

ANALYSIS OF THE UTILIZATION AND IMPACT OF  
ANIMAL TRACTION IN KATSINA STATE, NIGERIA

BY

AKINWUMI MOSES OMOTAYO

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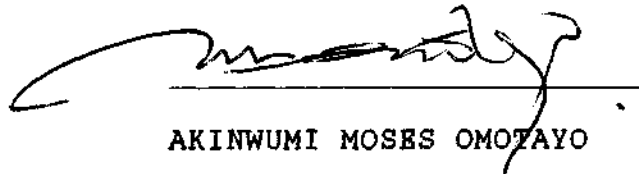
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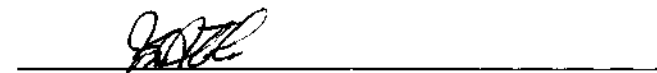
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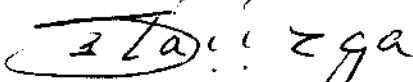
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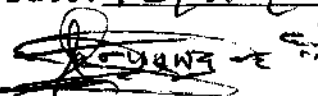
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\_\_\_\_\_  
Dr. T. K. Atala  
Chairman, Supervisory Committee  
Date: 15/10/96

  
\_\_\_\_\_  
Professor L.A. Ega  
Member, Supervisory Committee  
Date: 12/11/96

  
\_\_\_\_\_  
Dr. S.A. Ogunwale  
Member, Supervisory Committee  
Date: \_\_\_\_\_

  
\_\_\_\_\_  
Head, Dept. of Agricultural Economics and Rural Sociology  
Date: \_\_\_\_\_

  
\_\_\_\_\_  
Dean, Post Graduate School  
Date: 27/5/97

DEDICATION

This work is dedicated to:

- i. the memory of Peter "Bicycle" Omotayo, my father, who though never had the privilege of obtaining formal education, strongly believed in sound education as a first step in the struggle against poverty;
- ii. my mother, Elizabeth, who sacrificed a lot to see that I have a good education;
- iii. my wife, Folake, for her support and unlimited patience;and
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## ABSTRACT

This study assesses the utilization and impact of animal traction in Katsina State. One hundred and seventy farm households who were selected through a combination of purposive and systematic random sampling techniques were surveyed using both structured and unstructured interview techniques. Three distinctive types of farm households were identified, namely: households who owned work bulls and implements (independent users of animal traction), households who used animal traction but did not own the package (dependent animal traction users) and households who depended mainly on hoe cultivation (non-users of animal traction). Land tillage (ploughing and ridging) were the most common use to which animal traction was applied. Some farmers also used animal traction for weeding and carting. The use of cows for traction purposes was not known in the study area. Similarly the application of animal traction in driving stationary processes was not known.

The correlation and regression analyses showed that age, having training on animal traction, traction access status and farm size were positively and significantly related to the level of utilization of animal traction. On the other hand, off-farm employment, and education were negatively and significantly correlated with the level of utilization of the technology. Other variables such as

access to credit, ownership of cattle, extension contact, household labour capacity, leadership status and membership in associations were not significantly correlated with the level of use of the technology.

The study revealed that independent animal traction users recorded slightly higher average net incomes than both the dependent users and non-users of the technology. The regression analysis showed that the level of use of animal traction had a positive and significant impact on farm income. Similarly, the study showed that the use of animal traction had significant impact on control of resources within households. On the other hand, the regression analysis revealed that the use of animal traction did not have any significant impact on crop yield. Furthermore, the study showed that even though the average labour input per hectare was greater among non-users than the users of animal traction, there was no significant difference in the labour input per hectare among the Independent and Dependent user households.

Finally, a detailed examination of the animal traction knowledge system provided useful insights into the reasons for the low level of utilization of the technology and its trend of impact. Suggestions for improved utilization of animal traction include introduction and adaptation of weeding, seed drilling and harvesting animal drawn implements, introduction and

promotion of cow, donkey and camel traction, training blacksmiths in maintenance of animal drawn implements and the introduction of Animal Traction Hiring Units, by the ADPs and farmers organizations.

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**CHAPTER ONE**INTRODUCTION

Nigeria is largely an agrarian country. Over 70% of the population is believed to be engaged in agricultural production. During the pre-and immediate post-independence era, agriculture was the major foreign exchange earner. The country could then boast of self-sufficiency in food production as most of the food requirements were easily obtained locally without resorting to importation. During the oil boom era of the early seventies, agricultural production witnessed an unprecedented decline and local food supply had to be massively augmented with imported food items.

Apart from the neglect the agricultural sector suffered during the oil boom era, the inability of the sector to meet the food requirements for the whole country was often partly attributed to rudimentary levels of mechanization, which by itself was one of the consequences of years of neglect . Majority of the farmers are subsistence small-holders who depend mainly on family labour and utilize low-level mechanization inputs. The basic tools used by the majority of Nigerian farmers are hoes, cutlasses, axes and harvesting knives. In the northern part of Nigeria, however, draught animals are

used for land cultivation by a considerable number of farmers.

Draught animals were first introduced in 1922 in Nigeria by the colonial government to improve agricultural production, particularly the production of export crops like groundnut and cotton (Musa, 1990). The northern part of the country from latitude 12<sup>0</sup>N which is tsetse free and where there is a tradition of livestock keeping was then seen as a readily suitable area for such a technology. In the 1960s, Farm Training Institutions (FTI) were established in eight different locations in the northern parts of the country to train farmers on mixed farming technologies and the use of oxen for farm work. These locations were in the then Gongola, Borno, Kaduna, Sokoto, Katsina, Niger and Plateau States (Makanjuola et.al, 1991).

Whatever gains these initiatives should have brought then in terms of widespread use of draught animal technology was substantially curtailed by the lack of consistency and continuity in the mechanization policies adopted by successive administrations in the country. While the use of draught animals was being promoted through provision of credit facilities and veterinary services, state governments then introduced Tractor Hiring Units (THUs), administered by the Ministries of Agriculture and Natural Resources. Some THUs were also

operated by co-operatives and individual entrepreneurs. The THUs provided farmers with more efficient means of land preparation and therefore enjoyed greater patronage to the detriment of the development of draught animal power.

Also, during the oil boom era of the 70s, a number of programmes aimed at boosting food production in the country encouraged tractorization and ignored animal traction. Such programmes included Operation Feed the Nation (OFN) introduced in 1976, the National Accelerated Food Production Programme (NAFPP), introduced in 1973 and the Green Revolution Programme introduced in 1981.

The introduction of the World Bank assisted Agricultural Development Projects (ADPs) in the seventies and early eighties in Kaduna, Bauchi, Sokoto, Benue, Plateau, Kwara and Niger States was accompanied by massive importation of land clearing equipments and tractors. All these contributed towards stunting the growth of draught animal power utilization in Nigeria.

With the collapse of the oil market and a huge external debt burden, Nigeria's mechanization policy seems to have shifted in recent years in favour of animal traction since most of the THUs have folded up. The last five years has witnessed frantic efforts by the government to promote the use of animal traction in the northern parts of Nigeria. Efforts have also been made to

introduce the technology into areas where it has not been traditionally used. Most Northern states' ADPs have established workbull training centers and have extension components for the promotion of animal traction. For instance, Katsina Agricultural and Rural Development Authority (KTARDA) reported that a total of 140 farmers were trained between 1991 and 1993 on the use of animal traction at its two training centres at Tembu and Layin Minista.

Although, the spread of the technology has been relatively slow, it is estimated that there are currently over 200,000 workbull owners spread across the semi-arid areas of Nigeria (Musa, 1990). Evidently, animal traction technology has become a permanent feature of the farming systems of semi-arid Nigeria.

#### Statement of the Problem

A lot has been written on the benefits, actual and potential, of using animal traction (Phillip, et.al., 1988; Starkey, 1986; Anderson, 1985). First, animal traction is labour-saving per hectare as compared with hoe cultivation. For instance, Haswell (1979) showed that a man and his family with a pair of workbulls can handle 4 to 5 times the area of a hand-cultivated farm. In so far as animal traction use in agricultural production is for land preparation and not for other phases of crop production, the labour-saving aspect of animal traction

allows land-rich farmers to expand the area under cultivation. The extent to which this effect is important, again depends upon availability of labour for weeding and other field operations. Although it is argued (Kalkat and Kaul, undated) that all known farm operations i.e., land preparation, ridging, fertilizer application, weeding, planting, harvesting and threshing, can possibly be carried out with animal drawn implements, only the land tillage animal drawn implements seem to be popular with most Nigerian users of animal traction.

Another benefit of animal traction, though often disputed, is the fact that increases in yield per hectare is obtained when animal traction is used instead of hand hoe for land preparation. Barret, et.al. (1982) believed that higher yields result in the short run from better and more timely performance of tillage, and in the long run from improved soil fertility due to incorporation of manure and crop residues. However, Anderson (1985) argues that increases in yield as a result of land tillage with animal traction are mainly from experimental trials and that evidences from farmers' field do not support such claims. This argument notwithstanding, the ownership of animal traction does provide the farmer with the advantage of having access to organic fertilizer in the form of animal waste for improving soil fertility.

Other benefits associated with animal traction

include provision of meat or income to the farmer when workbulls have outlived their usefulness for traction purposes serving as means of transportation and for evacuation of manure, fertilizer, farm produce and other goods especially if the farmer owns a cart, and reduction in the level of drudgery often associated with traditional methods of land cultivation.

Moreover, studies have shown that the technology is profitable (Phillip, et al, 1986; Phillip, et al, 1990; Panin 1987). Nevertheless, the introduction of animal traction into a farming system and its full adoption almost invariably calls for several major changes in the traditional farming systems. Barret, et.al. (1982) listed the following as some of the changes that may accompany full adoption of animal traction in a farming system: (1) intensification of land use and maintenance of soil fertility; (2) changing the crop mixtures; (3) learning to manage large animals; (4) using new implements and agronomic techniques; (5) substantial borrowing to finance purchase of animal traction package; and (6) more dependence on outside institutions for input supply, repair and maintenance, animal health services, credit and extension advice.

However, not much is known about the actual effects of the introduction and use of the technology in any part of Nigeria. Although a few studies (Phillip, et.al, 1985;

Phillip, et.al, 1990) have attempted to document constraints to the adoption of the technology, none has undertaken a detailed and systematic analysis of the impact of the technology at the small-holder farm level in Nigeria. Katsina state is believed to have the highest concentration of animal traction users in Nigeria (Abubakar,1990).

The questions in this study therefore were:

- (1) what is the extent of use of animal traction in Katsina State?;
- (2) what changes in labour allocation (in time and tasks) are brought about within the household as a result of the use of animal traction;
- (3) does the use of animal traction create differential access to and control over resources such as land, labour, income, credit or capital, within households?;
- (4) what type of interactions prevail among institutions generating, disseminating and using the technology?

#### Objectives of the Study

The broad objective of the study is to determine the impact of animal traction on agricultural production in Katsina State. The specific objectives are to:

- (1) identify and describe the different kinds and extent of utilization of animal traction;

- (2) examine socio-economic and institutional factors which affect the use of animal traction;
- (3) assess the impact of animal traction on:
  - i. crop yields,
  - ii. farm income,
  - iii. allocation of family labour and access to and control of resources within households;
- (4) examine and describe the interactions and linkages existing among agencies generating, disseminating and utilizing animal traction technology; and
- (5) suggest, based on the findings, policy options and directions for more effective use of animal traction in Nigeria.

#### Justification for the Study

The introduction and acceptance of a new technology in a farming community inevitably bring about certain basic changes in the farming systems and in some cases, can significantly affect the inter- and intra-household processes within the community. Animal traction technology was introduced more than seventy years ago into the farming systems of the semi-arid areas of Nigeria and recently its promotion has been intensified. To date, most research have centered on the constraints to the adoption of the technology or the patterns of its diffusion in the area. Not much is known about the potential and actual

impact of the technology. Such vital information regarding the impact of the technology are necessary for better planning, more precise choice of promotion strategies and formulation of policy that could take care of the interests of majority of the farmers. Policy formulation on animal traction is presently hindered by the inadequate knowledge of the social and economic structure underlying the observed pattern of use of the technology. Within the policy environment for instance, views and policy pronouncements have been inconsistent over the years, ranging from full support, to introduction of projects and programmes that outrightly negate policy pronouncements. The inconsistency in policy seems to result from lack of reliable information on which to base an overall evaluation of problems facing agricultural production as it relates to farm mechanization.

This study is therefore expected to generate information that would provide a frame of reference for development planning and policy formulation more relevant to the needs of farmers. The study is also expected to provide a basis for further research on animal traction, and lead to specific theoretical synthesis in future work on social impact assessment in the area.

## CHAPTER TWO

### LITERATURE REVIEW

#### Introduction

This chapter contains relevant literature on the utilization and impact of animal traction. The chapter is divided into four sections. The first part discusses the various possible uses of animal traction, the second part looks at previous studies on the impact of animal traction, the third part highlights the constraints to the adoption of the technology, while the fourth part records the development and use of animal-drawn implements in Nigeria.

