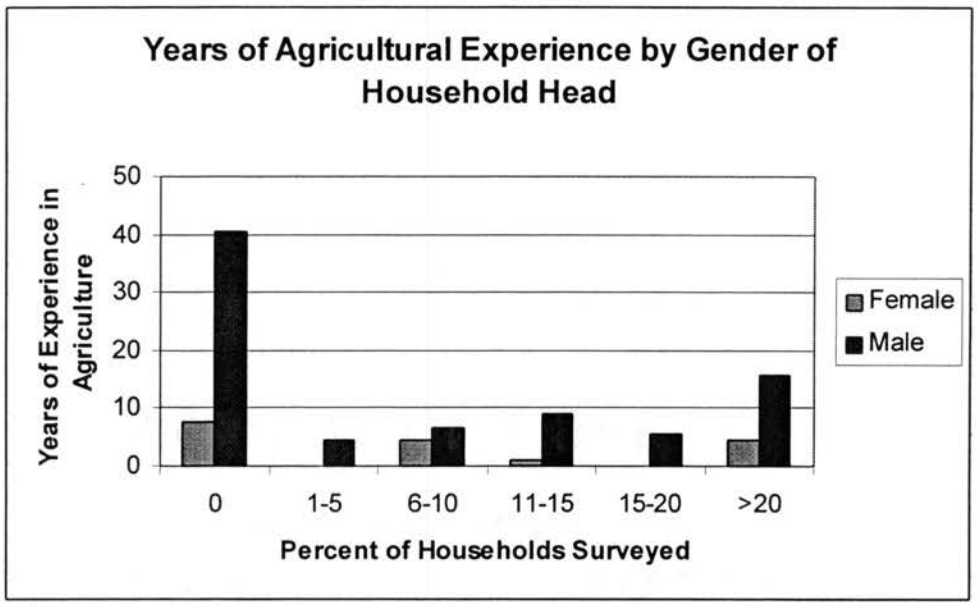


Figure 8. Gender and Farming Experience

Gender and Education. The region has one of the lowest rates of literacy of the country. There is a gap between the North and the rest of the country, but also between male and female. As shown in Figure 9 the proportion of illiteracy is higher among female household heads. This is a general tendency for the entire country, where females enter the production and the reproduction processes at young ages.

Education is an important issue in technology adoption. The more people are educated the more rapidly they can understand the benefits of adopting improved technologies. However, in the context of the study, educated people are more likely to be employed, as civil servants or in the private sector, with stable source of income. So they are less exposed to food insecurity. As a result, they will tend to adopt less small ruminants as a food security strategy.

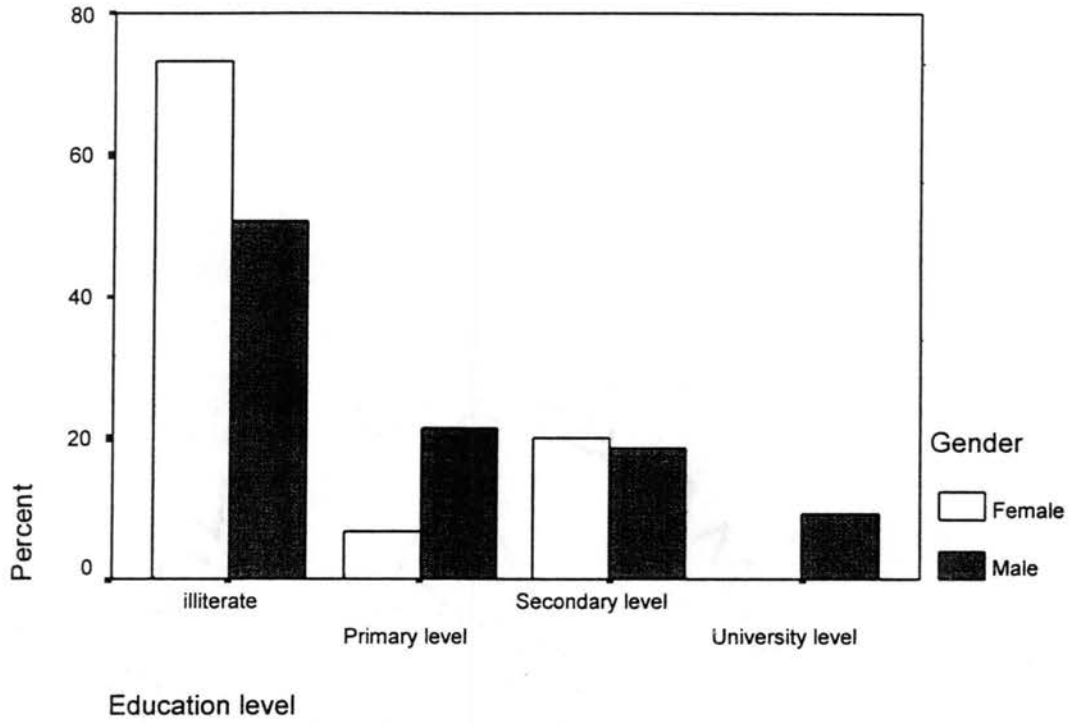


Figure 9. Education Level by Gender

Nationality of Household Head. The Korhogo region borders the countries of Mali and Burkina-Faso, with the same ethic groups sharing the same languages and the same values. As a result, many immigrants from these countries and other African countries live in the zone.

In the survey we found that approximately 20% of the respondents were foreigners. This is an important issue for policy makers who are interested in knowing who are exactly the small livestock owners, in order to implement adequate and targeted development policies.

TABLE 7

SMALL RUMINANTS DISTRIBUTION BY HOUSEHOLD

Distribution	Frequency	Percent
Households without small animals	66	73.3
Households with small animals	24	26.7
Total	90	100.0

Distribution of Small Ruminants

Number of Small Ruminants Owned by Gender and Age of the Household Head. One of the underlying objectives of the study was to characterize the owners of small ruminants, especially by their ethnic origin and gender in order to help policy makers target focus groups. The percentage of the 37 households surveyed who owned either sheep or goats are shown in Figure 10. Thirty-three of these households with small ruminants had male heads. Table 6 above indicated the average herd size in herd size in households headed by men was much larger than the herd size in households headed by women. However, those differences were not significant due to the small sample size. Figure 10 shows no real difference in herd size by age of female household heads. Herd size varies considerably among ages of male-headed households. Male heads under 40 and over 60 had more smaller herds while male heads in the 30-40 age group had larger herds.

Level of Small Ruminants by Nationality of Household Head. It is often argued that livestock activities are economically and technically controlled by foreigners. Table 8

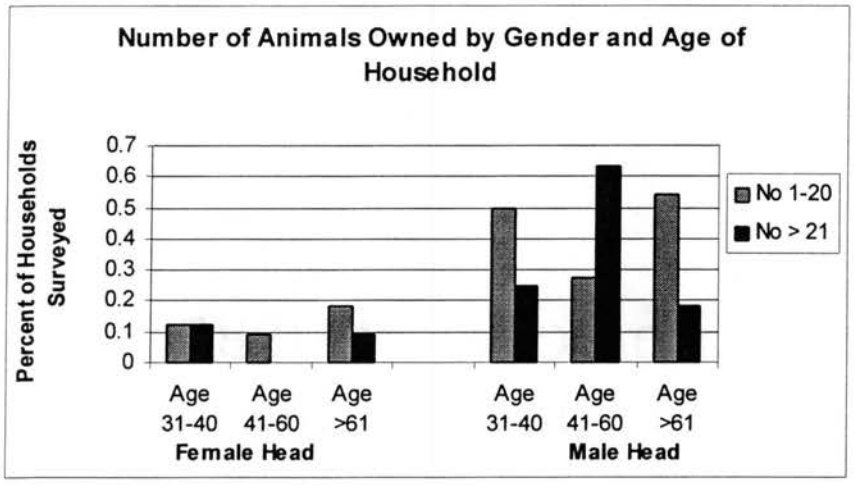


Figure 10. Number of Small Ruminants Owned by Age and Gender of Household Head.

TABLE 8

SMALL RUMINANTS FREQUENCY BY OWNERSHIP NATIONALITY

Distribution*	Nationality		Total
	Non citizen	Citizen	
Without small ruminants	8	55	63
With small ruminants	7	20	27
Total	15	76	90

* Distribution was not significantly different at .1 level from the expected by Chi Square test

shows the relative proportion of foreigners among the households surveyed. Fifty percent of non-citizens in the sample had small ruminants, compared to only 25 per cent

of citizens. However, only 15 of the 90 household heads were not citizens of Cote d'Ivorie so the differences in ownership patterns shown in Table 8 are not significant. These populations are originally from Mali and Burkina-Faso and tend to have a pastoral background. Figure 11 shows that households with small size herds dominate in both cases. The few owners of herds over 60 animals were non-citizens. Overall a higher proportion of non-citizen households did own animals. Casual observation by the author indicates that one of their main activities in the cities is selling roasted mutton in the streets. Non-citizens also work as butchers, herders, or intermediaries in the livestock market.

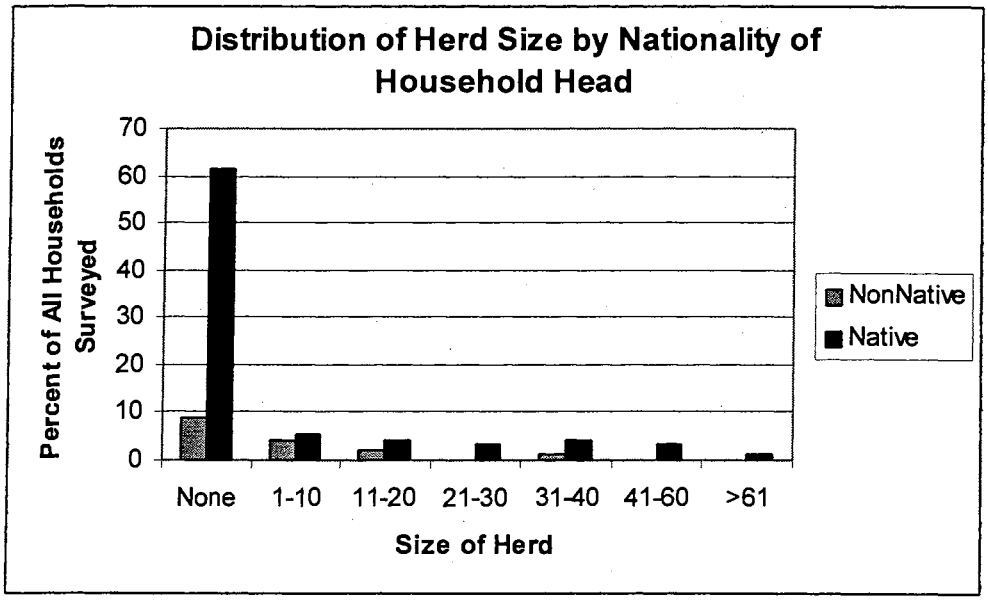


Figure 11. Livestock Distribution by Ownership Nationality

Small Ruminants and Education Level. Table 9 and Figure 12 imply that people with more education are less likely to adopt livestock. A Chi-Square analysis of the data in Table 8 indicates that the number of households with small ruminants is not different than what could be expected by chance. From the sample, people with advanced education levels were all civil servants or workers in the private sector with higher and more stable sources of income than less educated people.

TABLE 9.

HOUSEHOLDS WITH AND WITHOUT SMALL RUMINANTS BY LEVEL OF EDUCATION OF HOUSEHOLD HEAD

Households	**Education level**				**Total**
	Illiterate	Primary school	Secondary school	University level	
	Number of households				
Without small ruminants	30	9	12	5	56
With small ruminants	19	8	5	2	35
Total	49	17	17	7	90

Table 9 shows that there were only two livestock owners with a university level of education. People who did not attend school owned most of the animals in herds over 30 head. A Chi-Square analysis indicated the number of animals owned by households by

each education level (Figure 12) was significantly different than what might be expected by chance at the 2.5 percent level.