#### Uses of Animal Traction

The use of animal traction for different farm and non-farm operations dates back to pre-historic period in some parts of the world. In sub-Saharan Africa, however, the use of the technology is very recent, believed to be less than a century old (Thomas, et.al., 1990). The uses of the technology include, among others, its application in farming, driving stationary processes and transportation. In West Africa, the technology is applied largely in farm production. Thomas, et.al., (1990) argue that there are several constraints in diversifying uses of work animals and list four conditions to be satisfied in

applying animal traction to a wide range of uses, particularly stationary processes. These, according to them are:

- (a) the existence of processes that match the power output of one or two animals (equivalent to the power of between perhaps three to twenty human beings);
- (b) the presence of suitably trained and nourished animals;
- (c) the availability of equipment to inter-connect the animals and the processes to be driven; and
- (d) an overall favorable economic balance after the extra costs of equipment and feeding have been set against labour savings.

Apart from these, there are a lot of factors which influence the application of animal power to a wide range of uses. According to Kaul (1990) animal power, unlike, mechanical or electrical service is basically a biological system which can be influenced by many factors including temperature, humidity, time and duration of the work day, age, state of health, operator's control and a host of other factors.

There is a lot of research into how much power an animal can produce. Most of this research is oriented towards the use of work animals in farm cultivation. Table 1 shows the optimum tractive power and speeds of

various work animals.

Table 1: Draught Animal Power Outputs.

Animal	Body Weight Range	Approx. Draught (kg)	Average Speed (m/sec)	Working Day (hours)
Ox	500 - 900	60 - 80	0.6 - 0.8	5 - 6
Donkey	150 - 300	30 - 40	0.5 - 0.7	3 - 5
Cow	400 - 600	50 - 60	0.6 - 0.7	3 - 5
Camel	500 - 1000	50 - 90	-	-
Horse	700 - 900	60 - 90	0.8 - 1.00	-

Source: (Kaul, 1990)

Although the figures in Table 1 are believed to be probably based on large healthy animals and may not apply completely to African animals on normal African diet (Thomas et al, 1990) the limited application of animal traction to a wide range of uses particularly in Nigeria can be traced to factors other than size and power output of animals.

In Nigeria, the most common farm operation performed with animal traction is ploughing or ridging using the Emcot ridger. Some animals such as camels and donkeys are mainly used as pack animals. However, in certain areas where the terrain is amenable, the technology has been applied to pulling ox-cart. This is believed to be common in some parts of Kano, Bauchi and Katsina States (Musa, 1990).

Rural transportation is an area where animal traction

has not been widely applied in Nigeria. For instance, Adeoti (1990) found that the mode of travel in rural areas, in the proportion of trips by walking, animal, bicycle, motorcycle and 4-wheel vehicles were 54,3,23,12 and 9 per cent respectively. Animal mode of travel was the least utilized both in terms of trips frequency and total travel coverage. The unique advantage of animals in rural transportation especially for haulage of heavy loads over short distances include ability to traverse over unlimited terrain and on foot paths. Donkeys and Camels are used extensively in some rural areas in the northern parts of Nigeria for load carriage on their back. However, carrying load on the back limits the maximum quantity of load an animal can convey than if made to pull a cart mounted on wheels. Donkeys for instance can carry about 80 - 150kg of load and up to maximum of 200kg of grains per trip (Adeoti, 1990). Donkeys can pull 5 times the loads they carry on their backs (Musa, 1978) but require light carts and an access road.

The application of animal traction to weeding, despite its obvious benefits, is believed to be limited. Research on mechanization of weeding with animal-drawn implements shows that there is a significant savings in labour and time over hand weeding. For instance, while it takes between 4 - 8 hours per hectare to complete weeding with oxen-traction, it takes a man about 40 - 150 hours to

accomplish the same task (Musa, 1990). Although it is argued that animal traction can be applied to many more farm level operations such as planting, spraying, fertilizer application, and groundnut lifting, there is no record of such uses in any part of Nigeria (Kalkat and Kaul, undated).

Another dimension from which the diversified uses of animal traction can be viewed is the different types and sex of animals used for draught purposes. While horses and mules were known to be the major sources of farm power in the evolutionary mechanization process of countries in Europe and North America, oxen, buffaloes and elephants are known to play significant roles as draught animals in Asian countries. In most Sub-Saharan African countries, the oxen play a major role as draught animals. In Nigeria, a very insignificant number of horses are known to drive stationary sugarcane crushing machines particularly in Ikara Local Government Area of Kaduna State.

The use of female animals, particularly cows for draught purposes is not very common in Sub-Saharan Africa. Although a few cases have been reported in Gambia, (Sowe and Reed, 1990) and Ethiopia (Panin et al, 1987) there is no record of the use of cows for traction purposes in Nigeria. The use of cows for animal traction is believed to enhance efficient use of feed resources because the

farmer obtains milk and calves in addition to manure and work. In a comparative study of the farm level economic efficiency of cow traction and the traditional oxen-pair farm technologies in Ethiopian highlands, Panin and Broken (1993), reported that economic efficiency is higher in cow traction system than the traditional oxen-pair.

#### Constraints to Adoption of Animal Traction

A considerable number of studies have been carried out on constraints to the use of animal traction. Blench (1989) in a study on the social determinants of animal traction in central Nigeria indicated that lack of knowledge is a major cause of the failure to spread animal traction into some parts of the middle belt of Nigeria. The lack of knowledge of the technology may not be general in the area referred to as the sub-humid zone or central Nigeria. In the same study by Blench, it was found that some farmers had actually tried the technology and abandoned it at a stage for a number of reasons which include:

- a) diseases; not disease particularly associated with the humid zone (i.e. trypanosomiasis) but diseases such as contagious bovine pleuropneumonia (CBPP) and rinderpest;
- b) economic cost of traction implements and maintenance and inadequate availability of equipment; and

c) the presence of stumps.

Another study by Boyd and Ayok (1974) indicated that the use of too young animals, bought at low cost for a lucrative resale three to four years later is a problem. Age affects the size and weight of an animal. The size of an animal is a reflection of its pulling ability. It is expected that the bigger the size or weight of an animal, the higher the tractive force it will exert. Using very young animals therefore may reduce its efficiency considerably and discourage first time users of the technology from continuing with it, if performance falls short of expectation. Another study by Phillip, *et. al.* (1990) show that the purchase, hiring, maintenance and availability of traction implements are among the important constraints hindering the development of animal traction. The constraint of finance as it relates to development of animal traction is not surprising as it is a general problem in small farm development in Nigeria. Majority of farmers are small-scale producers with very low income. A pair of oxen, excluding implements may cost up to ₦24,000 which most farmers cannot afford.

The problem of feeding draught animals particularly during the dry season is one of the constraints often identified as limiting the development of animal traction. Poorly fed animals cannot be optimally used for draught

purposes. In addition to the energy used for maintenance, draught animals need extra food for production (Smith, 1990). Lawrence and Smith (1988) affirmed that with the best food and management, draft animals use an amount of energy equivalent to 1-7 times maintenance each day, whereas on poor quality food and management they consume only 1-4 times maintenance.

Most animals for traction purposes in Nigeria are fed on crop residues in the dry season and graze native forage in the rainy season. These crop residues are low in nitrogen and high in lignin or cell wall (Alhassan, et. al., 1983; Preston (1984). Because of the poor quality of available dry season feed for traction animals, some effort have been made in some states to teach work bull owners urea treatment of cereal crop residues which is also known as cru-process. In Kano State, between 1983 and 1988, more than 7,000 workbull owners were taught the technique of cru-process (Badawi, 1990). In promoting the cru-process programme pamphlets and video production on the technique were made available to extension staff who were required to carry the message to farmers. In addition, the Kano State Agricultural and Rural Development Authority also introduced the treatment of stovers with molasses and cultivation of fodder crops for dry season feeding of draught animals.

Even with these approaches to alleviating the problem of dry season feeding of work-bulls, some constraints were experienced in Kano state. These include: non-availability of inputs such as urea, polythene sheet and molasses for sale to farmers; high cost of inputs; water shortage; difficulty in digging the cru-process pit; and lack of credit facilities to enable farmers purchase bulls and implements (Badawi, 1990).

#### Impact of Animal Traction

The introduction and adoption of new farm technologies has different types of impact on households and the farming system in general. There are reasonable speculations that adoption of animal traction may bring about increase in area under cultivation, shifts in the cropping emphasis in favour of cash crops and to the detriment of food crop production, and shifts in labour input requirements among household members with women and children having to put in more hours of work. A few studies have confirmed some of these speculations. For instance, Westneat, et. al. (1988) reported that farmers who adopted animal traction in Togo increased the area of land they cultivate, support their food needs and "tend toward a progressive improvement in their quality of life". Similarly, Reddy (1988) noted that although studies have shown that there was no difference in yields and output per unit area between farmers using animal

traction and those not using it, animal traction use in Mali has generally led to an increase in areas cultivated.

Perhaps one of the most important issues often overlooked is the issue of the impact of the introduction, or the use of a particular agricultural technology on inter-and intra-household processes. Peters (1986) argued that different categories of members, i.e. men, women and children, within a farming household often have different, sometimes competing goals. This argument is supported by Jones (1986) in her findings in Cameroon in which the adoption of irrigated rice production which required a major reallocation of household labour resulted in women unwilling to participate in rice production because the proceeds were controlled by their husbands, largely for the husbands' own benefit. Also, introduction of new technologies in a farming system has been known to result in significant shifts in the labour requirement among men and women within the household. Savane (1986) found that the development of export crop production, mainly groundnut and cotton in Senegal resulted in the participation of women in various cultivation tasks such as sowing, weeding, clearing the fields, guard duty, harvesting and transporting of the produce, particularly for major food crops such as millet, sorghum and maize, while men concentrate on cash crop production.

In the same study in Senegal, it was found that women were excluded from agricultural work when tasks were mechanized. Similarly, in Cote d'Voire, Zana (1990) found that the widespread adoption of cash crops resulted in men working in the plantations that produce cash crops while women concentrate on subsistence farming. Animal traction technology is potentially capable of producing side effects similar to the ones discussed above among and within households. In another study in Northern Ghana, Panin (1987), concluded that although there was a major increase in average cultivated area per animal traction household, there was no significant change in the area cultivated per adult worker.

#### Development and Use of Animal Drawn Implements in Nigeria

The "Emcot" ridger which is the most common animal drawn implement in Nigeria today was introduced over fifty years ago. It was then manufactured by Ransomes in the United Kingdom, and imported mainly to be sold to cotton farmers in Nigeria by John Holt. The success of the product among draught animal users then led to the establishment of John Holt Agricultural Engineers Limited (JHAEL) in Zaria in 1966 which took over the manufacturing of the Emcot ridger without modification from its original form. Later JHAEL commenced the manufacturing of other ox-drawn implements such as the cultivator, the plough, the groundnut lifter, the weeder and the ox-cart. The

cultivator, weeder and groundnut lifter were designed and developed by JHAEL in 1972 in response to a request from the Ministry of Agriculture, Kano for new implements to ease the burden of the farmers in the area of groundnut production (Abubakar, 1990). However, because of low demand for these ox-drawn implements JHAEL stopped manufacturing them. Only the Emcot ridger which is in very high demand could be produced on a continuous basis by the company.

Historically, there have been some attempts to encourage farmers to adopt a whole package of animal drawn technologies in Nigeria. For instance, Musa (1990) reported that in 1928 three farmers were trained, each given a pair of work bulls, an ox-plough, a cultivator, an ox-cart and a cow for milk production and were settled on an 8 ha (20 acres) of plot at Shika to grow crops and rear livestock. The effort according to Musa (1990) recorded a spectacular success. During the same period, animal drawn implements for tillage, planting, fertilizer application and groundnut lifting were known to have been imported from Europe, Egypt, South East Asia, Canada and U.S.A. for testing in Samaru, Daudawa, Kano and Maiduguri farm centres.

In recent years, some international research centres, particularly the International Crops Research Institute for the Semi-arid Tropics(ICRISAT) have tested and

introduced more sophisticated animal drawn implements into the country. The independent 4 - row planter and fertilizer applicator is an example of these. There have been in fact, similar attempts to introduce some sophisticated animal drawn implements in the 1960s in Nigeria. Starkey (1986) reported that the National Institute of Agricultural Engineers (NIAE) designed tool carriers and French manufactured poly-culteurs were tested in Nigeria. As a result of the outcome of the comparative trials with tractors, single purpose ox-drawn implements and hand tools, these tool carriers were rejected because they proved more expensive per hectare than single purpose ox-drawn implements, and almost as costly as tractor cultivation (Starkey, 1986).

## **CHAPTER THREE**

### THEORETICAL FRAMEWORK

#### Introduction

The analysis in this study is premised on some theoretical and conceptual perspectives in social impact assessment. First the theory of social change is discussed, then the diverse view points and paradigms on impact assessment are considered and finally the conceptual perspectives adopted for the study are presented.

#### The theories of social change

Social change theory relates basically to what social change is, how it occurs, factors responsible for it and its impact or consequences. There seems to be a broad consensus among sociologists on the definition and the causes of social change. For instance, Rogers (1969) defined social change as the process by which alteration occurs in the structure and function of social systems. This definition is similar to that of Horton and Hunt (1980) who see social change as the transformation of social structures and social relationship in society. However, some have attempted to define social change by linking it to development. They argue that the concept of social change converges around the idea of development,

and that for development to take place in a society, all its structures, principally social, economic and political, should serve as stimulants to change. Etzioni and Etzioni (1976) reasoned that the mode of production in a social system determines the trend of change and development that occurs in a society. They stressed that if the economic foundation changes, the entire superstructure can be rapidly transformed. Several similar explanations have been put forward to explain the processes through which social change occurs. Four specific processes have, however, been consistently identified by social theorists, namely: discovery, invention, innovation and diffusion. Rogers (1969) broke down these processes into three steps: creation of new ideas and practices (invention); communication and spread of these new ideas (diffusion); and change occurring within the system as a result of the acceptance or rejection of the new ideas or practices (consequences or impact).

The foregoing brief description of social change shows clearly that the introduction of new practices to traditional farmers, acceptance and use of these new practices and their impact on farming and the farm household are elements of social change theory.

Perspectives in Social Impact Assessment

Although theoretical development in the area of social impact assessment is believed to be extremely limited (Murdock, 1979). An examination of social assessment research efforts has led to the identification of four major theoretical bases underlying such efforts (Leistritz and Murdock, 1981). These are:

- (1) The symbolic interactionist perspective
- (2) The conflict perspective.
- (3) The functionalist perspective.
- (4) The human ecological perspective.

The symbolic interactionist perspective emphasizes group actions and interactions and the mutual effects of individuals and groups on each other. The individual's perceptions and actions are seen as having substantial effects on group characteristics and in turn, as being affected by group characteristics. In the analysis of social impacts, the use of the symbolic interactionist perspective is believed to be particularly evident in those studies which assess the effects of development on individual behaviour, perceptions and patterns of interactions between and among groups (Leistritz, et. al., 1981). In the analysis of the impact of animal traction, the symbolic interactionist framework is useful as a guide for understanding the differentials in the individual and group choices and decisions with regards to farm

enterprise and crop combinations, among users and non-users of the technology. It is also relevant in explaining the differences in labour allocation and patterns of access to and control of resources between and among users and non-users of animal traction. The framework is also useful in analyzing the inter- and intra-household bargaining that accompany draft arrangements and the decision to invest or not in draft animals and equipments among households.

According to the conflict perspective, life involves a struggle for control of resources. Individuals come together to form interest groups to more effectively compete for resources. According to this perspective, the major groups between which conflict occurs include the social classes and economic ownership groups. In impact assessment research, the conflict perspective has been used in examining relative costs and benefits of an intervention. It has also been used in the analysis of the potential conflicts that may occur between various interest groups during project development (Fitzsimmons, et al, 1975). In the analysis of the impact of animal traction, this perspective provides the leads in explaining the possible competing and conflicting interests of household members with regards to application of labour and time for household farm production and for non-farm employment.

The functionalist perspective sees society as a system in which such basic elements as culture, individual personalities, and societal factors interactively determine the nature of the social system. These elements seek to perform such functions as adaptation, integration, goal attainment and the maintenance of total social pattern. Social structures and institutions are examined in terms of their roles in maintaining functions. Studies on the social effects of the processes of modernization, economic development among others, and studies examining the effects of an intervention on key functions and institutions often adopt the functionalist perspective. The functionalist framework provides useful guideline for analyzing the role of rural institutions such as the family and lineage structures, credit/work groups, blacksmiths and fabricators in the use and sustenance of animal traction. The analysis of the impact of the technology on the emergence or formation and maintenance of such similar rural institutions is also justified by this framework.

The human ecological perspective sees the most central human problem as the need to adapt to an ever-changing environment. The process of adaptation is believed to inevitably lead to some types of social interactions and organizational arrangements (Leitritz and Murdock, 1981). This perspective has been used in

assessing the impact of the application of technology to various environmental resource bases (Murdock, 1979). Although no cause-effect relationship has been established, the adoption of animal traction is often associated with increased farming intensity, deforestation and permanent cropping; all which can result in depletion of the environment and reduced ecological stability. The human ecological perspective provides a useful analytical framework for the study of the impact of animal traction on land use, soil conservation and fertility maintenance.

While these four perspectives are expected to provide some guidance in the study of the impact of animal traction, the central analytical focus will be the farm household production system. As suggested by Behnke and Kerven (1983), the acceptability of a farming technology cannot be adequately judged solely by its technical or economic impact on farming. It must also be assessed in terms of the prevailing production and knowledge systems affecting the use of the technology.

Thus, a theoretical perspective that focuses on household production system and the entire system that produces the knowledge used in agricultural production becomes expedient in analyzing the factors affecting the use and impact of animal traction. As noted by Ega (1990), the important thing to consider is the behaviour of people in their specific economic, social and political

contexts, which may mean simultaneously putting strong emphasis on actors and the system within which they operate. The concept of Agricultural Knowledge and Information System (AKIS) perspective presents such a framework within which the factors affecting the utilization and the impact of animal traction can be analyzed.

Agricultural Knowledge Information System (AKIS)  
Perspective

The AKIS perspective is the theoretical framework chosen for this study. The concept of an AKIS is not new. It has been discussed extensively in the literature under different names. Roling (1989) defined an AKIS as "a set of agricultural organizations and/or persons and the links and interactions between them, engaged in such processes as the generation, transformation, transmission, storage, retrieval, integration, diffusion and utilization of knowledge and information with the purpose of working synergically to support decision making, problem solving and innovation in a given country's agriculture or domain there of." Roling's definition of AKIS, simply put, are the links and interactions between all the agencies producing, disseminating and utilizing agricultural knowledge. The critical points of linkages and interactions are described by Long (1989) as the "interface". Box (1989) refers to AKIS as "sets of

interactions and communications between actors involved in different knowledge networks." The reference by Box (1989) to 'actors' in his description of knowledge systems agrees with Long's "actor oriented" and "Interface" perspectives for analyzing interventions in rural development.

Put in a layman's language what AKIS and Long's "actor-oriented interface analysis" are saying is that in order to understand the effects of an intervention and the circumstances surrounding the acceptance or use of the intervention, it is important to explore how different types of households, communities or groups develop strategies for dealing with the new circumstances engendered by the intervention and the interactions between the various organizations, agencies or "actors" responsible for generation, diffusion, dissemination and utilization of the intervention. This necessarily means exploring the interactions between research, extension and the farmer.

Historically, the research - extension farmer linkage system in Nigeria have been weak. Researchers have operated largely independent of extension and without due consideration for the actual needs, interests and individual ingenuity of farmers. Agricultural development has been seen as merely a way of demonstrating to the small farmers the benefits of modern scientific farming.

4gNot much cognizance was paid to the farming systems and the knowledge the farmers have accumulated over the years (Ega; 1990). Thus, technologies developed by research and promoted through the extension service recorded minimal adoption.

Development of animal traction in Nigeria suffered a similar fate. For instance, Starkey (1986) reported that during the 1960s, several wheeled tool carriers designed by the National Institute of Agricultural Engineering (NIAE) in Britain and French manufactured *polyculteurs* tested in Nigeria could not go beyond the stage of testing because the technology was too expensive and incompatible with the farming systems of the areas where animal traction was being used. Farming in the ox-using areas of Northern Nigeria where the technology was tested is based on ridge cultivation and the tools were designed for cultivation on the flat (Starkey; 1986). Similarly, a lot of effort has gone into designing, modifying and testing different kinds of animal drawn implements in Nigeria. Examples are the Emcot ridger, groundnut lifter and the cultivator of which only the Emcot ridger is popularly accepted among animal traction users. This is partly because researchers on animal traction, manufacturers of traction implements, extensionists and farmers worked as independent entities. It was a classical case of an AKIS that was not operating synergically.

Nevertheless, with the realization in recent times that farmers cautious attitude or lack of response to interventions may not be as a result of resistance to change, there has been some effort to understand the farming systems, encourage active farmer participation in the development process and explore the socio-cultural milieu within which the farmer operates. The adoption of Farming Systems Research (F.S.R.) in technology generation systems and the Training and Visit (T and V) system of extension are efforts in this direction. Currently in Nigeria, animal traction is being promoted within the framework of the T and V system in the ADPs and there have been attempts to analyze animal traction farming systems using the FSR approach. The Training and Visit extension system seeks to create regular information flows between research, extension workers and the farmers. Rolings (1989) argued that the Training and Visit system can be seen as a management tool for improving the interconnectedness of an AKIS components. Similarly, FSR with its interdisciplinary, participatory method for developing technology favours Long's 'actors-oriented' approach, so long as the "central source" of innovation mode of thinking is not the premise upon which the philosophy and practice of FSR are based. According to Biggs (1990) the "central source" approach to FSR assumes that technological and institutional innovations are

created or generated at "centers" and then transferred to less developed "peripheries". On the other hand, the political economy approach to FSR postulates that technology has multiple sources and that technological change does not necessarily follow hierarchical patterns but arises from multiple sources. Another fundamental feature of the political economy paradigm of FSR is its explicit recognition of the diversity of agroecological and socio-economic conditions in which the poor seek livelihoods (Biggs and Farrington; 1993).

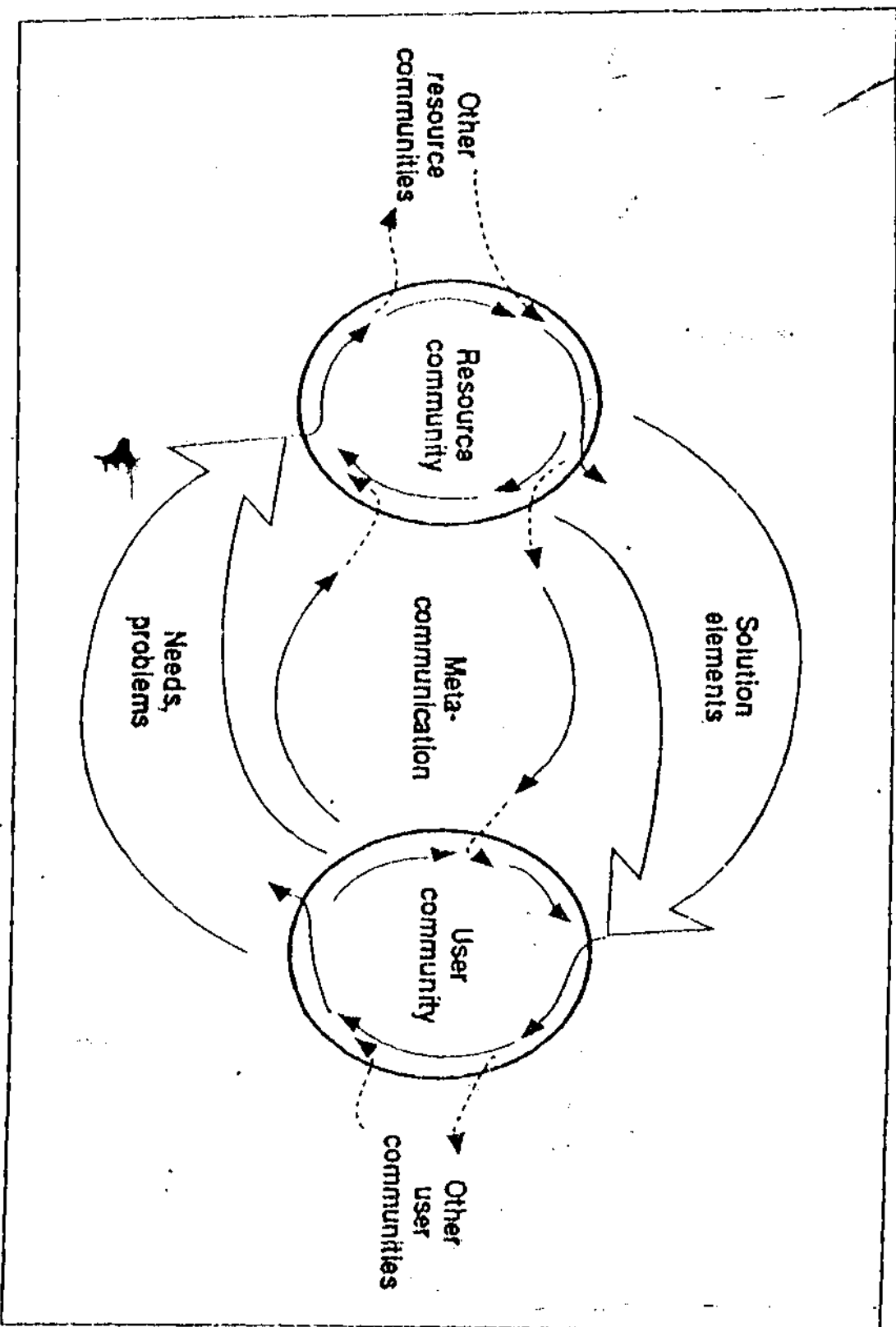
Clearly, the political economy approach to FSR is again, a way of improving the inter-connectedness of the AKIS. The question of whether or not FSR in Nigeria is based on the political economy paradigm is not an issue for argument in this analysis.