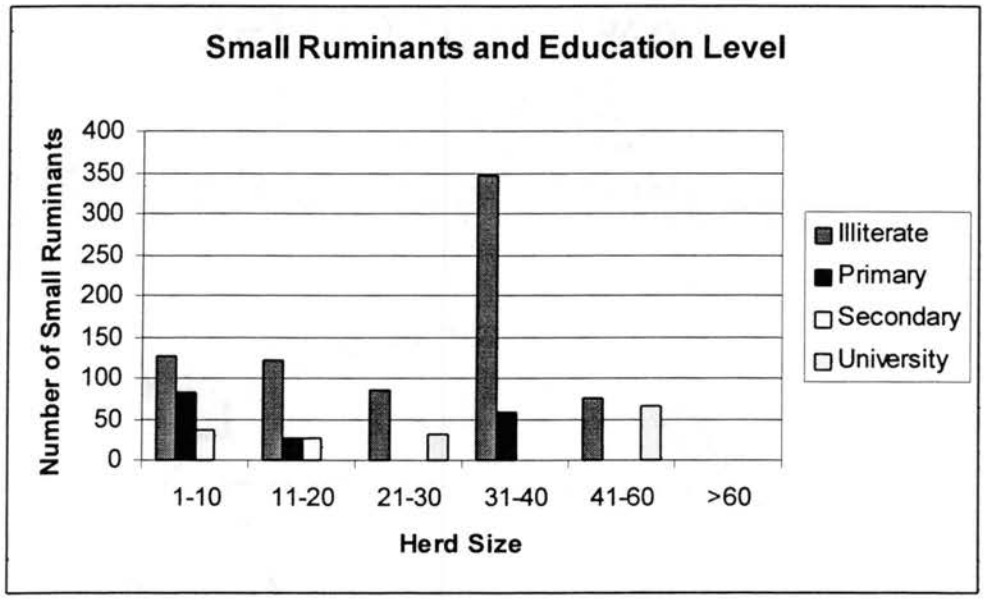


Figure 12. Number of Small Ruminants by Level of Education

Number of Small Ruminants and Family Size. From Figure 13 it can be observed that the herd size does not necessarily increase with the size of the family. When the size of the family increases, family expenses also increase and space for animals in the compound decreases. As a result, the household savings and investment capacity might decrease through the supply of potential labor would increase.. The results show that families with more than 20 members dominate in the 1 to 10 herd size group, while families with 6 - 10 members owned most of the herds of over 30 head. A Chi-Square test

verifies the distribution of total animals among households is significantly different at the .01 level than that which would have expected by a uniform distribution between family size and herd size.

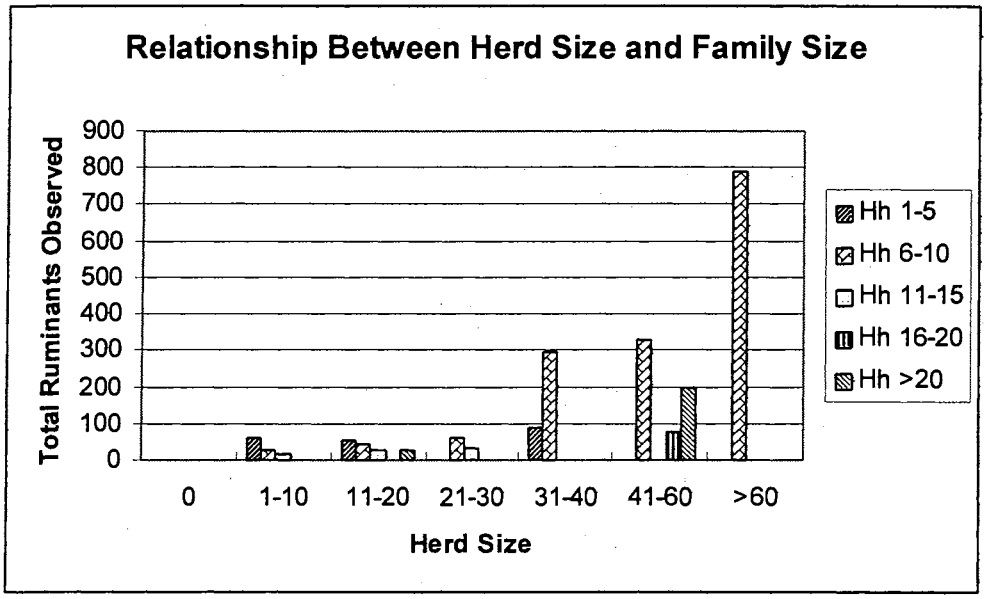


Figure 13. Number of Small Ruminants and Family Size

In the cities, merchants or workers in the private or public sector often head large families. And as mentioned earlier, these households face less food insecurity, and would be less likely to rely of the small stock for their contingencies or their income fluctuations.

Number of Small Ruminants and Primary Occupation. Figure 14 tends to confirm what was observed previously. Civil servants and merchants who are assumed to have

relatively high incomes own no animals or herds of less than 10 head. These two occupations dominate the first level of herd size (0-10 head). Farmers and the category "other" owned the larger herds.

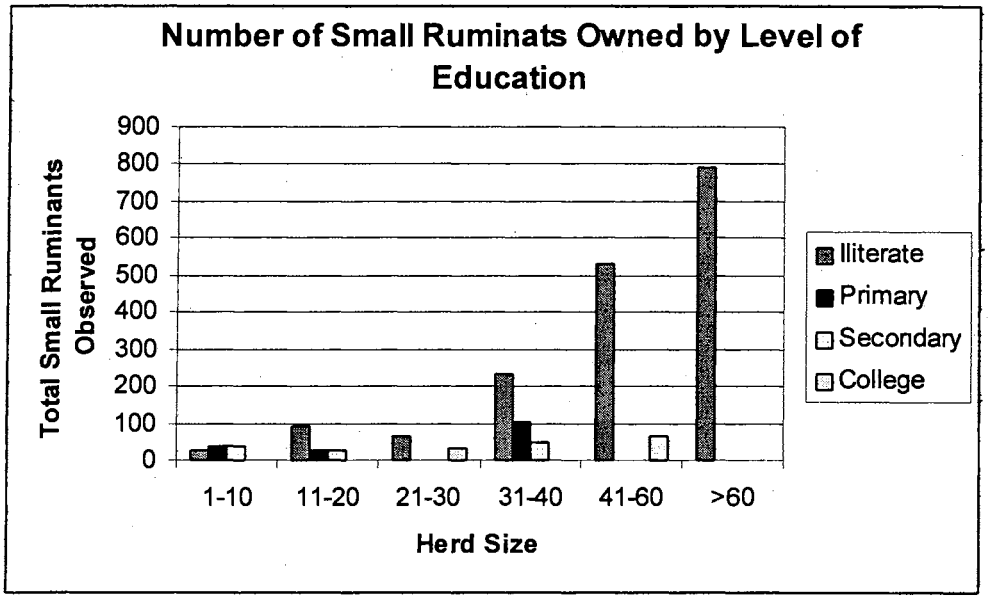


Figure 14. Number of Small Ruminants Owned by Primary Occupation of Household Head.

Number of Small Ruminants and Income Level. The largest number small ruminants from all herd sizes are accounted for by households in the 50-200 thousand CFA per year income classes. There was however, a substantial presence of high income households with more than 400 thousand CFA incomes owning herds. A Chi-Square test rejects the hypothesis that small ruminants are distributed uniformly among all income classes at the .01 level.

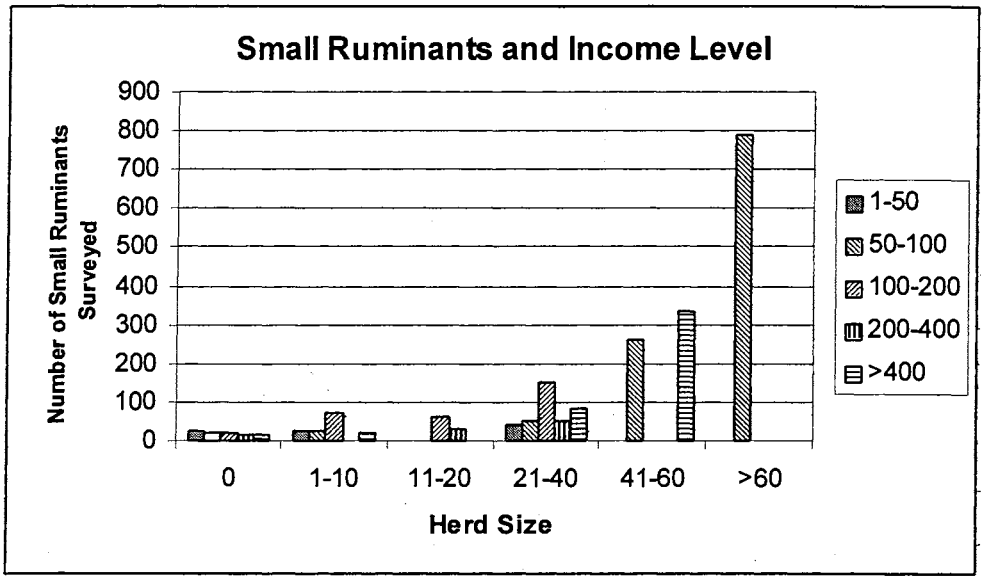


Figure 15. Number of Small Ruminants and Income Level

Number of small ruminants and number of years of experience in farming. Farmers with more experience are usually assumed to raise more livestock. Figure 16 tends to confirm the idea. Farmers with more than 20 years of experience owned all the herds over 60 head.

Production Parameters for Urban Sheep and Goats. Table 10 shows selected production parameters for goats. The average herd size was 29 head. Of the eight herds, two were not supplemented with purchased feedstuffs. One of them had only 8 animals, which is far below the average, the other had 33 head, which is above the average. Apparently the herd size was not a sufficient condition for requiring purchased feed. Producers could not recall the number of kids born in the year, but they reported the number of kids that survived; which are reported in column 5 of Table 10.

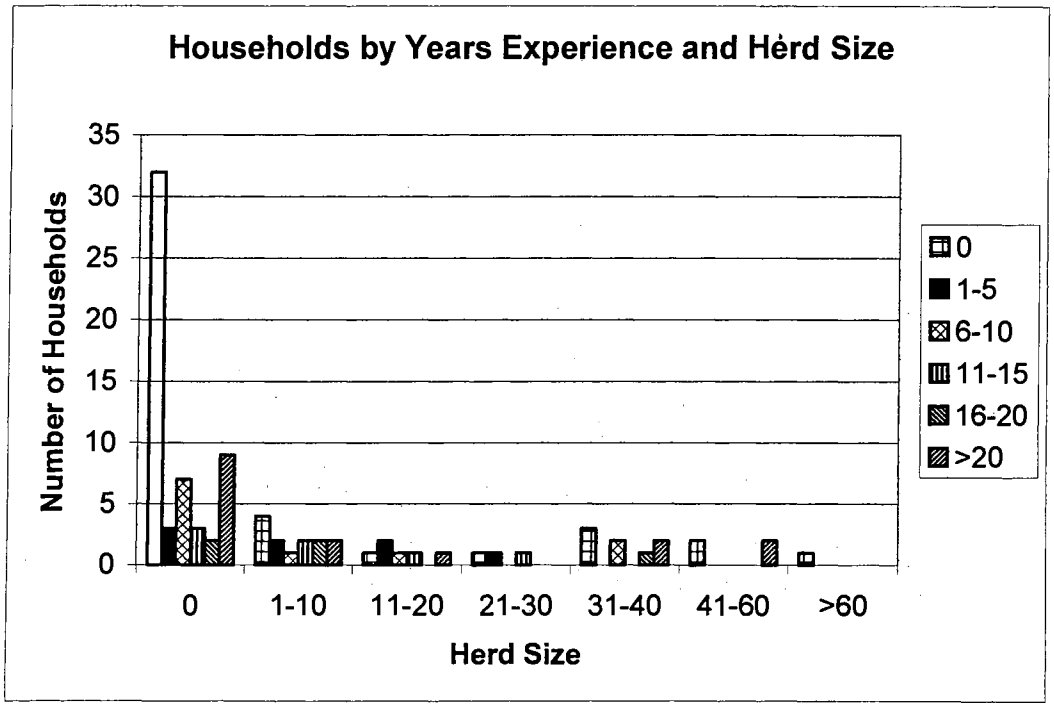


Figure 16. Number of Small Ruminants and Number of Years of Experience in Farming.