This study is not about farming systems method, neither is it a study of knowledge systems. The focus is on the use and impact of animal traction in Katsina state. Broadly, the study examines the factors affecting the use of animal traction and its impact on the farming system, household income, and how the relationships between the "user community" and the "resource community" (Havelock 1986) affects the use of the technology. A modified form of Havelock's model of the AKIS provides the analytical framework for the study. Havelock, (1986) in his model, distinguished between those who generate technology (the

resource community) and those who implement it (the user community), and went ahead to specify that the exchange of information between the two communities is crucial to successful generation and transfer of technology. Moreover, Havelock's model recognizes the farmer as a possible member of the resource community, as he\she too generates information and technology, and that scientists or researchers (resource community) may become users of information and technology, both from farmers and from other resource communities. In other words, the roles of the two communities are interchangeable. These two communities according to Havelock, must be linked by communication channels.

This framework was used to identify, interpret and evaluate data on factors affecting the use of animal traction and its impact in Katsina State.

Figure 1. A two-way model of the AKIS



Source: Adapted from Harvelock (1986). Cited in Roling, 1989.

## CHAPTER FOUR

### METHODOLOGY

#### The Study Area

This study was carried out in Katsina state which is one of the states in the semi-arid zone of Nigeria. The semi-arid zone of Nigeria stretches from about latitude 11°N at its southern most part to the Nigeria-Niger frontier. It encompasses the sudan and sahel savanna and part of the Northern Guinea Savanna. It is believed to constitute about 30% of the land area of Nigeria (Ojanuga, 1987). The area is hot for most part of the rainy season with a relatively cool dry season. The mean annual temperature is between 26 and 28°C. Rainfall in the area is highly variable, occupying a single rainy season. It starts around mid-April and lasts till October in most parts. The mean annual rainfall is between 1016mm in the wettest and Southern most parts and less than 508mm in the driest parts of the region. Upland soils which comprise over 95% of the total land of the area and lowland soils (Fadama) which are located near river basins and in valley or gully bottoms are characterized by high year round water table.

Katsina State was selected as the study area among the states namely: Kano, Sokoto, Kebbi, Borno, Adamawa, Bauchi, Kaduna and Yobe state, which fall clearly within the area described as semi-arid in Nigeria. The state was selected for a number of reasons;

- 1) the state has all the characteristics representative of the semi-arid climate, vegetation and socio-economic activities. This is the same as Kebbi, Sokoto, Borno and Kano;
- 2) Daura, the town where the technology was first introduced in Nigeria (Musa, 1990) is located in Katsina state;
- 3) the state is noted for having one of the highest concentration of animal traction users in Nigeria (Suleiman, 1989); and
- 4) the state has promoted the adoption of animal traction over the years and has intensified extension activities on it in the last five years.

TABLE 2: Average Rainfall Data During the Year 1993 as Compared to Same Year 1992 (mm) in Zones I & II of KTARDA.

	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
ZONE I	93	-	-	-	-	-	-	67.7	94.5	51.3	-	-	-	213.5
	1992	-	-	-	-	53.60	19.70	62.80	-	75.50	13.20	-	-	224.80
ZONE II	1993	-	-	2.5	7.5	119.2	70.0	176.3	219.5	133.4	-	-	-	748.1
	1992	-	-	-	88.90	51.0	167.7	234.4	251.8	265.3	-	-	-	1061.0
ZONE III		-	-	-	-	-	-	-	-	-	-	-	-	-
STATE														941.9**
**	1992	-	-	-	88.90	104.6	187.4	299.1	251.8	340.8	13.20	-	-	1285.8

NB: \* The zone lacks rain gauges for measuring rainfall data throughout the year.

\*\* State Figures reflect rainfall records from zone I & II only.

Source: Annual Report, KTARDA, 1993

### Sampling Procedure

The sample size for this study consisted of a total of 176 households selected through a combination of purposive and systematic random sampling techniques. The purposive random procedure was undertaken to include the following three categories of households in each community:

1. households which use animal traction and own workbulls and implements (Independent Users);
2. households which use animal traction but own neither the workbulls nor the implements (Dependent Users); and
3. households which depend entirely on hoe cultivation (Non-Users). These three categories of households were identified as the most common in all the farming communities in Katsina state during the preliminary survey and pre-testing of the survey questionnaire between May and July 1993.

The systematic random sampling procedure involved selecting every "ith" household from the lists of households in each community based on the three categories of households mentioned earlier. The systematic random sampling procedure is represented by the following equation:

$$i \text{ th} = \frac{I-D+N}{176}$$

where:

I=Independent Users

D = Dependent Users and

N = Non-Users

The systematic random sampling technique yielded the following results:

Independent users: 55 households

Dependent users: 55 households

Non - users: 60 households; Total=170

households

The households were selected from 16 villages of 4 Local governments areas, in Zones I & II of KTARDA. The villages and Local government areas were selected through simple random sampling technique. The break down of the sampled households and the villages where they were sampled is presented in Table 3.

# MAP OF KATSINA STATE SHOWING THE LOCAL GOVERNMENT AREAS AND THE VILLAGES

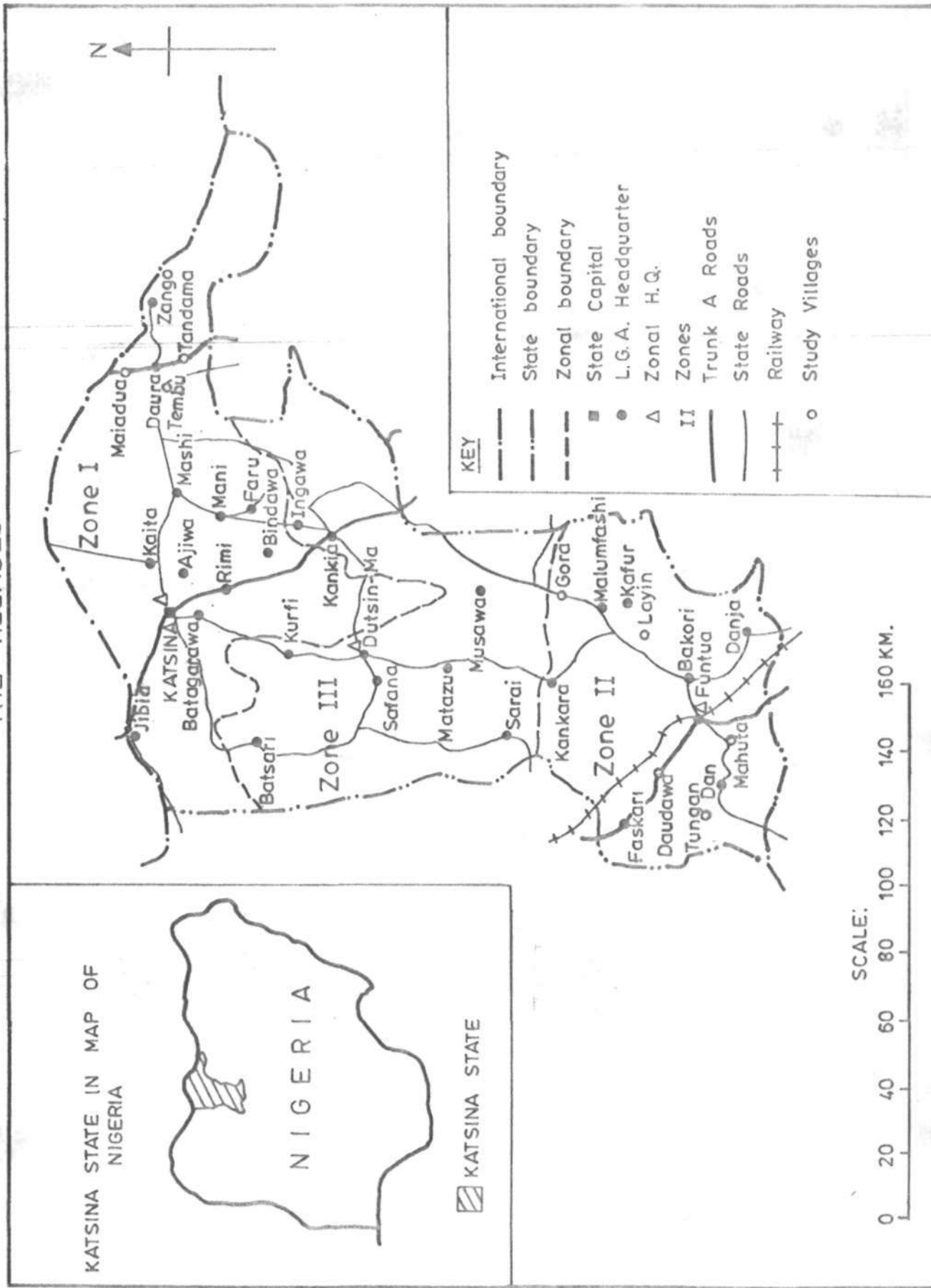


Table 3: Distribution of Sample by Zone, L.G.A. and Village

Zone	L.G.A	Village	Number of Independent Users	Number of Dependent Users	Number of Non-Users	Total
I	Zango	Zango	3	3	4	10
		Tandama	3	3	3	9
	Daura	Mai Adua	4	3	3	10
		Tembu	4	2	1	7
		Gari	4	0	1	5
		Faru	3	3	2	8
II	Jibiya			2	3	9
	Malumfashi	Gora	4	3	4	10
		Pabilago	3	1	1	6
				4	5	13
		Minista	4	5	5	14
		DanSarai	4	5	6	14
Funtua	Funtua	3	5	7	15	
	Tundun	3	5	5	13	
	Iya	3				
	Mahuta	3	5	5	13	
	Daudawa	3	6	5	14	
Total			55	55	60	170

Data Collection:

The field work for the study started in April 1992 and continued until early part of November of 1994. Questionnaires were designed and pre-tested in 1992, and modified before the commencement of field work in 1993. Two separate questionnaires were designed and used for collecting data from users and non - users. The data collected included socioeconomic characteristics of the

households, such as age distribution of household members, farm size, household size, crops grown, Labour use, educational level of household heads, non-farm income, ownership of cattle and other livestock. Other data collected were on various application of animal traction at farm and off-farm levels, records of input, yield of major crops grown and items to measure resource control within households.

#### Secondary Data Sources

At different stages of the study, several secondary data were utilized to provide both background information and other necessary information to achieve some of the objectives of the study. These sources were the annual and quarterly reports of KTARDA, technical reports such as lists of villages and households. The household listing used in this study is the one obtained from the Primary Health Care Project in the state.

Other sources are annual reports of the National Livestock Project Department (NLPD), The International Livestock Center for Africa (ILCA) Kaduna, National Animal Production Research Institute (NAPRI), Agricultural Engineering Department of the Institute for Agricultural Research (IAR), the National Agricultural Extension and Research Liaison Services (NAERLS), The Agricultural Policy document of Nigeria, John Holt Agricultural Engineers, Farmers Supply Company, Katsina, and the

records of the two Animal Traction Training Institutes at Layin Minista and Tembu. Documents such as the Central Bank annual reports were also consulted for information on current government policy on animal traction.

Informant Opinion:

Interviewing of some key informants provided useful information on the use of animal traction in the communities surveyed. Such informants included village heads and blacksmiths who provided useful insights into animal traction ownership structure, the important bargaining which accompany hiring-in or hiring-out of workbulls and the different types of arrangements for acquisition and maintenance of work animals and implements.

Discussion of the Variables.

The following variables were considered in the analysis: age, education, household size, total farm size, size of farm under cultivation, tenurial status, ownership of cattle, traction access status, access to credit, training on animal traction (AT), leadership status, available labour, extension contact on animal traction, level of use of animal traction, impact of animal traction.

Following Havelock's model of an AKIS, the farmer as a member of the "user community" of an AKIS on animal traction is the unit of analysis. The variables

considered here therefore relate to information obtained mostly from the household heads.