The average household with goats in the urban areas of Korhogo had 18 females, 10 males and 5 kids. The average household spent less than 5 hours of labor (nearly equal amounts of male and female labor) per week. Purchased feed inputs were 2100 CFC per year. The coefficient of variation for the means in Table 10 varied from .07 to .31. The relatively high CV (coefficient of variation) values for the means are mostly due to the small number of cooperating households with goats.

The correlation coefficients for goats in Table 11 measure the linear relationship between variables. The high correlations between female, male and kid goats indicate the make up of the herd remained constant as size varied. Total labor was only weakly correlated with the numbers of sheep which would indicate most of the labor is overhead

and does not vary significantly with herd size. Male and female labor has a high positive correlation which would indicate that male and female labor varies in fixed proportions.

TABLE 10

OBSERVED GOAT REPRODUCTION AND LABOR PARAMETERS*

Household ID	Adult goats				Purchased Inputs			Labor	
	Female	Male	Total	Kids	Feed	Per head	Male	Female	Total
	Head				CFA			(hours/week)	
4	30.0	12.0	42.0	6.0	4,000.0	109.2	2.0	3.5	5.5
5	5.0	3.0	8.0	1.0	0.0	0.0	1.0	2.0	3.0
30	16.0	8.0	24.0	4.0	3,500.0	145.8	3.5	2.0	5.5
38	18.0	8.0	26.0	10.0	4,125.0	158.7	2.0	3.5	5.5
40	34.0	24.0	58.0	9.0	3,500.0	60.3	2.0	3.5	5.5
41	12.0	8.0	20.0	3.0	500.0	25.0	2.0	2.0	4.0
42	21.0	12.0	33.0	8.0	0.0	0.0	1.0	3.0	4.0
84	11.0	8.0	19.0	1.0	1,250.0	65.8	3.5	1.0	4.5
Total	147.0	83.0	230.0	42.0	16,875.0	0.0	17.0	20.5	37.5
Average	18.4	10.4	28.8	5.2	2,109.0	70.1	2.1	2.6	4.70
Coefficient of Variation of Mean	0.19	0.21	0.19	0.24	0.31	0.31	0.16	0.13	0.07
Mean per Female		0.56	1.56	0.29	115.0	3.8	0.12	0.14	0.26

* Estimates from the extension agencies place expected birth and mortality rates at 68 and 40 percent respectively.

TABLE 11

SIMPLE CORRELATION COEFFICIENTS BETWEEN THE SELECTED VARIABLES FOR GOAT PRODUCTION IN TABLE 10.

	Female	Male	Adults	Kids	T.Imput	Imp. Hd_{-1}	M. Labor	F. Labor	T. Labor
Female	1								
Male	**0.885**	1							
Adults	**0.983**	**0.956**	1						
Kids	**0.738**	0.622	**0.713**	1					
T.Imput	0.629	0.4	0.555	0.546	1				
Imp. Hd_{-1}	0.273	0.022	0.181	0.353	**0.893**	1			
M. Labor	-0.059	-0.033	-0.051	-0.285	0.408	0.594	1		
F. Labor	**0.782**	0.571	0.72	**0.899**	0.551	0.265	-0.486	1	
T. Labor	**0.708**	0.527	0.656	0.594	**0.945**	**0.85**	0.516	0.498	1

(Boldfaced correlation coefficients are different from zero at the 5 percent levels with 6 degrees of freedom).

Similarly, sheep reproduction parameters are given in Table 12. The ratio of females to males is also low, meaning that the herd is not milk oriented and that males are sold after at least one year of age. The respondents also gave production in terms of surviving kids or lambs.

The average urban household with sheep in the surveyed area of Korhogo was found to have 18 females, 9 males and 5 kids or lambs. There is one adult male for every 2 adult females. Purchased inputs, mainly for feed, cost about 3,850 CFA per year. The total labor requirement for the average flock is about 5 hours per week. The coefficient of variation for the means in Table 12 varies from .07 to .30. The greatest variability was associated with the cost of feed inputs.

The simple correlation coefficients shown in Table 13 for female sheep, male sheep, and lambs are highly positive indicating the composition of the herd or flock

TABLE 12

OBSERVED SHEEP REPRODUCTION PARAMETERS

	Sheep								
Household	Female	Male	Adults	Live kids	Input (F.CFA)	Input/head (F.CFA)	M labor (H/week)	F labor (H/week)	Total labor
6	9	6	15	2	1,200	80.0	1	1	2
8	19	15	34	3	500	14.7	3.5	2	5.5
10	8	3	11	2	2,500	227.3	2	3.5	5.5
14	10	5	15	3	0	0.0	1.5	1	2.5
24	45	15	60	7	1,3750	229.2	3.5	2	5.5
27	15	7	22	5	8000	363.6	1	3.5	4.5
30	12	5	17	3	1,3750	808.8	3.5	3.5	7
36	12	5	17	5	500	29.4	2	1	3
38	23	5	28	6	5,125	183.0	2	3.5	5.5
40	16	15	31	5	3,125	100.8	3.5	2	5.5
41	8	3	11	2	500	45.5	2	2	4
42	34	16	50	7	4,500	90.0	3.5	2	5.5
62	5	2	7	1	3,500	500.0	2	1	3
67	29	11	40	9	500	12.5	2.5	3.5	6
74	39	27	66	10	2,250	34.1	3.5	2	5.5
80	20	11	31	8	6,000	193.5	1	2.5	3.5
81	9	4	13	3	2,750	211.5	3.5	1	4.5
82	8	3	11	3	3,125	284.1	2	3.5	5.5
83	15	10	25	5	3,250	130.0	3.5	2	5.5
84	16	5	21	5	2,250	107.1	1	1	2
Total	352	173	525	91	77,075	- - -	48	43.5	91.5
Mean/hsld	17.6	8.7	26.2	4.7	3,853	146	2.4	2.2	4.6
Mean Coef. Variation	.14	.16	.14	.12	.23	.30	.09	.10	.07
Mean/Female		.49	1.49	.27	218	8.34	.13	.12	.26

remains fairly constant from one household to another. Male and female labor inputs are weakly correlated but female labor was highly correlated with total labor and with the number of female sheep. Total household labor inputs amount to less than one hour per day per household. This indicates the flock could be handled as a supplementary enterprise.

TABLE 13

SIMPLE CORRELATION COEFFICIENTS BETWEEN THE SELECTED VARIABLES FOR SHEEP PRODUCTION SHOWN IN TABLE 12.

	Female	Male	Adults	Kids	T.Imput	Imp. Hd^{-1}	M. Labor	F. Labor	T. Labor
Female	1								
Male	**0.806**	1							
Adults	**0.974**	**0.918**	1						
Kids	**0.837**	**0.736**	**0.839**	1					
T.Input	0.349	0.081	0.264	0.154	1				
Input Hd^{-1}	-0.249	-0.35	-0.299	-0.318	**0.723**	1			
M. Labor	0.431	**0.538**	**0.493**	0.206	0.235	0.062	1		
F. Labor	0.14	-0.01	0.091	0.220	0.386	0.361	0.031	1	
T. Labor	0.399	0.371	0.407	0.296	0.430	0.294	**0.719**	**0.717**	1

(Boldfaced correlation coefficients are different from zero at the 5 percent level with 18 degrees of freedom).

It was the author's observation that animals receive supplements in rudimentary corrals built in the backyard. The author has observed that the major feedstuffs are hay, cottonseed, crop residues and kitchen wastes. There is no market for hay. Usually the owner of the herd or his children will harvest hay outside the city and carry it with bicycles, or on their heads. In the dry season crop residues are the most widely feedstuffs used. There is no ration formulation as animals are just fed ad-lib with hay in confinement part of the time.

However when the Muslim celebration is close, the owner uses more intensive feeding methods by increasing the daily ration and adding vitamins and minerals. So at that period, most the feed and attention is devoted to adult males. Cottonseed meal is

also widely used, since it is available in the region. Crop residues and kitchen wastes are also fed.

Marketing Activities

The majority of these small ruminants are destined for the market. Men usually dominate livestock marketing activities. Even if the animals belong to the women, the men market the live animals. The marketing figures are shown in Table 14. Five of the 21 households had both sheep and goats.

The average age of sale was 1.6 and 1.8 years for goats and sheep respectively. Nearly 90 percent of the families with sheep and 65 percent of the families with goats reported sales. The average household with goats and sheep sold approximately 5 and 10 animals respectively. The average price per head received was 8,875 and 11,387 CFA for goats and sheep respectively.

The mean prices per head by age for sheep and goats are shown in Table 15. The price received per head does not increase show any significant trend between ages one and three years of age.

The average price of sheep was higher than the average price of goats (Table 15). This is expected because sheep are more prestigious and are larger animals. The goats raised in the area are mostly of the local dwarf breeds such as Djallonke which are smaller, but rustic and tolerant to the trypanosomiasis. Both goats and sheep are sold at between ages of one and three years. Most small ruminant owners in the survey, declared they sold most of their animals during the Muslim celebration of "Aid El Kebir".

The surveyed households had 230 and 525 adult goats and sheep, respectively. From the goatherds only 40 animals (17 percent) were sold, while 179 sheep out of 514

(34 percent) where sold. This may mean that households with goats are less market oriented. Small goats may serve as source or protein for the households or may be marketed through more informal channels. Goat meat is not sold in the markets or by street venders. Only live animals are marketed.

TABLE 14

MARKETING ACTIVITIES (Korhogo 2000)

	Goats				Sheep			
Household number	Herd size	Number sold	Revenue received (f cfa)	Age at sale (Years)	Herd Size	Number sold	Revenue (f cfa)	Age at sale (Years)
4	42	4	42000	3				
5	8	5	60000	3				
6					15	3	60000	3
8					34	4	44000	
14					15	5	75000	3
24					60	100	500000	
27					22	0	0	
30	24	7	56000	1	17	5	300000	2
36					17	3	45000	2
38	26	4	32000	1	28	0	0	
40	58	2	14000	1	31	0	0	
41	20	0	0		11	0	0	
42	33	11	88000	1.5	50	8	72000	1.5
62					7	0	0	
67					40	10	200000	3
74					66	12	90000	2
80					31	10	200000	1
81					13	7	160000	1.5
82					11	0	0	
83					25	6	100000	1
84	19	7	63000	1	21	6	200000	1
Total*	230	40	355,000	- - -	514	179	2,046,000	
Average	28.75	5.0	44,375	1.64	27.05	9.53	108,477	1.8
CV of means	.19	.24	.23	.20	.05	17	38	.13
Percent HH with Sales			17.4%			34.8%		

TABLE 15

AVERAGE PRICE RECEIVED FOR SHEEP AND GOATS IN SURVEY

	AGE YEARS			
	1	1.5	2	3
	CFA/Head			
Sheep	23,333	15,929	27,500	17,500
Goats	8,000	8,000		11,250

Livestock Orientation. Only a few households reported they raise small ruminants for their own consumption. The author has observed that mutton and goat meat are consumed at home or in the streets only occasionally. Mutton and goat meat are more considered luxury items as compared to beef. Lack of refrigeration precludes storage of meat. Table 16 shows the livestock orientation of the urban households with livestock.

It appears from Table 16, that in households headed by women, goats are more often used as a source of protein than are sheep. But the number of responses was small. Similarly, in the households headed by men, sheep may be used more frequently as a source of protein. In both type of households, most households reported that animals raised only for sale.

Sheep are the most commonly used animals for celebrations like weddings, anniversaries, funerals, and Muslim festivities. However, goats do play and important role in esoteric festivities, where they serve for libations. These orientations suggest also that goats contribute more to the non-market source of protein.