#### The Independent Variables

Age: This was measured in years as reported by household heads during the survey. Age is believed to be capable of influencing an individual's interests, perceptions, views and conduct. Age has been found to affect an individual's interest in adoption of innovations. It is believed that younger people are more adventurous, less risk-shy and therefore more favourably disposed towards trying new things. A few studies (Voh, 1979; Atala, 1981; Abalu, et. al., 1978) support this belief. However, a study by Panin (1987) on the use of bullock traction in northern Ghana found age to be positively related to adoption. Household heads using animal traction were found to be relatively older. This is explained by the fact that cattle was kept more for security than for farming and that it is most likely that household heads who control the cattle, release them for cultivation only when they (the farmers) are too old to use the hoe for seed-bed preparation. Although Northern Ghana and Northern parts of Nigeria have similar agroecological and socio-cultural characteristics, the circumstances surrounding the need to use animal traction may not be entirely the same.      A g e      i s

expected to be negatively related to the use of animal traction.

Education: Education refers to acquisition of knowledge through organized or formal means or through schooling. Educational level of an individual is usually indicated either by number of years in formal schooling or by educational certificates obtained or qualifications. Education is considered very important in the acceptance of new or innovative farm practices (Obibuaku and Osuji 1978). Generally, education is expected to enable farmers to have access to a diversified sources of information on innovations. For instance, educated farmers can collect useful information from written materials such as extension guides, bulletins, agricultural newsletters, Newspapers and other print media. A few studies (Osuji 1983), Monu, et. al., (1983) and Bongunjoko, (1983) have shown that there is a positive relationship between education and adoption of innovative farm practices by farmers. Similarly, Jagne and Patel (1981) found that literacy significantly improved farmers knowledge on improved practices. Education was measured by the total number of years of schooling.

Education is expected to be positively related to the use of animal traction.

Household Size: This refers to the total number of people in the household which includes the wives, children and dependant who reside within the same household and eat from the "same pot" (Hill, 1975). A household as defined here has the same meaning as a family unit. In most parts of Northern Nigeria, as it is in almost all parts of Africa, the extended family system has traditionally been prevalent. Defining the boundaries of a household or the household size has been problematic, because the traditional family systems are fast collapsing. It is therefore desirable to identify a single, distinct economic or sample unit representing a production decision-making unit (Kleene, 1976), which is in most cases synonymous with a consumption unit (Norman and Baker, 1986). The size of a household may affect the amount of family labour available to the household and the quantity of resources (e.g land, capital etc) available for agricultural production. Studies on innovation adoption have shown that there is a relationship between adoption and household size. For instance Clark and Akinbode (1968) found that family size was one of the variables important to the adoption of maize, cocoa and poultry improved practices in Western Nigeria. Similarly, Patel and Anthonio (1971) found that family size were related to the adoption of improved practices of tobacco. Panin (1987) in his study of the use of bullock traction

technology in Northern Ghana found that bullock households were larger than hoe households.

Household size was measured by the total number of people reported as members of the household at the time of this study. Household size is expected to be positively related to use of animal traction.

Farm Size: It refers to the area of land available to the farmer for cultivation. Farm size can have different effects on innovation use depending on the characteristics of the technology and institutional setting. The rationale for the differences in adoption behaviour between small farm and large farm operators is well documented in the literature. Possible explanations include:

- a) the greater access to scarce farm inputs and technical information which the relatively big farmers often enjoy;
- b) the economic advantages which bigger farmers have over the smaller ones; and
- c) the different orientations to risk aversion and profit between the two classes of farmers.

One of the often-mentioned constraints to adoption of new technology by operators of small farms relates to fixed costs attached to implementation of the technology. Some of the literature on adoption suggest that large

fixed costs cause a reduced tendency to adopt and a slower rate of adoption of new technology by small farmers. For instance, Weil (1970) found in Gambia that adopters of animal traction cropped larger areas and operated significantly larger farms than those using hand cultivation. Studies in Togo (Westneat et al, 1988; Reddy, 1988) had similar conclusions. Panin's (1987) study in Northern Ghana also concluded that the average area cultivated by bullock households was higher than the hoe households.

Farm size was measured in hectares. Farm size is expected to be positively related to the use of animal traction.

Land tenure: It Refers to the land ownership status of the farmer. Feder et al (1981) noted that some empirical and descriptive studies on the effects of tenure arrangements on adoption have not shown a clear relationship. For instance, they pointed to the study by Parthasarathy and Prasad in India which concluded that tenants had a lower tendency to adopt high yielding varieties (HYV) compared to owners although that nitrogen fertilizer use levels were the same for tenants and owners.

The conflicting empirical results regarding tenure relationship and adoption have been linked to the fact that a pure distinction is not usually drawn between pure

tenants (who own no land) and tenant - owners (who own at least some of their land). It has further been noted by Feder et al (1981) that any observed effect of tenancy on adoption may be indirectly due to the implied relation between tenure and access to credit, input markets, product markets, and technical information. It is therefore important to specify the terms of tenurial agreement explicitly and consider the underlying socio-cultural factors for empirical analysis. It is often assumed that security of tenure is not a problem among farmers particularly in the northern part of Nigeria. However, the study by Ega (1980) in Zaria area point to the existence of three distinctive stages in the evolution of land tenure; namely, the communal mode of production, the tribute paying mode of production, and incipient capitalism. He concluded that under the prevailing situation, the security of tenure of the farmer appears threatened as there was "evidence of socio-economic inequality and a likelihood of land speculation, land grabbing, and land concentration". Land tenure was measured by assigning weights to methods of land acquisition. Weights are assigned based on assumed relative security of method of land acquisition. For convenience of coding, the weighting is specified as follows; Purchased =4, Inherited =3, Gift=2, Lease or rent=1.

Ownership of Cattle: Ownership of cattle is expected to facilitate the transition from hand-hoe cultivation to animal traction. However studies carried out by the International Livestock Center for Africa (ILCA) along the "plough-line," that is, the boundry line between the semi-arid and sub-humid region of Nigeria, show that lack of cattle is not a factor for the non-use of animal traction in the area. Nevertheless, studies conducted in other parts of West Africa show that cattle ownership is more prevalent among AT households than non - AT households. For instance in Northern Ghana, Panin (1987) found that the average number of cattle per animal traction household was 17.3 compared to 1.5 per hoe household. Similarly, Bangura (1990) noted the non-availability of cattle for animal traction as a major constraint in the Sierra Leone Work Oxen Programme. In northern Ghana, Panin (1987) noted that nearly all animal traction households owned cattle before adopting the technology.

Ownership of cattle was measured by the total number of heads of cattle reportedly owned by the farmer. It is expected that ownership of cattle will be positively related to the use of animal traction.

Traction Access Status: This refers to whether a farmer owns workbulls and implements, or whether he borrows or hires them. The farmer who owns workbulls and implements

controls these resources and can use them at will. This is as against the farmer who depends on animal traction owners. The latter's decision to plough or ridge depends on availability of animal traction from animal traction owners.

Traction access status was measured by assigning 3 to Independent Users; 2 to Dependent Users; 1 to Non-Users.

Access to Credit: Access to capital in the form of either accumulated savings or credit is necessary in financing the adoption of innovations. Thus, differential access to credit is often cited as a factor affecting differential rates of adoption. This is particularly the case with a technology like animal traction which is not completely divisible, and requires a substantial initial investment. A number of studies have confirmed the role of credit in innovation acceptance. For instance, Fedder et al (1981) cited a study by Bhalla in India which reported that lack of credit was a major constraint for 48% of small farms and found only 6% of large farmers not using fertilizer. Similarly, studies in Nigeria have pointed to the differential access of farmers to credit as explanation for variations in adoption. The study by Monu, et al (1983) among cocoa farmers in Nigeria is an example.

On the other hand, some have argued that lack of credit is not a crucial factor inhibiting adoption of

innovations which are scale neutral. In Nigeria, promotion of animal traction in some states is accompanied by a credit package. Access to credit was measured by total amount of money borrowed in Naira in the previous farming season for farming related activities. Access to credit is expected to be positively related to use of animal traction.

Training on Animal Traction: Farmers need guidance and training particularly at the initial stages of animal traction utilization. Farmers without experience in working with draught animals need to be trained in order to acquire the necessary skills. Training of farmers should necessarily cover handling and management of draught animals, nutrition of draught animals, health, selection of work animals for training, implement selection, adjustment and maintenance. Farmers also need training on how to train animals for work. Training on animal traction was measured by the total number of days of training on animal traction received by respondents.

Leadership Status: The social status of a farmer is generally believed to influence acceptance or adoption of innovations. An individual's social status, either as a community leader, chief, compound head or village head, can enhance access to production resources such as land,

labour and capital. For instance, a study by Helga Vierich (1986) in Burkina Faso shows that among the Dagara-djula ethnic group, production units headed by compound leaders were, on the average, twice as large as those headed by ordinary household heads. All traction-owning production units were headed by compound leaders whereas only 11% of the units were led by ordinary household heads and the amount of cash involved in livestock transactions (sales and purchases) was far greater in production units headed by compound heads than the amounts involved in units headed by ordinary household heads. Leadership status was measured by assigning 2 to leaders and 1 to non-leaders.

Available Labour: Labour availability is one of the variables that affects the decision of farmers regarding acceptance of improved or new agricultural practices. It is believed that if a technology is labour saving its adoption might be encouraged by labour shortage. That is, households who do not have enough labour available for farm work might be encouraged to adopt a labour-saving technology. Animal traction is labour saving, can make for more timely farming operations, and allow increased production through expansion of areas to be cultivated. It has been argued however, that selective adoption of animal traction, for ridging or ploughing only, may

actually lead to increased labour demand for other phases of farm operations which are carried out manually (Starkey, 1990). Nevertheless the empirical work by Spenser and Byerlee (1976) in Sieria Leone points to the labour saving advantage of animal traction over manual cultivation.

Labour was measured in man-equivalents and household labour Capacity was computed using the weightings in Appendix D.

Extension Contact on Animal Traction: The role of extension in the different stages of adoption and diffusion of innovations is well documented in the innovation diffusion literature. Extension has a lot of roles to perform in creating awareness, demonstrating the benefits of an innovation and enlightening farmers on sources of input for sustained use of the technology. Generally, studies in different parts of Nigeria (Voh, 1978; Atala, 1984; Monu et al 1983; and Osuji; 1983) confirm the importance of extension contact in diffusion of innovations.

The variable was measured by the total number of times a farmer was visited in connection with animal traction as reported by the farmer.

Dependent Variables

Use of Animal Traction: Animal traction can be applied in various farm operations. These among others include ploughing, ridging, weeding, carting, harvesting, planting and water lifting. In Nigeria, however, it has been noted by Kaul (1989) that the technology is commonly applied in ploughing and ridging in several parts of northern Nigeria. However, the use of the technology for ploughing, ridging, weeding, seeding and carting has been promoted in recent years in almost all the ADPs in the northern parts of Nigeria. Use of the technology therefore refers to the different farm or non-farm operations performed by farmers using animal traction.

Impact of Animal Traction: This refers to the effect of the use of animal traction on farm income, crop yield, labour use and resource control.

Explanatory Notes on some Measurements:(a) Crop Yield

Yield of the six major crops grown in this area was obtained by using the local measurement instrument (the Tiya) to measure samples of these crops in three different locations namely; Daura, Jibiya and Malumfasi. Averages of the local measures obtained in the three locations were computed and converted into standard Units (Kilogram).

The criteria for conversion into standard units are presented in Appendix C.

Using the standard units, the actual yield of each crop reported in bags was converted by multiplying each standard unit by the total number of bags reported by each household.

(b) Labour: The labour data were collected from 30 households made up of 10 Independent users of animal traction, 10 Dependent users, and 10 Non-users. The data were collected through a weekly record kept by enumerators on each household throughout the 1993 and 1994 farming seasons. The number of households was scaled down to 30 to ensure that very accurate information about labour use and other transactions were collected and to enable the researcher effectively monitor and supervise the collection and recording of the data.

Measuring labour input of household members particularly, for households using animal traction was a problem because men and children from six years old and above were involved in various farm activities and tasks, from land preparation to harvesting. During land preparation, children commonly serve as handlers of draught animals. In some cases 2 or 3 children are involved at a time. Using man-hours looks inappropriate since both children and adults tend to possess equal skills in handling the animals and may spend the same

number of hours per day, accomplishing equal amounts of work. Nevertheless, during the latter stage of the field work, it was found that where animal traction is applied in weeding, only very experienced adult male handled the animals. It was therefore decided that Man - equivalent hours would be most appropriate since it was difficult to come up with a uniform weighting for labour. But then it became necessary to categorize the ages and the Man - Equivalents carefully since very young children are involved in almost all the households using animal traction. The categorization used by Metzger and Diehl (1993) was found most suitable. This categorization also includes criteria for determining household consumer units. This is presented in Appendix D.

(c)Livestock Units and Wealth Status: Livestock is kept by most farm households in the study area for various purposes. However, it serves mainly as a more flexible means of savings for most households than formal finance institutions like the bank. For instance, previous studies in this area indicate that cattle is kept by many households for the following reasons:

to meet expensive cash outlays such as funerals, marriages, sacrifices;

accumulate wealth  
 insure against extreme crop failures  
 insure against old age (Abalu et al., 1978; Balcet et al., 1982).