TABLE 16

LIVESTOCK ORIENTATION BY LIVESTOCK TYPE AND HEAD OF HOUSEHOLD GENDER

Gender of Household Head	Livestock Orientation	Livestock type				
		Goats	Sheep	Cattle	Pork	Total
		Number of Households Reporting				
Female	Consume and sell	2	1			3
	Sell only	2	2	1		5
	Total	4	3	1		8
Male	Consume and sell	1	7	2	1	11
	Sell only	4	11	7		22
	Total	5	19	9	1	34

Labor supply. The author's experience is that people in the study area usually work five days a week, take one day off, and spend one day marketing. The average workweek is 40 hours, which gives 2080 hours a year. In animal husbandry, men, women, children and hired labor usually provide labor; however, in the cities, children go to school so their contribution is meaningful only during school holidays.

Women usually devote more time to the household livestock, especially during the dry season, when the hired labor is unavailable, and feed and water are scarce.

The author has observed that finding feedstuffs consists of mowing hay from rural areas and carrying it back to the backyard, and giving it to the animals. Mostly men and the hired herder share this activity. However, women contribute also by providing human

garbage to the herd. Watering includes fetching water and bringing it to the animals. This it is usually a female task.

Veterinary care activities and contacts with extension agencies are usually in the hands of men. But women, children and the "Fulani" do give a hand sometimes, especially when it comes to administer drugs to the herd. Cleaning the stable is solely a women and girls affair, as is disposal of manure, which is used in gardening. Building an enclosure takes place once a year. It is male activity, helped by children and the hired labor. It necessitates just some maintenance activities, done generally by men, with the help of the boys and the herder.

The author has observed that it takes the average owner two days to the owner to sell his animal. He will spend the entire first day bargaining and comparing prices. Only the second day that he will decide to accept an offer. He stays at the market place about 6 hours each day or a total of 12 hours per animal sold. If he sells on average 2 animals a month, it takes a total of 12 hours each month. This gives a 0.4h a day for marketing activities.

Decision-making. Even though the women were not observed or reported to take the small ruminants to the market, it would be the women who makes the decision to sell an animal from her herd.

Table 17 provides a simple budget analysis to indicate potential contribution of sheep and goats to household income. Tables 10 and 12 indicated the cost of purchased inputs (mainly for feed, veterinary supplies, facilities repair) was low and that average household labor inputs were less than one hour per week. The budgets in Table 17 indicate that sheep flock returns about 100,000 CFA over all costs while goats while

TABLE 17

ENTERPRISE BUDGETS FOR SHEEP AND GOATS BASED

ON HOUSEHOLD SURVEY DATA.

Sheep	Unit	Quantity	Unit Price	Total
			CFA	
Production				
Adult Females	head	18		
Adult Males	head	9		
Lambs Surviving	head	5		
Sales	head	9.5	16,642	158,101
Inputs				
Labor-Male	hours/year	125	350	43,750
Labor-Female	hours/year	113	75	8,475
Feed	CFA	1	3,854	3,854
Total Cost	CFA			56,079
Net Return	CFA			102,022
	$US		0.00133	$ 135.69
Return to All Labor*				
	CFA			154,247
	$US		0.00133	$ 205.15

Sheep	Unit	Quantity	Unit Price	Total
			CFA	
Production				
Adult Females	head	18		
Adult Males	head	10		
Lambs Surviving	head	5		
Sales	head	5	8,929	44,643
Inputs				
Labor Male	hours/year	111	350	38,850
Labor Female	hours/year	133	75	9,975
Feed	CFA	1	2,109	2,109
Total Cost	CFA			50,934
Net Return	CFA			(6,291)
	$US		0.00133	$ (8.37)
Return to All Labor*				
	CFA			42,534
	$US		0.00133	$ 56.57

* Total Receipts less Feed Cost.

goats show a slight loss. If sheep and goats are viewed as supplementary enterprises with respect to labor and other household activities, then the average urban sheep flock and goat herd returns over 150,000 ($US 205) and 42,000 CRA ($US56) per year respectively.

From Table 17 it appears that small ruminants make an important contribution to household income. This may be especially important for unskilled women. Women can find work only during the west season, for 600 F a day in rural areas, during bottleneck periods (planting, harvesting). They can work on the average two days a week. Their total/wages would be 7,200 F for this period. In the city, job opportunities are very scarce by a comparison, an average household with 18 female goats (selling 17 per cent a year), can make 44, 785 F, while an urban household with 18 female sheep can make on average 102,000 CFA ($US 236) per year which is more than 10 times that an unskilled woman can get in town or by working outside during the wet season.

The budget analysis indicates that urban sheep flocks and goat herds can increase household income especially when there is a low opportunity cost for labor. A Tobit analysis is used in the next section to examine in more detail the factors that influence the household's decision to adopt sheep or goats.

The Empirical Tobit Model

Definition of Variables. The dependent variable (NRUM) is the number of small ruminants (goats and sheep) owned by the household. These small ruminants are considered as a food security strategy, in the sense that it can generate cash income to buy food.

Explanatory variables are:

AGE= Age the household head

GEND=Gender of the owner (0=female 1=male)

EDUC = Education level of the respondent (in years of schooling)

NATION= Nationality of the respondent (1 if Ivoirian, 0 if non-Ivoirian)

FSIZE = Number of members of the household

NWIF=Number of wives in the household

WPROCC=Wife primary occupation

INC=income of the household

PROCC=Primary occupation of the head of the household.

NYXP=Head of household's number of years of experience in farming.

a) Age of the respondent may affect the adoption of small ruminants as a food security strategy. It is commonly assumed that young people do not have small ruminants because they lack the necessary money to capitalize. Moreover, their labor supply is not sufficient for animal husbandry and crop production. Younger people are also assumed to have less farming experience. Therefore, we will expect the coefficient of variable age to have a positive sign.

b) Gender is often considered as an important variable in livestock ownership and management in Africa, where animals play a major role in matrimonial compensations. Women usually receive animals as presents in marriages, so they often own part of the household herd, especially small sheep or goats. In the model, this variable is a dummy (1 if male, 0 if female) so we expect gender to have a negative sign with small ruminant adoption.

c) The level of education may affect investment decisions in many ways. Usually education and income are positively correlated, although not linearly. So high-income households are more likely to have other opportunities in more profitable activities. So in general education will tend to have a positive effect on investment. However, in the case of investing small ruminants in the city as a food security strategy, the problem looks different. In the context of the study, educated people usually have alternative sources of income (government salaries), so they are less exposed to food insecurity. As a result they are less inclined to invest in small stock as a food security strategy. Therefore, we expect a negative sign of education of the probability of adopting urban livestock.

d) Nationality. In the traditional society, activities are very often differentiated by gender and ethnical background. Farming is considered more prestigious as animal husbandry, even though farmers own animals. The daily care and management of the stock are considered as minor activities. Therefore, women, children and foreigners are usually more involved in herd maintenance. In the model, this variable is a dummy (1 if citizen of Ivory Coast, 0 if foreigner). Since we expect more foreigners to be involved in animal husbandry, we will expect a negative sign for this variable.

e) Family size refers to the total number of people living in the same compound, and having their meals together, under the responsibility of the head of the household. Even thought large families are expected to have more labor supply, the likelihood of investing in the small stock in the cities is not quite evident,

because children go to school and usually large urban families rely more often on other sources of income like commerce. Thus, we expect any sign.

f) The number of wives in the household may have a positive influence of livestock adoption. However sometimes, in the cities only wealthy people can afford several wives; since wealthy people have other alternative sources of they might not invest in livestock. Thus, we expect a negative sign.

g) The wife's primary occupation is also an important element in animal husbandry in the cities. In the model the variable is a 0-1 dummy (0 if the wife works outside the household, 1 otherwise). As a result we expect this variable to have a positive sign with respect to livestock ownership.

h) Household income is also considered as an important factor in the decision to adopt livestock. It is often assumed that small ruminants are mostly present in low-income households, with risky prospects like crop revenues. It is also known that a certain amount of capital is required to get the initial herd. The sign for capital can be either positive or negative.

i) Primary Occupation. Urban livestock owners are diverse in their occupations and motivations. However those who rely on livestock for their livelihood are more likely to be farmers. In the model this variable is a dummy (1 if farmer, 0 if not). As a result we expect farming as a primary occupation to be positively correlated to the probability of having small ruminants as a food security strategy.

j) Years of Experience. The number of years of experience in farming might also have a positive effect on livestock management. However, in the study area,

many-experienced farmer just do not necessarily raise animals; so any sign is expected in the context of the city.

Estimation procedure. The model of small ruminant adoption is specified as a censored regression model, expressed as:

$$\begin{aligned} Y_i &= Y_i^* \qquad Y^* = \beta X_i + \mu_i > 0 \text{ for those who have small ruminants} \\ Y_i &= 0 \qquad Y^* \leq 0 \qquad \text{for those who do not have small ruminants} \end{aligned} \tag{4.1}$$

Where Y, the number of small ruminants, is the dependent variable. Y* is an underlying latent variable that indexes adoption. The **X** variables are socio-economic characteristics of the respondents. The error term which affect the adoption decision. μ is assumed to have a truncated normal distribution. The Tobit model can handle this type of model. The model presents two advantages: (1) it permits the investigation of the decision of whether or not to adopt and the level of adoption Adesina et al. (1995). The Tobit model also has an advantage in that its coefficients can be disaggregated to determine the effects of the change in one variable on changes in the probability of adoption and the expected intensity of the adoption.

The total change in Y associated with a change in X_i can be decomposed into the change in the probability of Y being above the limit and the change in Y when it is already above the limit Shapiro and Brorsen (1998).

The regression coefficients are computed using the mean values of the explanatory variables, as presented in Table 16. Elasticities are computed following the McDonald and Moffit decomposition.

$$EY = F(z)EY^* \tag{4.2}$$

Where $z = X\beta/\partial X_i$. Taking the derivatives of EY with respect to X_i we get:

$$\partial EY/\partial X_i = F(z)(\partial EY^*/\partial X_i) + EY^*(\partial F(z)/\partial X_i). \tag{4.3}$$

Multiplying both sides of equation (3.3) by X_i/EY, we get

$$\partial EY/\partial X_i\,(X_i/EY) = F(z)(\partial EY^*/\partial X_i) + EY^*(\partial F(z)/\partial X_i)(X_i/EY) \tag{4.4}$$

Replacing EY by its value from equation (3.2), and rearranging terms we get the decomposition of the total elasticities into the two effects:

The first effect is equivalent to the expression:

$$\left[Zf(z)/F(z) - f(z)^2/F(z)^2\right] \tag{4.5}$$

This is the fraction by which the β coefficients must be adjusted to obtain the correct effects for observations above the limit. The second fraction is obtained by subtracting the result obtained in equation (3.5) from one Shapiro and Brorsen (1988).

Results and Discussion

The interpretation of any fitted model requires that we be able to draw practical inferences from the estimated coefficients in the model Hosmer et al. (1989). For the linear models, where the link function is the identity function, the coefficients express the corresponding change in the dependent variable for a unit change in the independent variable. However in logit and tobit models these coefficients do not have a straightforward interpretation. The slope coefficients represent the change in the link function for a change of one unit in the independent variable. Proper interpretation of the

coefficients depends on being able to place meaning on the difference between two values of the link function. One of the main problems encountered in cross-section analysis is heteroskedasticity. Table 18 shows that income was the only heteroskedastic variable. We also checked for autocorrelation between variables. The correlation matrix in Appendix 3 did not show any autocorrelation between variables. The results are presented in Tables 18 and 19.

TABLE 18

CHECK FOR HETEROSCKEDASTICITY

Variable	Coefficient	Standard Error	t value	P[|Z|>z	Mean of Variable
Constant	-35.099	22.9265	-1.53	0.13	
AGE	0.954	0.4357	2.19	0.03	47.72
GEND	-29.501	16.8357	-1.75	0.80	0.83
EDUC	-4.496	9.1030	-0.49	0.62	1.80
NATION	-27.424	15.7802	1.74	0.08	0.87
FSIZE	-1.431	1.9632	-0.73	0.47	8.05
NWIF	-1.233	6.9405	-0.18	0.86	1.24
WPROCC	29.582	13.6946	2.16	0.03	0.60
INC	0.013	0.0134	0.94	0.35	427.08
PROCC	16.350	14.6049	0.12	0.26	0.33
NYXP	1.000	0.9057	1.14	0.27	8.42
		Heteroscedasticity Term			
NYXP	0.034	0.0223	1.53	0.13	8.42
NWIF	0.219	0.2726	803	0.42	1.24
INC	-0.003	0.0014	-1.84	0.07	427.08
	Disturbance Standard Deviation				
Sigma	31.34042	11.3941	2.75	0.01	

Significant factors related to livestock adoption for the survey include (AGE), age of the household head; (GEND), head of household gender; (NATION), the nationality of the household head; (WPROCC), wife's primary occupation, and (INC), the household income level. The sign of this variable confirms that those who adopt small ruminants as a food security strategy are not among the wealthiest people. All these variables enter the model with the expected sign. The variable number of years of experience in farming (NYXP) was not significant. Other variables were not statistically significant The relative importance of the factors considered appears in Table 19, Columns five and six, which present the partial derivatives, marginal effects and columns are reported in Table 20.

From Table 21 we get z=0.411 so the predicted probability of urban livestock adoption for a household with characteristics X (the vector of explanatory variables) is estimated as: $F(X'B/\sigma) = 0.6591$

Where F is the cumulative standard normal distribution function. This result indicates that there is 66% chance that an average urban household would adopt small ruminants as a food security strategy. The expected value of small ruminant adoption is defined in the model as:

$E(Y) = X\,\beta\,\mathrm{F(z)} + \sigma\,\mathrm{f(z)}$

Where $z = X\beta/\sigma$ and f (z) is the unit normal density

Replacing by values obtained in Table 20 we get:

E (Y)=12.894*0.6591+31.3404*0.3668=19.994

TABLE 19

TOBIT ESTIMATES

Variable	Coeff.	Std.Err.	t-ratio	P-value
ONE	-35.0987	22.9265	-1.53	0.13
AGE*	0.9544	0.4357	2.19	0.03
GENDER*	-29.5015	16.8357	-1.75	0.08
EDUCATION	-4.4963	9.1030	-0.49	0.62
NATIONALITY*	-27.4239	15.7802	-1.74	0.08
FAMILY SIZE	-1.4306	1.9632	-0.73	0.47
NUMBER OF WIVES	-1.2329	6.94047	-0.18	0.86
WPROCC*	29.5823	13.6946	2.16	0.03
INC	0.0126	0.0135	0.94	0.35
PROCC	16.3502	14.6049	1.12	0.26
NYXP	1.0002	0.9057	1.10	0.27

*Denotes significance at 10% level

This result indicates that we expect new adopters to rise on the average, 20 small ruminants.

Similarly, the expected number of small ruminants to be raised by those who already have goats and sheep is estimated as:

$$E(Y^*) = X\beta + \sigma f(z)/F(z) = 12.894 + 31.3404 * 0.3668/0.6591 = 30.35$$

The result indicates that we expect small ruminants owners to raise an average of 30 animals, which is pretty close to the averages found in the study.

Table 21 presents the elasticity decomposition for changes in the explanatory variables, and the marginal effects. Total elasticity of change has two components: the first (E1) is the elasticity on the number of small ruminants to be raised and the second (E2) is the elasticity of the probability to adopt. Since we are looking for probabilities only on one side of the Cumulative Distribution Function, these probabilities look high. Age exhibits the highest elasticity (.69) of intensity of adoption, meaning that a unit change in age will cause the intensity of adoption to increase by .69, or more significantly, with a ten year increase in age, we will expect a herd with 7 more animals. Similarly, the probability to adopt will increase by 8% for a 10-year increase in age of non-adopters. The elasticities of categorical variables show the effects of switching from one category to another. For instance, gender exhibits an elasticity of adoption of (-0.43), meaning that the probability of livestock adoption by women is 43% higher than the probability of adoption by men. And among those who already have animals, we expect on average, that women's herd will have 4 more animals than men's' herd.

Conclusion

The Tobit analysis has shown that small ruminants are adopted by many types of people, as a food security strategy in the city. However, as expected, the primary occupation of the household members, especially women is one of the most important determinants. Because, livestock care needs time, especially for feeding and watering, labor availability is important in backyard animal husbandry. When the wife works

TABLE 20

TOBIT PARTIAL DERIVATIVES DECOMPOSITION

	Means	*B*	*XB*	dE(Y*)/dXi	dF(z)/dXi
Constant	1	-0.35098			
AGE	47.7191	0.954	45.538	0.440	0.011
GEND	0.8314	-29.501	-24.527	-13.617	-0.345
EDU	1.7977	-4.501	-8.092	-2.078	-0.053
NATION	0.8651	-27.424	-23.724	-12.658	-0.321
FSIZE	8.0449	-1.431	-11.509	-0.660	-0.017
NWIF	1.2359	-1.233	-1.524	-0.569	-0.014
WPROCC	0.5955	29.582	17.616	13.654	0.346
INC	427.0786	0.013	5.373	0.006	0.000
PROCC	0.3258	16.350	5.327	7.547	0.191
NYXP	8.4157	1.000	8.417	0.462	0.012
XB			12.894		
Sigma	F (z)	f(z)	z		
31.3404	0.6591	0.3668	0.411		

M1 (Marginal effect on adoption)= EY*((dF(z)/dXi)
M2 (Marginal effect on intensity of adoption) = F (z)* (dEY*/dXi)
E1 (Elasticity of intensity) = dEY */dXi* /Xi/EY*
E2 (Elasticity of adoption) = dF(z)/dXi*Xi /F(z)
XB =12.894
f(z) =0.3876
σ = 31.3404

E (Y*)=XB + σ f(z) /F(z)= 30.335

E (Y) = F (z) EY*= 19.994

{1-zf (z)/F (z)-f (z) ^{2}/F (z)^2 = 0.462

TABLE 21

TOBIT MARGINALS AND ELASTICITIES DECOMPOSITION

Variables	Marginals M1	Marginals M2	Elasticities E1	Elasticities E2
Constant				
AGE	0.3388	0.2903	0.8086	0.6929
GEND	-10.4740	-8.9748	-0.4355	-0.3732
EDUCATION	-1.5982	-1.3694	-0.1437	-0.1231
NATION	-9.7365	-8.3428	-0.4213	-0.361
FSIZE	-0.5079	-0.4352	-0.2044	-0.1751
NWIF	-0.4377	-0.3751	-0.0271	-0.0232
WPROCC	10.5027	8.9993	0.3128	0.268
INC	0.0045	0.0038	0.0954	0.0817
PROCC	5.8048	4.9739	0.0946	0.081
NYXP	0.3551	0.3042	0.1495	0.1281

outside the household, animals are abandoned most of the time, and since human garbage is still one the most important feedstuffs, the role of women is preponderant in urban livestock management.

Age also play an important role in urban livestock adoption. Older people are more likely to have more labor supply in their households, and presumably more savings to buy animals than younger households, under the assumption that there is no credit available to purchase animals. The herd is progressively capitalized, over time. As also expected, the proportion of foreigners involved is important. People from neighboring countries, often considered as animal husbandry specialists, dominate in fact the

marketing activities. The number of years of experience in farming happened to be not a determinant factor. The more highly educated people seem to embrace activities other than animal husbandry. The low and middle-income people are the most common urban livestock producers.

CHAPTER V

SUMMARY AND CONCLUSIONS

Research Objectives

The study was undertaken in the city of Korhogo, in northern Cote d'Ivorie where small ruminants are widely adopted in the city as a food security strategy. Livestock are owned both by farmers and by other socio-professional categories. The general objective of this research was to determine the impact of urban livestock on food production and household income in the city of Korhogo. Specific objectives were:

1. Determination of the number of livestock owned by urban households in selected neighborhoods of Korhogo, Cote d'Ivorie.
2. Estimation of the input-output relationships of the urban livestock production systems.
3. Quantification of the factors that most influenced the adoption of small ruminants by urban households.

The first objective was accomplished by the use of strip transect survey techniques in the selected neighborhoods of Korhogo. The second objective was accomplished by sociological survey of households located in neighborhoods of Korhogo with high densities of livestock. The third objective was accomplished by a Tobit analysis of data from the household survey.

Research Results

Survey to Estimate the Number of Urban Livestock.

All eleven neighborhoods identified having significant numbers of livestock were surveyed. The total net residential area was located near the center of the city and totaled 1009 hectares. Some sixty strip transects were made which covered 36 percent of the residential family compound area. The number of sheep, goats, cattle, and poultry encountered in each transect were recorded as was the area of each transect. The density or ratio estimates were expressed as the number of animals per residential hectare.

The average density of small ruminates, cattle, and poultry in the eleven neighborhoods were found to be 28.5, .6, and 13.5 animals per hectare respectively. The total number of sheep, goats, cattle, and poultry for the eleven neighborhoods were estimated to be 14,780, 12,000, 500, and 12,650 respectively. The percentage errors for these estimated totals of sheep, goats, cattle, and poultry were .06, .05, .23, and .04 respectively. The results confirm there are substantial numbers of livestock and small ruminants in particular in the urban center.

Characteristics of Households in Urban Areas with Livestock

Urban households were randomly selected from the transects which had the most livestock. Some 90 surveys regarding the age, gender, education, nationality, income, and primary occupation of the household head were obtained. Additional questions related to family size, ages and literacy of family members. Of particular interest was whether the family kept small ruminants. If they kept ruminants, then questions relating to the number of animals, their age, their sex, production and sales were asked. Questions as to the amount of inputs such as labor, feed, medicine and other items were

asked. Questions as to whether it was the men or the women owned the animals and supplied the inputs were also asked. The mean age of the household head was 47, which is lower than the regional average of 51 but comparable to the national mean of 48 years. The mean family size was eight people. The literacy rate in the town is low especially among females. Fifty percent of the males were illiterate as were 75 percent of the females. The average household surveyed reported an annual income of 414,500 CFA (US$ 551). The major characteristics of the household such as age, family size, and literacy closely matched responses from other data in the city so the households seemed to be representative.

Thirty-one of the 90 households surveyed owned small ruminants. The major occupations of the household head were agriculture (30 percent), merchant (5 percent), civil servants (5 percent), and 60 percent were other (mainly wage earners). The respective average annual earnings for these groups were 260,700 CFA ($US 346), 748,000 CFA ($ US 995), 312,000 CFA ($US 432), and 531,000 CFA ($US 691). Households headed by men had average incomes of 441,000 CFA (US$587) while households headed by women earned 284,000 CFA (US$ 378) per year. However, the size of the average household headed by men was larger than the average household headed by women. On a per-member basis, there was no significant difference in income of households headed by men or women.

The number of small ruminants kept by urban households varied from 1 to nearly 800. The average household with either sheep or goats was found to have a herd containing approximately 18 adult females, 8-10 adult males, and 5 surviving kids. Labor inputs for the average herd were less than 1 hour per day. Men and women

supplied labor in nearly equal amounts. The average age for selling sheep and goats was 1.8 and 1.6 years respectively. Annual purchased inputs (mainly feed) were low, averaging 3,853 CFA ($US 5.13) and 2,100 CFA ($US 2.80) per household.

The relatively small sample size prevented drawing firm conclusions but the urban households with small ruminants were mainly agricultural, illiterate or had only a primary education, earned between 50-100 thousand CFA (US$65-$130), had more agricultural experience, and had between 6-10 family members. Enterprise budgets indicated that sheep production was more profitable than goat production. The average sheep flock was found to return 136,000 CFA (US$ 102) over all costs including labor while the average goatherd broke even. Both types of production can account for substantial portions of the total household income especially where wage opportunities for men or women are limited.

The Decision to Adopt

The Tobit analysis has shown the relative importance of socio-economic factors in the decision to adopt small ruminants as a food security strategy. The variables significantly associated with the ownership of small ruminants were age of household head, nationality, total household income, and occupation of the wife. The age range is an important factor. Young household heads do not have ruminants. People above 60 years of age tend not to have small ruminants because of age and labor constraints. Usually at that age, children are grown and have gone. Gender is also an important factor. The analysis has shown that wife's primary occupation is crucial in animal husbandry. Women not only own small ruminants, but they also contribute to feeding and watering animals. Men are more involved in marketing activities. It appears also

that foreigners are more likely to adopt small ruminants in town. This result was expected because of the preponderant role-played by these groups in the livestock system of the country. They have the skills and the background in raising animals.