The quantity of livestock owned by each household can therefore be used as proxy for the wealth status of the household. However, since the value of each type of livestock differed widely, it became necessary to come up with a common unit of measurement for all the types of livestock reportedly owned by households. A conversion factor designed by Metzger and Diehl (1993) for tropical African countries was found suitable for this purpose. This is presented in Appendix E. To compute the wealth status of each household, the total livestock units possessed by each household was added together.

(d)Control of Resources: This was measured by including questionnaire items which require respondents to indicate who takes certain decisions about, and control some resources such as land, livestock, cash income, farm inputs, work bulls and farm produce. To analyze the responses require coming up with some composite indices of measurement. The following index was therefore derived for the purpose:

$$\text{HDEX} = \frac{P_1 * 1 + P_2 * 2 + P_3 * 3}{P_1 + P_2 + P_3}$$

Where HDEX = Control of resources index.

$P_1$  = number of respondents indicating that decisions and resources were controlled by household head only. The score = 3

$P_2$  = Number of respondents indicating that decisions and control were jointly done. The score = 2

$P_3$  = Number of respondents indicating that decisions and control were by household member other than household head. The score = 1

\* = Multiplied By

(e) Farm income. This was derived by adding together the total value of the yield of major six crops, dry season farm income and income from hiring out work animals and cart.

#### Statement Of Hypotheses.

Based on the discussions and the literature reviewed on each of the variables, it was hypothesized that there is a relationship between farmer's socioeconomic and institutional characteristics and the use of animal traction. The following sub- hypotheses were derived and tested:

Hypothesis 1: Age is negatively related to the level of use of animal traction.

Hypothesis 2: There is a positive relationship between educational level of farmer and the level of use of animal traction.

Hypothesis 3: Farm size is positively related to level of use of animal traction.

Hypothesis 4: Access to credit is positively related to level of use of animal traction.

Hypothesis 5: Having training on animal traction is positively related to the level of use of the technology.

Hypothesis 6: Ownership of cattle is positively related to the use of animal traction.

Hypothesis 7: Traction access status is positively related to the use of animal traction.

Hypothesis 8: Extension contact on animal traction is positively related to use of the technology.

Hypothesis 9: Household labour capacity is positively related to the use of animal traction.

Hypothesis 10: The use of animal traction has significant impact on crop yield, farm income, labour allocation, and resource control within households.

#### Data Processing and Analysis:

The data collected were checked for consistency. Subsequently the data were organized into different sections according to the objectives of the study. Each Section was then coded and analyzed using the Statistical Package for the Social Sciences (SPSS).

To achieve objective 1, which is to identify and describe the different kinds and extent of utilization of

animal traction, descriptive statistics were used. For objective 2, which is to examine socio-economic and institutional factors which affect the use of animal traction, correlation and the step-wise multiple regression analyses were used.

For objective 3, which is to assess the impact of animal traction, step-wise multiple regression analyses were also used. The following models were used for the correlation and multiple regression analysis to achieve objective 2;

$$1. \quad Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + U$$

where Y = Level of use of animal traction (Total number of farm operations with animal traction).

$X_1$  = Training on animal traction (number of days)

$X_2$  = Age of farmer (years)

$X_3$  = Income from off-farm employment (₦)

$X_4$  = Amount of money borrowed (₦)

$X_5$  = Membership of organizations/co-operations (total number of organizations and associations the farmer

belongs to)

$X_6$  = Household labour Capacity.

$X_7$  = Leadership status (2 for leaders, 1 for non leader)

$X_8$  = Total farm size (ha)

$X_9$  = Extension contact on animal traction (number of times)

$X_{10}$  = Ownership of Cattle (total number of heads of cattle owned)

$X_{11}$  = Education of farmer (years)

$X_{12}$  = Traction access status (Independent users = 3  
Dependent users = 2, non - users = 1)

$b_1$  to  $b_{12}$  = regression coefficients.

$a_0$  = constant.

$U$  = error term.

2. For objective 3, the following models were used for the multiple regression analysis.

a.  $Y_i = s_i + X_1 t_1 + X_2 t_2 + X_3 t_3 + X_4 t_4 + e$

Where  $Y_i$  = Total Value of crops produced in Naira

$t_1$  = Total Farm size under cultivation (ha)

$t_2$  = Cost of input in Naira

$t_3$  = Amount of money borrowed in Naira

$t_4$  = Total number of farm operations with animal traction.

$s_i$  = constant,  $X_1$  to  $X_4$  = regression coefficients,

$e$  = error term.

b.  $Y@ = d + X_1 a_1 + X_2 a_2 + X_3 a_3 + X_4 a_4 + e$

Where  $Y@$  = Gross farm income (₦)

$a_1$  = Total Size of Farm under cultivation (Ha)

$a_2$  = Income from off-farm employment (₦)

$a_3$  = Total amount borrowed (N)

$a_4$  = Total number of farm operations with animal traction

$X_1$  to  $X_4$  = regression coefficients.

d = constant, e = error term

$$c. \quad Y_f = \theta + X_1 c_1 + X_2 c_2 + X_3 c_3 + X_4 c_4 + X_5 c_5 + X_6 c_6 + X_7 c_7 + e$$

Where  $Y_f$  = Index of Control of resources

households

$c_1$  = Total household labour capacity (Man hours)

$c_2$  = Income from off-farm employment (N)

$c_3$  = Age of household head (years)

$c_4$  = Total farm size (Ha)

$c_5$  = Education of household head (Years)

$c_6$  = Animal traction access status (3= Independent users; 2= Dependent user; 1= Non-users)

$c_7$  = Use of animal traction (no of farm operations)

$X_1$  to  $X_7$  = regression coefficients

$\theta$  = constant, e = error term.

In all the cases, the step-wise regression technique was used and the linear functional forms of the regression models were found suitable for the analyses.

## CHAPTER FIVE

### FINDINGS AND DISCUSSIONS

#### Introduction

This chapter contains the results obtained from the data collected and analyzed for the study. The chapter is divided into five major sections. The first section presents information about the general characteristics of households in the study. The next section deals with the various uses of animal traction in the study area. The last three sections deal with factors affecting the use of animal traction, the impact of animal traction and the interactions and links among the subsystems of the animal traction technology system.

#### General Characteristics of Households

Table 4 shows the general characteristics of the surveyed households. Both users and non-users of animal traction had large household sizes of between 5 and 16 persons with a wide range of age distribution and a high level of illiteracy. About 24% of household heads of animal traction users and 7% of non-users were more than fifty years old.

In the animal traction user sample, 58% of household heads were illiterate while only 17% of non-user household heads were illiterate. The non-user households had lower

potential labour capacity (8.8 persons) than animal traction user households (9.2 persons).

Table 4: General Characteristics of Households

Characteristics	Animal Traction Users (N=110)		Non Users (N=60)	
	No	%	No	%
i. Age Category of Household Heads:				
Below - 29	2	1.8	2	3.3
30 - 39	22	20.0	24	40.0
40 - 49	36	32.7	16	26.7
50 - 59	24	21.8	14	23.2
60 and above	26	23.6	4	6.7
	Min=34; Max=68 Mean=43		Min=18; Max=42 Mean=27	
ii. Education of Household Head:				
Illiterate	64	58.2	10	16.7
Quoranic Education	18	16.4	24	40.0
Primary	12	10.8	12	20.0
WASC/Equiv	8	7.3	12	20.0
Above WASC	8	7.2	2	3.3
iii. Total Household Size:				
Below - 5	62	56.4	24	40.0
6 - 10	28	25.5	16	26.7
11 - 15	8	7.3	2	3.3
16 and above	12	10.9	18	30.0
	Min=4; Max=30; Mean=12.5		Min=2; Max=16; Mean=8	
iv. *Potential labour Capacity (ME)	7.2	32 (c.v)	8.8	29 c.v.
v. Total Farm Size Owned (ha):				
Below - 5	20	18.2	34	56.7
6 - 10	15	13.6	12	20.0
11 - 15	64	58.2	12	20.0
16 and above	11	1.0	2	3.31
	Min=2; Max=26; Mean=15.7		Min=1; Max=16; Mean=13.5	

vi.	Total Farm Size Under Cultivation (ha):				
	Below - 5	40	36.4	38	63.3
	6 - 10	20	18.2	12	20.0
	11 - 15	40	36.4	10	16.7
	16 and above	10	1.0	0	0.0
		Min=1.5; Max=16.5; Mean= 12.5		Min=0.3; Max=8; Mean=3.5	
vii.	Membership in Farmers Organization/Associations:				
	Below - 2	68	61.8	27	45.0
	Above 2	42	38.2	33	55.0
viii	Leadership Status:				
	Leaders	62	56.4	32	53.3
	Non-Leaders	48	43.6	28	46.7
ix.	Tenurial Status:				
	Lease or rent/borrowed	0	0	7	11.7
	Purchase	16	14.5	15	25.0
	Inheritance	94	85.5	38	63.3
x	Off-farm Employment:				
	Yes	62	56.4	45	75.0
	No	48	43.6	15	25.0

\* See Appendix D for explanation on Calculation of ME/h (Man Equivalent hours).

Table 5. Average Number of Cattle owned and Household consumer Units.

Characteristics	Animal Traction Users		Non Users	
	No.	CV	No.	CV
Average number of cattle owned	10.5	10	2.7	23
Household Consumer Units.	10.2	28	7.3	33

<sup>1</sup>C.V. = Co-efficient of variation.

Both user and non-user households had access to fairly large farm sizes. Generally, animal traction user households cultivated larger farm lands ranging between 3 ha and 28

hectares while non-traction households cultivated between 1ha and 13ha. While animal traction households cultivated over 80% of the total farm land they owned, the non-user households were able to cultivate only about 58% of their farm lands.

Farm sizes differed considerably when one moved from the southern part of the state to the northern part. Farmers, (both animal traction users and non-users) around Funtua, Malumfashi, and Faskari which are in the Northern Guinea Savanna Zone, generally cultivated lower farm sizes than farmers around Daura, Jibia and Zango, in the Sudano-Sahelian Zone. This trend could be explained as a strategy to contain the risk of crop failure. Crop failure is much more likely in the drier northern part of the state due to more erratic and unstable rainfall pattern than in the southern part. Another possible explanation is that land preparation in the southern part of the state could be more demanding as there would be need for land clearing, destumping and packing of cleared bush, which are usually not necessary in the northern part of the state. The data in Table 4 show that almost all households surveyed operated under relatively secure tenurial arrangements as most households owned the land they cultivated. Except for a few (12%) non - users who either borrowed or operated their land on a leasehold basis, all households either purchased or inherited the land they operated.

Although the potential labour capacity which was standardized to man-equivalents (ME) did not differ much among the two households, i.e users and non-users of animal traction, the same cannot be said of the consumer units which averaged 10 persons among users and 7 persons among non-users. Both households had similar spread of individuals who were either members or non-members of farmers organizations and associations. The associations indicated include co-operative societies, Farmers Congress, youth clubs and religious associations.

Non-farm employment was common among both users and non-users of animal traction. However, a larger percentage (75% as against 56.4%) of non-users were engaged in non-farm occupations. These occupations include trading, driving, bicycle repairing, blacksmithing, butchering, teaching and civil service job.

Cropping systems among users and non-users of animal traction

The dominant characteristic of the farming systems in the study area among both users and non-users of animal traction was mixed cropping. Cropping system in this study was therefore considered by identifying the major crop combinations and the spatial arrangements of the crops among users and non-users of animal traction. The result showed that a total of sixteen crops were grown in the study area. A wide diversity of crop mixtures emerged

from the results obtained from both users and non-users of animal traction. This diversity cuts across the whole of the study area. It therefore became necessary, for ease of analysis, to classify them based on the frequency of occurrence. Although up to at least twelve different kinds of crop arrangements/mixtures were found during the field work, three could be conveniently classified for analysis and these three were selected. The three were sole cropping, two crop mixtures and three crop mixtures. They are presented in Tables 6, 7, and 8 respectively.

Table 6 shows the distribution of households with regards to sole cropping. The Table shows that a larger percentage of animal traction users devoted more land area to sole cropping particularly in the cultivation of sorghum (10.5% for users and 6.7% for non-users), groundnut (users 12%, non-users 4%), Cowpeas (14.7% users, 7.5% non users), and Cotton (18.8% users and 6.8% for non-users)..

The co-efficient of variation in each case, for both users and non-users were quite low except for cotton which in the case of animal traction users was high (51%), suggesting that there was a more tendency among users of animal traction to grow sole cotton which is a cash crop than among non-users of animal traction. It also pointed to the relative importance of these crops in the cropping system adopted by users and non-users of animal traction.

Table 6: Percentage of Users and Non-Users of Animal Traction who Devoted Land to Sole Cropping.