Policy implications

The survey indicated there are substantial number of small ruminants in the city and that they both represent a food reserve and contribute substantially to income of poor families. The interest of the Tobit analysis for decision makers is to know exactly what are the determinants of adoption. When a project of a kind is to be implemented, what characteristics should the beneficiaries have to be eligible? The analysis also predicts the expected herd size given the characteristics of an adopter.

From the Tobit analysis the typical target would be a household with eight members, headed by a person 40 years of age, with a woman whose primary occupation is farming. The most highly educated people should not be targeted. If the objective of the decision makers is to improve the nutritional status of the urban households, women should receive more attention, and raising goats rather than sheep should be encouraged under the responsibility of women. Veterinary services should be provided in order to improve herd productivity. If the objective is to provide sources of income to urban dwellers, raising sheep can make it. In both cases, women will have a critical role to play in the success of any development policy. As far as Foreigners can also constitute an excellent target group.

Limitations and Suggestions for Further Research.

The small number of urban households surveyed and particularly the small number with livestock limit the conclusions that can be drawn from this study. A smaller

household survey administered to more households, which permit statistical testing of major parameters. However, this comes at the expense of losing all information on minor characteristics of the household.

The transect survey worked well. Improvements need to be made with respect of dealing with open area where livestock graze in common. These could be surveyed or recorded separately.

References

Abbott M. "Labor Supply, Commodity Demand and the Allocation of Time". *The Review of Economics and Statistics.* Vol70, No 2 (May 1988). pp.224-235.

Adesina, A. and A..Baidu-Forson. "Farmers' Perceptions and Adoption of New Agricultural Technology: Evidence from Analysis in Burkina-Faso and Guinea, West Africa. Agricultural Economics 13 (1995), pp. 1-9.

Ahuja, K. V. "Efficiency of Resource Use in Common Property: A Case of Land in Sub Saharan Africa PH.D. Dissertation (1996)

AITVM: Association of Institutions of Tropical Veterinary Medicine. Livestock Production and Diseases in the Tropics. Livestock Production and Human Welfare. Proceedings of the VIII International Conference. Berlin, Sept. 25-29 1995. Vol. 1.

Amemiya, T. "Qualitative Response Models: A Survey." *Journal of Economic Literature.* 19.4, 1981, pp. 481-536.

Baker, G. "A Treatise on the Family, (Enlarged edition, 1991). Cambridge, Mass., USA, Harvard University Press.

Baker, G. S. "A Theory of Marriage": Part I. *Journal of Political Economy* 1965, 81(4) 813 46.1973

Barry, M. B. "Les Conditions d'Integration de l'Agriculture et de l'Elevage dans le Nord de la Cote d'Ivoire." These de Doctorat de 3eme cycle, Universite de Montpellier I France 1979.

Bauer, L. L. A. "Target MOTAD Analysis of Sweet Potato Marketing." *South Journal of Agricultural Economics*. Experiment, Ga. The Association. Dec 1991.23(2) pp123-29.

Bellows, A. C. "The Invisible Food and Agriculture Production" Ecology and Farming. 16 Sept-Dec 1997 pp.19-20.

Bishop, J. P. "Backyard Animal Production in the Humid Tropics" Proceedings of Kansas State University's 1983 Farming Systems Research Symposium. Paper No. 6 Kansas State University, Manhattan, Kansas.1983

Bourguignon, F. and P. A. Chiappori. "Collective Models of Household Behavior." *European Economic Review.* 36 pp. 355-64. I992.

Browing, M., F. Bourguignon, P. A. Chiappori and V. Lechene. "Income and Outcomes: A Structural Model of Intrahousehold Allocation." *Journal of Political Economy.* 1994, 102(6), pp1067-1096.

Brown, A. and A. Deaton. "Surveys in Applied Economics. Models of consumer behavior". *The Economic Journal.* Vol. 82, No. 328 (Dec.1972), pp. 1145-1236

Cockram, M., and S. Feldman. "The Beautiful City: Gardens in the Third Word Cities". African Urban Quarterly Forthcoming, 1998.

Chataigner, J. "Les Systemes d'Elevage Bovin en Cote d'Ivoire." *Cahirers du CIRES.* Edition speciale Dec. 1985. CIRES Universite Nationale de Cote d'Ivoire. Abidjan 08.

Chiappori, P. A. "Collective Labor Supply and Welfare." *Journal of Political Economy,* 100(3), 1992, pp. 437-67.

Cochran, W. G. Sampling Techniques, Third ed., J. Wiley and Sons, New York, 1977.

Deaton, A. and J. Mullbauer. "An Almost Ideal Demand System" *The American Economic Review.* Vol. 70, No3, June 1980.

Dennry, P. "Inside Urban Agriculture: An Exploration of Food Producer Decision Making in Nairobi Slum. M.Sc. Thesis. The Netherlands: Wageningen Agricultural University, 1995.

Dhyrmes, P. "Limited Dependent Variables". In Z. Griliches and M. Intriligator, eds. *Handbook of Econometrics.* Vol. 2, Amsterdam: North Holland, 1984.

Dresher, Axel W. "Urban Agriculture in the Seasonal Tropics of Central Southern Africa: A Case Study of Lusaka Zambia". Paper presented at the International Policy Workshop on Urban Agriculture: A Growing Development Tool. University College London (NRI/CPU). 29 June 1994.

Due, J. M. "Agricultural Policy in Tropical Africa: Is a Turaround Possible?" 1986 *Agricultural Economics* 1:19-34

Due, J. M., and F. Magayane. "Changes Needed in Agricultural Policy for Female Headed Farm Families in Tropical Africa". 1989 Agricultural Economics 4:239-253.

Ehui, S. "The Contribution of Livestock to Food Security in Sub-Saharan Africa. A Review of Technology and Policy Issues." Paper presented at the XXIII Conference of International Association of Agricultural Economists in Sacramento. August 10-16 1997.

Ehui, S., B. Shapiro and V. C. Yapi-Gnaore. "Peri-urban Livestock Production and Development in Sub-Saharan Africa: a Review of opportunities and constraints. AITVM Vol. I, l995, pp. 151-63.

Epplin, F. M., and G. A. Al Sakkaf. "Risk-Efficient Tillage Systems and Program Participation Strategies for Land Subject to Conservation Compliance." *Review of Agricultural Economics.* Manhattan, Kansas: Department of Agricultural Economics, Kansas State University.. 17(3) Sept. 1995, pp.311-21.

Fisburn, P. C. "Mean-Risk Analysis with Risk Associated with Below-Target Returns" *American Economic Review.* Vol. 67 (1977): pp. 116-26.

Frankberger, T., E. B. Reeves, and C. M. Coughenour. "Animals in Farming Systems in North Kordofan Sudan: Integrated Short-Term and Long-Term Perspectives in FSR Approaches". Proceedings of Kansans State University's 1983 Farming Systems Research Symposium, paper No.6. Kansas State University, Manhattan, Kansas.

Freeman, D. B. "Survival Strategies or Business Training Ground? The Significance of Urban Agriculture for the Advancement of Women in African Cities." *African Studies Review.* 36:3 1993, pp. 1-12

Gladwin, C. and D. McMillan. "Is a Turnaround in Africa Possible Without Helping African Women to Farm?" 1989. Economic Developments *and Cultural Change.* 37(2): 345-369.

Gidis-C. I. Bulletin No 7 Avril 1994, pp.27-32 Abidjan ORSTOM

Greene, W. Econometric Analysis 3rd ed, Prentice Hall, Saddle River1997.

_____. "Marginal Effects in the censored Regression Model." *Economic Letters* 64.1999, pp: 43-49.

Greeve, R. W.; Plaxico J. S; and W. F. Lagrone. "Production and Income Variability of Alternative Farm Enterprises in Northwest Oklahoma." *Oklahoma Agricultural Experiment.* Bull. B-536, 1990

Haddad, L. and T. Reardon. "Gender Bias in the Allocation of Resources Within Households in Burkina-Faso". *Journal of Development Studies.* 29:2 (January 1993) 260:276

Harisson, Mark. "Chaynov and the Economics of the Russian Peasantry." *Journal of Peasant Studies.* 1975 2:389-417

Hazell P. B. R. "A Linear Alternative to Quadratic and Semivariance Programming for Farm Planning Under Uncertainty." *American Journal of Agricultural Economics,* 531971, pp. 53-62.

Heady, E. 0. "Diversification in Resource Allocation and Minimization of Income Variability." *Journal of Farm Economics*, Nov. 1952.

Helmers, G. A, L. J. Held, and J. Atwood. "Deviation Constrained Programming-The Impact on Risk-Income Frontiers." *North-Central Journal of Agricultural Economics*. Fargo: North Dakota State University. July 1984.

Henn, J. K. "Feeding the cities and feeding the peasants: What Role for Africa's Women Farmers?". *World Development*. 11:12 1983 pp. 1043-1055.

Hosmer, D. W. Lemeshow, S. Applied Logistic Regression. Willey Series in Probabilities and Mathematical Statistic Series 1989, John Willey and Sons New-York

Holthausen, Duncan. "A Risk-Return Model With Risk and Return Measured as Deviations From a Target Return." *American Economic Review*, 71(March 1981):182-88.

Krieger, J. "Rural Women, Urban Food". African Rural and Urban Studies. 2:1 1995, pp. 89-109

Lee-Smith, D. and A. L. Pyar. "Urban Agriculture in Kenya". Canadian Journal of African Studies: 37:1 1993, pp. 24-42.

Lele, U. "Women and Structural Transformation". Economic Development and Cultural Change, 1986. 34:195-221

Lourenco-Lindell, I. "The Informal Food Economy in a Peripheral Urban District". Habitat International. 19:2(1995), pp. 195-208.

Lundberg, S. "Labor Supply of Husbands and Wives; A simultaneous Equations Approach"

Mademba, B. (1984). Proceedings of Kansans State University's 1983 Farming Systems Research Symposium, paper No. 6. Kansas State University, Manhattan, Kansas, 1983.

Mapetla, M., H. Phororo, and G. Prasad. "Urbnization, Gender and Environment: the Role of Wild Vegetables". Paper presented at the International Seminar on Gender, Urbanization and Environment: Nairobi, Kenya. 13^{th} –16^{th} 1994.

Maxwell, G. D. "Alternative Food Strategy: a Household Analysis of Urban Agriculture in Kampala" World Development. 23:10 1995, pp. 1669-1681.

Maxwell, G. D. "Internal Struggles Over Resources, External Struggles for Survival: Urban Women and Subsistence Household Production". Paper presented to the African Studies Association. Toronto, Canada. November 1994.

Maxwell, S. and T. Frankberger. "Household Food Security: Concepts, Indicators, Measurements: A Technical Review. 1992 UNICEF and IFAD, New York and Rome

McCamley, F. and J. B. Kliebenstein. "Describing and Identifying the Complete Set of Target MOTAD Solutions." *American Journal of Agricultural Economics*, Aug. 1987, pp. 669-75.

McFaden, D. "Econometric Analysis of Qualitative Response Models" In Z. Griliches and M. Intriligator, eds., *Handbook of Econometrics*. Vol. 2, Amsterdam:North Holland,1984

McElroy, Marjorie B. "The Empirical Content of Nash-Bargained Household Behavior. *The Journal of Human Resources* 1990. 25:560-84.

McIntire, J., D. Bouzat, and P. Pingali. "Crop Livestock Interactions in Sub-Saharan Africa, 1992. The World Bank, Washington D.C.

Mekuria, M. "An Economic Analysis of Smallholder Wheat Production And Technology Adoption in the Southeastern Highlands of Ethiopia" PH, Dissertation 1994 Michigan State University.

Misra, S. K. and S. R Spurlock. "Incorporating the Impact of Uncertain Fieldwork Time on Whole-Farm Risk-Return Levels: a Target MOTAD Approach." *South Journal of Agricultural Economics*. Experiment, Ga: the Association.. 23(2) Dec 1991, pp. 9- 17.

Missohou, A. Ly, C. Diedhou, M. E. Tillard, and S. Diouf. "Elevage Citadin de Moutons a Dakar." AITVM Vol. 1 1995, pp. 208-212.

Mougeot, L. J. A. "African City Fanning From a World Perspective". Cities Feeding People. IRDC (1994). Ottawa, ON, Canada.

Nichola, T. "The Decision to Adopt and the Intensity of Adoption of Technology: A Double Hurdle Model Application in the Adoption of Sorghum Hybrid. *Journal for Studies in Economics and Econometrics* V20, n3 (November 1996): 49-57

Ninez, V. "Nature and Function of Household Gardens and Backyard Animals: General Considerations with Emphasis on Peru." Proceedings of Kansas State University's 1983 Farming Systems Research Symposium. Paper No. 6. Kansas State University, Manhattan, Kansas.

Omitti, J. M., K. A. Patron, J. A. Sinden, and S. K. Ehui. "Economic Contribution to the Subsistence Economy of Rural Households: the Case of Ethiopia." International Livestock Center for Africa (1995).

Pindyck, S. D.; and D. L. Rubinfeld. Economic Models and Economic Forecasts. McGraw Hill, Inc 1990

Pollack R. and J. W. Terrence "Estimation of the LES". *Econometrica*, Vol. 37, No4 (oct.1969) pp.611-628.

Poats, S. "The Role of Gender in Agricultural Development". *Issues in Agriculture* 3. CGIAR (Consultative Group on International Agricultural Research), Washington DC, USA.

Powell, J. M. and T. O. Williams. "An Overview of Mixed Farming Systems in Sub Saharan Africa. International Livestock Center for Africa. Technical papers, Vol. II Nov. 1993.

Prevatt, J. W.; L. L. Bauer, E. H. Kaiser, and P. J. Rathwell. "Measuring the Effect of Capital Structure and Seasonality on Expected Returns and Risk: the Fresh Market Vegetable Case." *South Journal of Agricultural Economics*, Experiment, Ga: the Association. July 1992. 24(1)171-78.

Quisumbing, A., L. R. Brown, H. S. Feldstein, L. Haddad, and C. Pena. (1996). Women. The Key to Food Security. Food Policy Report. Washington, D.C.: International Food Policy Research Institute.

Rakodi, C. (1988). "Urban Agriculture: Research Questions and Zambian Evidence". The Journal of Modern African Studies. 26:3 (1988) 495-515.

Rawlins, R. B. and D. J. Bemardo. "Incorporating Uncertainty in the Analysis of Optimal Beef-Forage Production Systems. "*Southern Journal of Agricultural Economics*, Experiment, 'Ga: the Association. July 1991. 23(1) 213-25.

Sadoulet, E.and A. de Janvry. "Quantitative Development Policy Analysis" 1995. The John Hopkins University Press, Baltimore Maryland.

Sanders J. H., I. B. Shapiro, and S. Ramaswamy. The Economics of Agricultural Technology in Semiarid Sub-Saharan Africa. The Johns Hopkins University Press. Baltimore and London.

Shapiro, B. I. and W. Brorsen. "Factors Affecting Hedging Decisions. *North Central Journal of Agricultural Economics*. Vol.10, No2, July 1988.

Shurie, B. and B. L. Erven. "Sensitivity of Efficient Frontiers Developed for Farm Enterprise Choice Decisions." *American Journal of Agricultural Economics,* 61(1979):506-11.

Singh, I., L. Squire, and J. Strauss. (eds) (1986). Agricultural Household Models: Extensions, Applications and Policy. The John Hopkins University Press, Baltimore MD.

Snauer, B., M. Garcia, and E. Jacinto (1988). "Determinants of the Intrahousehold Allocation of Food in the Rural Philippines." *American Journal of Agricultural Economics,* Vol. 70. No. I pp. 170-80.

Stone, R. "The Linear Expenditure System and Demand Analysis of Pattern of British Demand. *The Economic Journal*, Vol. 64 No 225 (Sep. 1954) pp.511-527.

Stoval, J. G. "Income Variation and Selection of Enterprises." Journal of Farm Economics, 48:1575-79, 1966.

Strauss, J. A. and D. Thomas. Human Resources: empirical modeling of household and family decisions. In Handbook of Development Economics, 1995, ed. T. N. Srinvisan and J. Behrman. Amsterdam: North Holland.

Swanson, E. R. "Variability of Yields and Income from Major Illinois Crops." 1927-53, *Illinois Agricultural Experiment.* Bul. 610, 1957.

Tauer, L. W. "Target MOTAD." *American Journal of Agricultural Economics*, 651983, pp. 606-614.

Teague, M. L. D., D. I. Bernardo, and H. P. Mapp. "Farm-Level Economic Analysis Incorporating Stochastic Environmental Risk Assessment." *American Journal of Agricultural Economics,* 54 Feb.1995, pp. 8-19.

Thiombiano, D. and M. Mattoni. "Characteristiques de 1'elevage de petits ruminants dans la ville de Bobo-Dioulasso et sa Peripherie." ATVM Vol. 11995, pp. 213-18.

Tinker, I. "Urban Agriculture is Already Feeding Cities" Cities Feeding People. IRDC (1994). Ottawa, On. Canada.

_____. "Feeding the Megacities. Urban Age:5:3 Winter 1998, pp. 4-7.

Vandeveer, L. R., K. W. Paxton, and D. R. Lavergne. "Irrigation and Potential Diversification Benefits in Humid Climates." *Southern Journal of Agricultural Economics.* Experiment, Ga: the Association.. 21(2) Dec. 1989, pp.167-74.

Vieth, G. R. and P. Suppapanya. "An Evaluation of Selected Decision Models: a case of Crop Choice in Northern Thailand." *Journal of Applied Economics*. Lexington, Ky.: Southern Agricultural Economics Association, 1993. Dec. 1996. 28(2): pp.381- 91.

Warde, B. Sampling Methods. Oklahoma State University (1990).

World Bank. World Bank Staff. Working Papers, (1986). No.559, P.25

APPENDIX

APPENDIX 1

ESTIMATED CORRELATION MATRIX

Partial Correlation Coefficients when Herd Size is Controlled

		HHAGE	HHSIZE	WPROCC	NYEXP	INCOME	HHOCC
HHAGE	cor.coef.	1	0.6013	0.0787	0.4506	-0.012	-0.2402
	deg. free.		(84)	(84)	(84)	(84)	(84)
	signif.(P)		0	0.471	0	0.913	0.026
HHSIZE	cor.coef.	0.6013	1	0.1011	0.4118	0.088	-0.2589
	deg. free.	(84)		(84)	(84)	(84)	(84)
	signif.(P)	0		0.354	.000	0.42	.016
WPROCC	cor.coef.	0.0787	0.1011	1	0.0884	0.0509	-0.2096
	deg. free.	(84)	(84)		(84)	(84)	(84)
	signif.(P)	0.471	.354		.418	.641	.053
NYEXP	cor.coef.	0.4506	0.4118	0.0884	1	-0.142	-0.637
	deg. free.	(84)	(84)	(84)		(84)	(84)
	signif.(P)	.000	.000	.418		.192	.000
INCOME	cor.coef.	-0.012	0.088	0.0509	-0.142	1	0.2473
	deg. free.	(84)	(84)	(84)	(84)		(84)
	signif.(P)	.913	.420	.641	.192		.022
HHOCC	Cor.Coef.	-0.2402	-0.2589	-0.2096	-0.637	0.2473	1
	Deg. Free.	(84)	(84)	(84)	(84)	(84)	
	signif.(P)	.026	.016	.053	.000	.022	

Variables: HHAGE, Age of Household Head;
HHSIZE, Household Size; WPROCC, ;
NYEXP, Number of Years of Experience With Agriculture,
INCOME, Income of Household,
HHOCC, Occupation of Household Head

Abbreviations: Cor. Coef. = Correlation Coefficient, Deg. Free. = Degrees of Freedom,
Signif. = Two Tailed Level of Significance

APPENDIX 2

INVENTORY OF LIVESTOCK IN KORHAGO AS ESTIMATED BY STREET SURVEY

	Sheep				Goats				Cattle	Poultry
Street	Female	Males	Kids	Total	Female	Males	Kids	Total	Total	Total
	Number of Animals									
Neighborhood: Air France										
1	44	5	12	61	41	7	5	53	0	53
2	55	10	14	79	36	8	15	59	0	57
3	35	13	20	68	46	12	17	75	0	50
4	69	8	18	95	54	21	17	92	7	89
5	69	20	20	109	64	9	14	87	0	63
Total	272	56	84	412	241	57	68	366	7	312
Neighborhood: Nouv quartier										
1	65	7	13	85	42	15	19	76	0	59
2	56	12	17	85	42	8	12	62	0	62
3	48	8	10	66	40	9	10	59	0	69
4	49	16	17	82	31	5	8	44	6	53
Total	218	43	57	318	155	37	49	241	6	243
Neighborhood: Dem										
1	109	15	21	145	81	15	16	112	0	93
2	62	13	15	90	44	7	12	63	9	73
3	31	4	10	45	23	9	8	40	0	45
Total	202	32	46	280	148	31	36	215	9	211

APPENDIX 2 (Continued)

	Sheep				Goats				Cattle	Poultry
Street	Female	Males	Kids	Total	Female	Males	Kids	Total	Total	Total
				Number of Animals						
Neighborhood: Koko										
1	66	11	9	86	50	9	11	70	0	77
2	62	12	21	95	77	19	9	105	12	96
3	65	11	6	82	64	11	15	90	0	92
4	64	10	13	87	54	17	15	86	0	73
5	71	10	12	93	42	9	9	60	0	76
6	54	15	9	78	45	18	24	87	0	65
7	66	10	24	100	42	4	13	59	0	82
8	55	12	9	76	47	12	14	73	0	55
9	74	13	14	101	45	18	16	79	4	60
Total	577	104	117	798	466	117	126	709	16	676
Neighborhood: delafosse										
1	65	4	10	79	61	5	11	77	2	63
2	43	5	7	55	57	2	3	62	0	64
3	63	3	9	75	62	6	13	81	0	64
4	42	7	19	68	56	4	10	70	3	72
5	88	7	21	116	64	10	21	95	0	95
6	72	4	5	81	64	13	11	88	0	80
7	82	4	11	97	61	12	0	73	0	93
Total	455	34	82	571	425	52	69	546	5	531
Neighborhood: Teguere										
1	55	8	13	76	34	8	11	53	0	59
2	38	9	8	55	51	10	17	78	0	66
3	39	8	15	62	46	8	0	54	0	61
Total	132	25	36	193	131	26	28	185	0	186

APPENDIX 2 (Continued)

	Sheep				Goats				Cattle	Poultry
Street	Female	Males	Kids	Total	Female	Males	Kids	Total	Total	Total
	Number of Animals									
Petit-Paris										
1	11	3	7	21	23	6	11	40	0	27
2	39	9	13	61	16	3	7	26	10	62
3	20	6	12	38	11	4	4	19	3	33
4	35	10	15	60	12	9	12	33	11	40
5	20	4	9	33	14	5	6	25	0	37
6	73	5	19	97	32	0	17	49	0	87
7	59	0	6	65	10	0	5	15	0	41
Total	257	37	81	375	76	27	40	207	24	327
Hsabougou										
1	93	5	14	112	91	2	12	105	6	133
2	155	19	17	191	100	10	14	124	20	150
3	160	18	25	203	58	12	23	93	25	206
4	172	18	35	225	96	20	31	147	11	244
5	75	16	26	117	59	13	14	86	15	103
6	81	5	31	117	56	9	17	82	0	158
Total	736	81	148	965	460	66	111	637	77	994
Banaforo										
1	90	12	16	118	69	24	24	117	4	88
2	60	10	15	85	43	6	17	66	0	61
3	60	19	37	116	77	20	27	124	8	83
4	71	14	15	100	61	13	17	91	3	73
5	86	4	8	98	53	14	14	81	4	90
6	112	18	28	158	116	4	7	127	21	123
Total	479	77	119	675	419	81	106	606	40	518