Crop	Users		Non Users	
	%	C.V.	%	C.V.
Maize	5.2	27	1.1	12
Millet	3.2	32	2.5	15
Sorghum	10.5	11	4.7	27
Groundnut	12.3	12	3.6	10
Cowpea	14.7	21	4.5	38
Rice	1.2	38	0.2	34
Cotton	15.8	51	5.8	11

*C.V. is co-efficient of variation*

Tables 7 and 8 show that both users and non-users of animal traction had the tendency to grow crops in mixtures. However Table 8 shows that a greater percentage of non-users of animal traction grew crops in three mixtures than users of the technology except for the millet/maize/cotton mixture which recorded a greater percentage of animal traction users.

Cropping strategy had been explained from different perspectives by different researchers who studied crop mixtures in the northern part of the country. It has been attributed to a strategy for income maximization (Norman, 1975), risk avoidance (Abalu, 1976) and balanced nutrition (Abalu and D<sup>^</sup>silva, 1976).

Table 7: Percentage of Users and Non-Users of Animal Traction who devoted Land to Different Types of Two Crop Mixtures.

Crop Mixture	USERS		NON-USERS	
	%	C.V.	%	C.V.
Millet/Maize	20.0	10	16.2	15
Maize/Groundnut	12.2	38	13.5	22
Millet/Cotton	5.7	37	12.9	32
Millet/Sorghum	16.8	14	15.3	31
Maize/Cowpea	10.2	40	8.9	28
Maize/Cotton	1.5	12	0.8	23
Sorghum/Maize	16.5	18	12.7	22
Cowpea/Cotton	1.1	29	1.2	27
Millet/Groundnut	0.2	32	0.3	38

Table 8: Percentage of Users and Non-users of Animal Traction who devoted Land to Different Types of Three Crop Mixtures.

Crop Mixture	Users		Non-Users	
	%	C.V.	%	C.V.
Millet/Sorghum/Groundnuts	10.7	25	16.7	25
Millet/Maize/Cowpeas	15.6	28	20.8	38
Millet/Sorghum/Maize	25.2	29	22.3	41
Millet/Sorghum/Cowpeas	0.5	35	16.5	22
Sorghum/Groundnuts/Cocoyams	16.2	10	19.5	17
Millet/Sorghum/Peppers	18.5	8	22.8	18
Millet/Maize/Rice	3.2	35	8.5	14
Millet/Maize/Cotton	10.5	37	25	36

The nature of the variations in the number and types of crop mixtures by the users and non-users of animal traction in this study seemed to point to a more need for income maximization among the users of animal traction than non-users. This is evidenced in the relative proportion of animal traction users and non-users growing

their crops sole and the area of land devoted to cash crops.

A further articulation of the spatial arrangement of crops is necessary to shed more light on farmers strategy in adopting different kinds of mixtures. Balcet *et.al.* (1982) noted that it was misleading to talk about the existence of dichotomy between sole and mixed cropping in the norther part of Nigeria, pointing out that what existed was a continuum between the pure sole crop and the most complex mixture. Based on this reasoning, three types of spatial arrangements were compared between users and non-users of animal traction. These were, Sole row planting, interplanting on the same row, and interplanting between rows i.e. planting the second or third crops between the ridges of the earlier crop either in the furrow or on the side of the ridge. Table 9 shows the distribution of households according to their spatial arrangement of crops.

Table 9: Spatial Arrangement of Crops Among Users and Non- Users of Animal Traction.

Crop Arrangement	Users %	Non-Users
1. Sole Row Planting	100	67
2. Inter-Planting on same row	92	61
3. Inter- Planting between rows	08	19

Table 9 shows that while all animal traction users row-planted their crops only 67% of non traction households planted their crops in rows. Interplanting of crop mixtures on the same row was done by higher percentage of animal traction users (92) than non-users (81%). Similarly, interplanting between rows was more common among non-users (81%) than users of animal traction (8%). This situation could be explained from the point of view that row planting was common among animal traction users since ridges were made in rows and planting had to be done on ridges. Another possible explanation for this is that some animal traction users also used the technology for weeding and row planting was necessary for animals to be easily manoeuvred on the farm during weeding.

#### Diversified Uses of Animal Traction

The diversified uses of animal traction were examined from two major perspectives, namely; the various applications of the technology at farm and off-farm levels, and the various types and sex of animals utilized for traction purposes.

Before animals are used for any type of work, they are carefully selected and trained. Selection of animals for work was generally based mainly on age, size, sex, breed and health status. The breed of cattle usually selected for draft purposes in the study area included the

white Fulani and the Red bororo. The cattle for traction purposes were trained either by the farmer, his friends or any other experienced users of the technology. The age at which cattle was selected for training ranged between 2.5 to 3.5 years. The period of training reported by households ranged between 2 weeks and 6 weeks.

Table 10 shows the distribution of respondents with regards to age of cattle at selection for training and the duration of training.

Table 10: Age of Bull at Selection for Training and Duration of Training

Item	No. of Respondents (N=55)	Percentage
1. Age of Bull at Selection for Training		
2.0-2.4 years	10	18.2
2.5-2.9years	18	32.7
3.0-3.4 years	22	40.0
3.5 years and above	5	7.1
2. Duration of Training		
2 - 3 weeks	15	27.3
4 - 5 weeks	25	45.4
above 5 weeks	15	27.3

Male animals (Bulls) were used mainly for traction purposes. Although donkeys were very common and to some extent camels particularly in the northernmost parts of the state, they were mainly used as pack and transport animals. Camels and donkeys were usually selected and trained for work purposes when they were between the age

trained for work purposes when they were between the age of 2 and 4 years. Three distinct types of Camels and 5 types of donkeys are common in the study area. Around Daura, Maiadua, Zango and Jibiya, the following types of camels were identified as the most common Bakinburi, Ja and Taguwa. In both Zones I & II which constitute the study areas the following types of donkeys were commonly identified: Bakinjaki, Goho, Jangora and Gwambaza.

Table 11 shows the age of Camels and Donkeys at selection for training and duration of training.

Table 11: Age of Donkeys and Camels at Selection for Training and Duration of Training.

Item	No of Respondents (N=55)	Percentage
1. Age of Camel and Donkeys at Selection for Training (years)		
2.0-2.4 years	5	0.1
2.5-2.9 years	10	18.2
3.0-3.4 years	10	18.2
3.5 years and above	30	63.5
2. Duration of Training		
4 - 6 weeks	25	45.4
7 - 8 weeks	10	18.2
9 - 10 weeks	12	21.8
Above 10 weeks	8	14.6

The age at which animals were selected for training and the duration of training differed from one community

to the other depending on the predominance and intensity of use of animals for transport and pack purposes. In communities where animals were intensively used for such purposes, animals were selected at relatively younger age and the training lasted for a shorter duration than communities with less intense use of the practice. This is perhaps due to the fact that in communities where there were extensive use of animals for work, there were more experienced trainers of the animals than in other communities with less use of animals for work purposes. Trained draft animals were used for a host of farm activities. These included ridging, ploughing, weeding and carting. Table 12 shows the distribution of households according to the various farm-level uses of draft animals.

Table 12: Distribution of Households According to the Various Farm Level Uses of Draft Animals

Activity	Independent Users (N=55)		Dependent Users (N=55)	
	No	%	No	%
Ploughing	10	18.2	3	5.5
Ridging	55	100	55	100
Weeding	38	69.1	12	21.8
Carting or Transport	22	40.0	8	14.5
Groundnut Lifting	3	5.5	0	0

The data in Table 12 show that while all Independent and Dependent Users apply the technology in ridging, very few of both groups of users apply the technology in ploughing and groundnut lifting.

About 69.1% of the Independent users apply the technology in weeding while only 21.8% of the Dependent users weed with draft animals. This is expected because the independent users have access to the technology and can use it any time and for any purpose they consider necessary. In addition, the application of draft animals in weeding require considerable skill and experience which only those who owned the technology and control it possessed. The dependent users on the other hand could only use the technology when the "owner Controllers" were ready and willing to release it.

The length of time taken to complete weeding varied from location to location and this depended on the experience of the handlers, the density of weed and crop spacing and how well trained the animals were. Table 13 shows the average time taken to complete weeding and ridging in four locations in the study area.

Table 13: Average Time Taken For Ridging and Weeding Using Draft Animals in 4 Locations in the Study Area.

Location	Time For Completing Tasks (Hours/ha)	
	Ridging	Weeding
Funtua	80.2	88.0
Malumfashi	81.1	85.2
Daura	78	69.3
Jibiya	76.5	72.5

The data in Table 13 show that using draft animals for weeding required between 69 and 88 hours per hectare. It has been estimated that it requires about 132 hours per hectare to accomplish the same task manually (Twomlow, 1994). It has also been argued that a similar task could be accomplished at the rate of 68 hours per hectare if the proper cultivator or weeder is used.

Carts were used extensively particularly in the northern most part of the state. Most of the carts are wooden-framed, fitted with roller bearings and pneumatic tyres. There were a few steel-framed carts mainly adapted from disused pick-up vehicles. The carts were used mainly for transporting farm produce, fertilizer, manure, water and all types of household items.

Throughout the period of the survey, the application of animal traction technology in driving stationary processes such as grinding mills and water-lifting devices were not found in any part of the state. Also, the use of cows for draft purposes was not reported by any of the

households. Reasons given for not using cows as draft animals as stated by the respondents included:

- i. Cows are mainly for reproduction and milking
- ii. Cows cannot be used for draft purposes
- iii. Work will interfere with the productive capacity of the cow
- iv. It is against our culture to use cows for draft purposes
- v. Cows are smaller in size than bulls and therefore have little draft power
- vi. Cows cannot be trained for work because they are more temperamental
- vii. I have never seen cows used for work.

The last reason most accurately described the problem about the use of cows for draft purposes in the study area. Most farmers were not aware of the possibility of using cows and the advantages inherent in them for draft purposes. These include; provision of milk and milk products for the households and possible utilisation of the animal for other purposes especially during off seasons. Mathewman et al(1993) noted that cows are used where land and food resources for ruminants are scarce. In Bangladesh, up to 50% of draught animals are cows (Mathewman et al 1993). Other advantages of using cows for work as highlighted by Smith (1981) include the following;

- i. male animals can be slaughtered at a more optimum time.

- ii. draught cows, when they produce milk and calves are capable of using food energy more efficiently than oxen.
- iii. the total number of animals needed to maintain the draught herd is significantly lower than when oxen are used.

The bargaining which accompanied draft arrangements among Independent and Dependent users varied considerably. Such arrangements included borrowing, lending at a monetary cost, and lending at a cost in kind. The type of arrangement depended on the relationship of the parties involved in the transactions. If the dependent user was a member of the extended family he could borrow work animals and implements at no cost. If the dependent user was a friend, the arrangement could be at a cost in monetary terms or the dependent user was made to pay in kind. Cash payment ranged between N N100 and N350 per hectare. Payments in kind varied a lot, and in most cases were quite personal. These included providing labour for various farm activities such as planting, fertilizer application, pledging a percentage of grains harvested from the farm, exchange of draft work with certain quantities of fertilizer, and repair of draft implements particularly if the dependent user was a blacksmith.

Factors Affecting the Utilization of Animal Traction

It was hypothesized that socioeconomic and institutional factors were related to the use of animal traction. The hypotheses stated in the methodology were tested using correlation and regression analysis. An alpha level of .05 was established *a priori* for determining the significance of the correlation and regression coefficients. The pooled within - group correlation matrix is presented in Table 14.

Age of Household Head

It was hypothesized that age was negatively correlated with level of use of animal traction. The data in Table 14 show that age was moderately, ( $r = .39$ ) positively correlated with level of use of the technology. The correlation coefficient was not significant. Similarly, the regression coefficient in Table 15 was not significant. This implies that older farmers use the technology more than younger farmers. This finding, though not consistent with many findings on innovation adoption studies in Nigeria, (see for instance Atala, 1981; Voh, 1979 and 1982) could be explained from the point of view that older farmers controlled the cattle owned by the household and used them for traction purposes as they wished. This point of view is supported by the fact that ownership of cattle was slightly, ( $r = .47$ ) but not significantly correlated with

the level of use of the technology. The finding is also similar to that of Panin (1986) in Northern Ghana which concluded that age was positively correlated with the adoption of Bullock traction technology. The hypothesis that age was negatively correlated with level of use of animal traction was therefore rejected.