APPENDIX 2 (Continued)

	Street	Sheep				Goats				Cattle	Poultry
		Female	Males	Kids	Total	Female	Males	Kids	Total	Total	Total
		Number of Animals									
Soba											
	1	50	8	8	66	30	7	10	47	0	63
	2	39	5	9	53	33	3	9	45	0	2
	3	40	5	7	52	30	4	10	44	0	58
	4	40	5	11	56	35	4	9	48	0	53
	5	47	7	14	68	36	8	11	55	0	65
	6	47	5	14	66	30	8	14	52	0	50
	Total	263	35	63	361	194	34	63	291	0	291
Sinistre											
	1	72	5	11	88	49	7	9	65	0	49
	2	55	7	12	74	45	12	16	73	0	68
	3	55	18	24	97	60	6	17	83	10	65
	4	60	3	11	74	42	8	14	52	0	50
	Total	242	33	58	333	196	31	55	282	10	249

APPENDIX 3

SOCIO-ECONOMIC CHARACTERISTICS

HH#	hh age	hh gender	hh education	hhhnat	hhsize	hhhpocup	livestock	livestype	herdsize	livorientnyearexp	livecare	typekeepg	livcplemt	Income lv
1	55	1	1	1	2	1	0	0	0	0	12	0	0	0	15
2	42	0	1	1	6	4	0	0	0	0	0	0	0	0	345
3	56	1	1	1	5	1	1	1	42	4	10	1	1	1	195
4	37	1	1	1	8	1	1	1	8	3	5	1	2	1	167
4	37	1	1	1	8	1	1	4	23	3	5	1	2	1	167
5	66	1	1	1	26	1	1	2	15	3	10	4	2	1	20
5	66	1	1	1	26	1	1	3	10	3	10	4	2	1	20
6	69	1	1	1	10	1	0	0	0	0	25	0	0	0	6
7	42	1	1	1	13	1	1	2	34	4	15	1	2	0	275
8	28	1	1	1	1	1	0	0	0	0	9	0	0	0	177
9	30	1	2	0	5	3	1	2	11	3	2	1	2	0	44
10	38	1	3	1	5	3	0	0	0	0	0	0	0	0	255
11	28	1	3	1	4	2	0	0	0	0	0	0	0	0	670
12	60	1	1	1	6	4	0	0	0	0	0	0	0	0	1300
13	66	1	1	1	8	1	1	2	15	4	19	0	2	0	670
13	66	1	1	1	8	1	1	3	30	4	19	0	2	0	670
14	57	1	1	1	12	4	0	0	0	0	0	0	0	0	174
15	38	1	4	1	2	2	0	0	0	0	0	0	0	0	1375
16	50	0	1	1	9	1	0	0	0	0	35	0	0	0	170
17	50	1	1	0	5	4	0	0	0	0	0	0	0	0	350
18	65	1	1	1	14	1	0	0	0	0	50	0	0	0	370
19	41	1	2	1	7	4	0	0	0	0	0	0	0	0	180
20	53	1	3	1	12	3	0	0	0	0	2	0	0	0	550
21	75	1	1		24	1	0	0	0	0	6	0	0	0	390
22	41	0	1	1	6	1	0	0	0	0	25	0	0	0	86
23	65	1	1	1	20	1	1	2	60	3	30	4	2	1	1625
23	65	1	1	1	20	1	1	3	15	3	30	4	2	1	1625
24	40	0	1	1	5	4	0	0	0	0	7	0	0	0	370
25	55	0	1	1	3	1	0	0	0	0	5	0	0	0	47
26	92	1	1	1	10	4	1	2	22	1	30	4	2	1	160

APPENDIX 3 (Continued)

HH#	hh age	hh gender	hh education	hhhnat	hhsize	hhpocup	livestock	livestype	herdsize	livorient	nyearexp	livecare	typekeepg	livcplemt	Income lv
27	49	1	3	1	4	4	0	0	0	0	0	0	0	0	620
28	50	1	1	0	5	1	1	3	15	4	16	1	2	1	105
29	60	1	1	0	6	1	1	1	24	4	10	3	2	1	275
29	60	1	1	0	6	1	1	2	17	4	10	3	2	1	275
29	60	1	1	0	6	1	1	3	12	4	10	3	2	1	275
30	50	0	1	0	4	1	0	0	0	0	10	0	0	0	25
31	61	1	2	1	14	1	0	0	0	0	20	0	0	0	175
32	54	0	1	1	4	3	1	1	2	4	0	4	2	0	286
33	8	1	1	1	8	4	0	0	0	0	0	0	0	0	100
34	55	1	3	1	13	4	0	0	0	0	0	0	0	0	40
35	68	1	1	1	14	1	1	2	17	4	31	1	1	1	20
36	40	0	3	1	4	4	0	0	0	0	0	0	0	0	60
37	34	1	2	1	4	4	1	1	26	4	5	1	1	1	110
37	34	1	2	1	4	4	1	2	28	4	5	1	1	1	110
38	50	1	2	1	9	4	0	0	0	0	0	0	0	0	165
39	36	1	1	1	7	1	1	1	58	3	23	4	2	0	90
39	36	1	1	1	7	1	1	2	31	3	23	4	2	0	90
40	33	1	2	1	3	1	1	1	20	4	27	1	2	0	19
40	33	1	2	1	3	1	1	2	11	4	27	1	2	0	19
41	40	0	1	1	6	1	1	1	33	4	22	2	2	0	90
41	40	0	1	1	6	1	1	2	50	4	22	2	2	0	90
42	63	1	2	1	28	4	1	3	214	4	33	4	1	1	790
43	58	1	1	1	10	4	0	0	0	0	0	0	0	0	710
44	33	1	1	1	1	4	0	0	0	0	0	0	0	0	770
45	35	1	1	1	4	4	0	0	0	0	0	0	0	0	195
46	33	1	3	1	1	4	0	0	0	0	0	0	0	0	410
47	48	0	3	1	3	4	0	0	0	0	0	0	0	0	1700
48	23	1	3	1	1	4	0	0	0	0	0	0	0	0	17
49	33	1	4	1	2	4	0	0	0	0	0	0	0	0	910
50	55	1	4	1	14	4	0	0	0	0	6	0	0	0	900
51	59	1	1	1	21	1	0	0	0	0	21	0	0	0	1630
52	28	1	3	1	2	4	0	0	0	0	0	0	0	0	900
53	48	1	3	1	7	4	0	0	0	0	0	0	0	0	960

APPENDIX 3 (Continued)

HH#	hh age	hh gender	hh education	hhhnat	hhsize	hhpocup	livestock	livestype	herdsize	livorient	nyearexp	livecare	typekeepg	livcplemt	Income lv
54	27	0	2	1	1	4	0	0	0	0	0	0	0	0	544
55	48	1	1	0	7	4	0	0	0	0	0	0	0	0	185
56	42	1	1	1	6	1	0	0	0	0	25	0	0	0	570
57	37	1	2	1	7	4	0	0	0	0	0	0	0	0	180
58	50	1	1	1	4	4	0	0	0	0	0	0	0	0	90
59	46	1	2	0	5	1	0	0	0	0	10	0	0	0	408
60	60	1	1	1	10	1	0	0	0	0	20	0	0	0	180
61	60	1	1	1	2	4	1	2	7	4	1	0	2	0	240
62	53	1	2	1	4	4	0	0	0	0	0	0	0	0	680
63	30	1	3	0	2	4	0	0	0	0	0	0	0	0	625
64	31	1	4	1	1	4	0	0	0	0	0	0	0	0	590
65	39	1	1	0	8	4	0	0	0	0	0	0	0	0	1265
66	42	1	1	0	5	4	1	2	40	3	17	1	1	0	
67	40	1	4	1	5	4	0	0	0	0	0	0	0	0	680
68	33	1	2	1	3	4	0	0	0	0	0	0	0	0	630
69	31	1	2	1	3	4	0	0	0	0	0	0	0	0	406
70	33	1	1	1	9	4	0	0	0	0	0	0	0	0	610
71	37	0	3	1	6	4	0	0	0	0	0	0	0	0	159
72	41	1	4	1	7	4	0	0	0	0	0	0	0	0	1790
73	43	1	1	1	9	4	1	2	66	4	13	1	2	0	115
74	34	1	3	1	6	1	0	0	0	0	12	0	0	0	100
75	37	0	1	1	6	1	0	0	0	0	8	0	0	0	55
76	49	0	1	1	8	3	0	0	0	0	0	0	0	0	130
77	54	1	1	1	13	1	0	0	0	0	29	0	0	0	20
78	48	1	4	1	8	4	0	0	0	0	0	0	0	0	200
79	64	1	2	0	10	4	1	2	31	4	11	3	2	1	720
79	64	1	2	0	10	3	1	3	4	4	11	3	2	1	720
80	52	1	2	0	4	3	1	2	13	3	7	3	2	0	290
81	60	0	1	1	11	1	1	2	11	3	5	3	2	0	200
82	30	1	3	1	1	1	1	2	25	4	2	1	1	1	100
83	61	1	1	0	8	4	1	1	19	3	15	1	2	1	610
83	61	1	1	0	8	4	1	2	21	3	15	1	2	1	610
84	45	1	3	1	3	4	0	0	0	0	0	0	0	0	290

APPENDIX 3 (Continued)

HH#	hh age	hh gender	hh education	hhhnat	hhsize	hhhpocup	livestock	livestype	herdsize	livorientn	yearexp	livecare	typekeepg	livcplemt	Income lv
85	71	1	1	1	6	1	0	0	0	0	30	0	0	0	210
86	45	1	3	1	9	2	0	0	0	0	0	0	0	0	200
87	67	0	1	1	25	3	1	3	50	4	23	4	1	1	
88	41	1	1	1	10	4	0	0	0	0	0	0	0	0	70
89	63	1	1	1	32	4	1	3	790	4	0	4	1	1	1180
90	52	1	2	1	16	1	1	2	195	4		4	2	2	100

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date: September 13, 1999 IRB #: AG-00-041

Proposal Title: "URBAN LIVESTOCK PRODUCTION SYSTEMS AND FOOD SECURITY IN THE "ZONE DENSE" OF KHOROGO (NORTHERN COTE D' IVOIRE)"

Principal Investigator(s): A. Stoecker
Barry Mody Bakar

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Signature:

Carol Olson, Director of University Research Compliance

September 13, 1999
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

Mody Bakar Barry

Candidate for the Degree of

Doctor of Philosophy

Thesis: URBAN LIVESTOCK PRODUCTION SYSTEMS AND FOOD SECURITY IN THE "ZONE DENSE" KHOROGO AREA OF COTE D'IVOIRE

Major Field: Agricultural Economics

Biographical:

Personal Data: BARRY Mody Bakar was born in 1945 in Guinea. He received his bachelors degree form University of Abidjan in Abidjan, Cote d'Ivoire in 1973. He then attended the Institut Agronomique Mediterraneen of Montpellier (France) in 1976. He received a Doctorate of 3eme Cycle at the University of Montpellier I (France) in 1979. He also attended the Institut National Agronomique of Paris-Grignon (France), where he received the diploma of Animal Nutrition.

Education: Received Bachelor of Science degree in Agricultural Economics from Ho Chi Minh City University of Economics, Ho Chi Minh City, Vietnam in July 1989; received Master of Science degree in Agricultural Economics from Oklahoma State University, Stillwater, Oklahoma in December 1996. Completed the requirements for the Doctor of Philosophy degree with major in Agricultural Economics at Oklahoma State University in May 2000.

Experience: Since 1976, BARRY is working for the Ivorian Center for Economic and Social Research (University of Abidjan) as a livestock socio-economist. His first studies dealt with the improvement of the traditional livestock productions systems. Then he studied the socio-economic conditions of the settlement of foreign herders coming from neighboring countries. He has also worked with extension agencies in charge of livestock development programs in the Northern Ivory Coast, where his main interest was to identify the constraints to the development of draft power and the integration of crop and livestock in the production systems.