Table 14: Correlation Matrix on The Relationship Between Level of use of Animal Traction and Socio-economic and Institutional Variables

Y	(N=170)											
X1	.382*											
X2	.392*	.167										
X3	-.536*	.093	-.186									
X4	.158	.621*	-.039	.070								
X5	.208	.159	-.125	.023	.172							
X6	.019	.105	.078	-.026	.325	.017						
X7	.147	.211	.136	-.061	.086	.120	.225					
X8	.856*	.410	.704*	.112	.021	-.521	.019	.431				
X9	.276	.732*	.161	.138	-.814*	.057	.105	-.211	.112			
X10	.272	.203	.702*	.030	.247	.206	.623*	.411	.572	.311		
X11	-.677*	.011	.673*	.015	.092	-.093	.276	.132	.322	.511	.212	
X12	.229	.175	.441*	-.504	-.521*	.099	.322	.203	.521	.322	.212	.311
		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11

\*:  $P < \text{or} = .05$

Where Y= Total number of farm operations with animal traction  
 X1= Training on animal traction  
 X2= Age  
 X3= Income from offfarm employment  
 X4= Access to credit  
 X5= Membership of associations  
 X6= Household labour capacity  
 X7= Leadership status  
 X8= Total farm size  
 X9= Extension visit  
 X10= Ownership of cattle  
 X11= Education  
 X12= Traction access

Table 15: Results of Multiple Regression Analysis to Determine Factors which Influence Use of Animal Traction

Independent Variable	Regression Coefficient	Standard Error	t-Value	Level of significance of t-Value
Training on Animal Traction	.9926	.3028	3.279	.0014**
Age	.01977	.0124	1.579	.113
Income from off farm	-1.6498	8.282	-1.992	.049*
Credit	1.9316	1.3247	1.458	.148
Membership of associations	.2507	.2425	1.034	.304
Household labour capacity	.007403	.05018	.148	.883
Leadership status	-.6358	.2775	-2.291	.0241*
Total farm size	.0213	.0094	2.255	.026*
Extension contact	8.0327	.0071	.010	.992
Ownership of cattle	.0108	.0081	1.522	.131
Education	-.0504	.0282	-1.783	.077
Traction access status	5.0568	5.6047	0.902	.024*
Constant	.6464			
F-ratio	5.9859			
R <sub>y</sub>	.6523			
R <sup>2</sup>	.4255			
Adjusted R <sup>2</sup>	.3544			

Dependent variable is the total number of farm operations performed using animal traction.

\*\* = t is significant at .01 level

\* = t is significant at .05 level

Training on Use of Animal Traction:

It was hypothesized that having training on animal traction was positively related to the level of use of the technology. Both the correlation ( $r=.38$ ) and regression coefficients (t-value significant at .01) with regards to this variable were positive and significant as shown in Tables 14 and 15 respectively. This positive correlation was expected, since having training on the use of the technology might encourage the farmer to acquire the animal traction technology package. The type of training provided to the farmers at the two training centers in Katsina state also exposed them to how they could obtain loan to acquire work bulls and implements. It was therefore no mere coincidence that access to credit was highly positively correlated ( $r=.62$ ) with training on animal traction as shown in Table 14.

Off-Farm Employment

It was hypothesized that having off-farm employment was positively related to level of use of animal traction. The data in Table 14 show that income from off-farm employment ( $r= -.536$ ) was negatively related to level of use of animal traction ( $r= -.54$ ). Similarly the regression coefficient as shown in Table 15 was significant (t-value significant at .05 level) and negatively related to use of animal traction. This was contrary to expectation as it

was assumed that having other sources of income other than from farming would expand a farmer's resources and enable him acquire the technology more conveniently than a farmer without off-farm income. The scenario presented by the data in Tables 14 and 15 with regards to off-farm income could be explained from the perspective that individuals with jobs other than farming might not be willing to invest their resources in acquiring animal traction technology package, more so if farming was practised as a secondary occupation. This point of view is reinforced by the fact that the data also show that Traction Access Status was highly and negatively correlated with income from off-farm employment ( $r = -.60$ ). This implied that individuals with low income from off-farm employment were much more likely to own their own work bulls and implements than individuals with high income from off-farm employment. Given the widespread use of the technology particularly in the area where this study was carried out, it was always generally believed that most serious farmers used the technology. The hypothesis that having off-farm employment was positively related to level of use of animal traction was therefore rejected.

#### Access To credit

It was hypothesized that access to credit was positively related to use of animal traction. Access to credit had very low correlation with level of use of the

technology( $r=.16$ ). The regression coefficient was also not significant as shown in Table 15. This may be due to the fact that very few farmers (less than 20%) of both users and non-users of the technology, benefited from credit schemes in the study area. Access to credit was expected to make it easy for the farmer to acquire the technology. The few farmers who benefited from credit schemes obtained loan from the Nigeria Agricultural and Co-operative Bank (NACB) and other Commercial Banks. Contrary to expectation, none of the respondents cited Community Banks or People's Bank as their sources of credit. This implied that neither the Community Bank nor the People's Bank was performing the expected role of provision of credit in the agricultural sector particularly in the areas where this study was carried out. The hypothesis that access to credit was positively related to use of animal traction was therefore rejected.

Total Farm Size:

It was hypothesized that total farm size was positively related to use of animal traction. The data in Table 14 show that farm size was highly correlated with level of use of the technology( $r=.86$ ). Similarly the regression coefficient in Table 15 was positive and significant at .05level. The explanation for this may be that individuals with large farms required much more labour for land preparation and other phases of farm work and therefore

had the need to invest in the technology. Another possible explanation could be that the use of the technology allowed farmers to expand the areas of land they cultivated. It may also be that users of animal traction also controlled other production resources such as capital and cattle which made it easy for them to acquire the technology. This argument was supported by the fact that the data in Table 14 also show that there was a high correlation ( $r=.57$ ) between ownership of cattle and farm size.

#### Education of Household Head

It was hypothesized that the education of household head was positively related to level of use of animal traction. The data in Table 14 show that education was highly and negatively correlated ( $r=-.68$ ) with level of use of the technology. The explanation here is that farmers with less education used the technology more than the others. Although this finding on the relationship between level of education and level of use of animal traction failed to agree with previous findings by Monu et al(1983), Voh (1982) and Atala (1981) on innovation adoption in Nigeria, it clearly highlighted the fact that having formal education may not always be a factor in innovation adoption. The hypothesis that education was

positively related to use of animal traction was therefore rejected.

#### Membership in Associations:

It was hypothesized that membership in associations was positively related to level of use of animal traction. The data in Tables 14 and 15 show that the correlation and regression coefficients respectively with regards to this variable were not significant ( $r=.21$ ). It was expected that being a member of association or farmers group could create the needed peer pressure for a farmer to use animal traction. The lack of significance of this variable could be explained from the perspective that even though many of the farmers belonged to several associations and farmers groups, none of such associations or groups existed specifically for any purpose related to animal traction. The hypothesis that membership in associations was positively related to use of animal traction was therefore rejected.

#### Household Labour Capacity

It was hypothesized that household labour capacity was negatively related to level of use of animal traction. The data in Tables 14 and 15 show that both the correlation and regression coefficients with regards to this variable respectively, were not significant. It was expected that households with lower labour capacity would adopt animal traction more than others, to meet the labour

demand for the various activities on the farm. The lack of significance of this variable suggests that the available household labour was not an important consideration in the level of utilization of animal traction among households. The hypothesis that household labour capacity was negatively related to use of animal traction was therefore rejected.

Ownership of Cattle:

It was hypothesized that ownership of cattle was positively related to the level of use of animal traction. The data in Tables 14 and 15 show that both the correlation and regression co-efficients respectively, regarding this variable were not significant. The expectation was that having cattle could facilitate ownership of work bulls and therefore the use of animal traction. Even though the data in Table 4 show that the average number of cattle owned by users of animal traction was higher (10.5) than that of non-users (2.7), the lack of significance of this variable suggests that owning cattle does not affect the level of use of animal traction. The hypothesis was therefore rejected.

Traction Access Status

It was hypothesized that traction access status was positively related to level of use of the technology. The data in Tables 14 and 15 respectively show that the

variable was positively and significantly correlated with level of use of animal traction. This suggests that those who had higher and more secure access to the technology used it more than those with less secure access. This finding is consistent with the information in Table 11 which show that independent users of animal traction used the technology for more farm operations than dependent users of the technology. The hypothesis that traction access status is positively related to level of use of animal traction is therefore accepted.

#### Extension Contact on Animal Traction

It was hypothesized that extension contact on animal traction was positively related to level of use of the technology.

Tables 14 and 15 respectively, show that the correlation and regression co-efficients of this variable were not significant. These suggest that extension visits were not important factors determining the level of use of animal traction. This could be explained from the point of view that even though animal traction was being promoted within the framework of the Training and Visit extension System in Katsina State, not much had been done in the area of visiting farmers with specific messages on animal traction in the last four years apart from the massive campaign concerning the use of the technology embarked upon by the Katsina state Agricultural and Rural

Development Authority. The hypothesis that extension visit was positively related to use of animal traction was therefore rejected.

#### IMPACT OF ANIMAL TRACTION

It was hypothesized that the use of animal traction had significant impact on crop yield, household income, labour utilization and control of resources within households. This hypothesis was tested using different regression models as stated in the methodology.

##### Impact on Crop Yields:

The means and standard deviations of the yields of seven major crops in Kilograms per hectare is presented in Table 16. The data in Table 16 show that yields of the major crops were generally low among both users and non-users of animal traction. However, non-users of animal traction recorded slightly higher yields for millet sorghum, groundnut and maize than users, while users recorded higher yields in rice and Cotton. Except for Cotton the F-test shows that the mean yields of all the crops did not differ significantly among users and non-users of animal traction.

Determining the impact of animal traction on crop yields was a difficult exercise because very many factors could influence crop yield. These include sowing date, plant density, number of weeding, quantity of fertilizer

applied, climatic/weather conditions, and incidence of pests and diseases among others.

To determine the relationship between yield of the seven major crops selected for this study, and some factors which influenced yield, a multiple regression analysis was carried out. To have a common factor for all the yields of the crops, yield for each crop was converted to Naira and added together. Eight independent variables were considered, this included the level of use of animal traction. The result of the multiple regression analysis is presented in Table 17.

Table 16: Means and Standard Deviations of Yields of Major Crops Among Users and Non-Users of Animal Traction

Crop	Users		Non - Users		t-value
	Mean	Stdv	Mean	Stdv	
Millet	767.8	688.9	789.2	883.4	.0687
Sorghum	892.5	929.3	935.5	726.5	.0804
Cowpea	430.6	120.5	340.3	240.3	.1922
Maize	982.2	1121.2	1011.6	930.8	.2648
Groundnut	340.7	299.2	424.0	620.2	.975
Rice	890.5	508.2	820.0	922.0	.1610
Cotton	520.7	513.0	410.0	502.7	.0192 <sub>t</sub>

\*: F-test Significant at  $P < .05$

Table 17: Results of Multiple Regression Analysis to Determine the Impact of Animal Traction on Crop Yield.

Independent Variable	Regression Co-efficient	Standard Error	t=Value	Significance of t
Total farm cultivated	-5.4576	0.8361	-6.527	0.0001 <sub>tt</sub>
Use of animal Traction	14.0501	8.4378	1.665	0.0999
Amount Borrowed	19.6119	22.5227	0.871	0.9753
Total input	0.1872	0.1040	2.007	0.0480*

F-Ratio = 49.1401\*\*

R = 0.7383

R<sup>2</sup> = 0.5452

\*\* = P < 0.01

\* = P < 0.05

(a) Dependent variable is the yield per hectare of seven major crops measured in naira.

The data in Table 17 show that the regression coefficient on use of animal traction was not significant. This implies that use of animal traction did not have any significant impact on crop yield, even though the results show that the regression model explained only about 55% (R<sup>2</sup> = 0.552)

of the variations in crop yield. This may be due to the fact that some other important variable such as climate, soil fertility, pests and diseases could not be included in the model. The result contrasted with the findings by Panin (1986) in Northern Ghana which showed that the use of animal traction had positive impact on crop yields. The result was also not similar to that of Barret et al (1982) in Eastern Burkana Faso which showed that animal traction households recorded generally higher yields than non-traction households. However, the result obtained in this study is similar to results obtained in other studies (Pingali et al, 1987) which concluded that the use of animal traction did not show any significant effect on crop yields on farmers field.

The data in Table 17 also show that total farm Size had significant effect on crop yield. Farm size had a negative sign, which indicated that farmers who cultivated smaller farms realized higher yields. It could be that farmers with smaller farms were better able to manage their farms particularly with regards to activities involving weeding, fertilizer application and plant population.

#### Impact on Household Labour Allocation and Labour Use

Table 18 presents a summary of the weighted average man-equivalent hours of labour per hectare for major farm activities. The data show that total labour

hectare was greater among non-users than users of animal traction. A further analysis showed that even among users, there was a saving of about 24ME-hours per hectare by Independent users of the technology over Dependent users. This was expected since all Independent users owned work bulls and implements and used them as they wished, particularly for all the phases of farm tillage activities, such as ploughing, ridging and weeding. Some dependent users carried out some of the tillage activities such as weeding and mounding or remolding manually.

Table 18: Average Hours of Labour per Hectare for Major Farm Activities

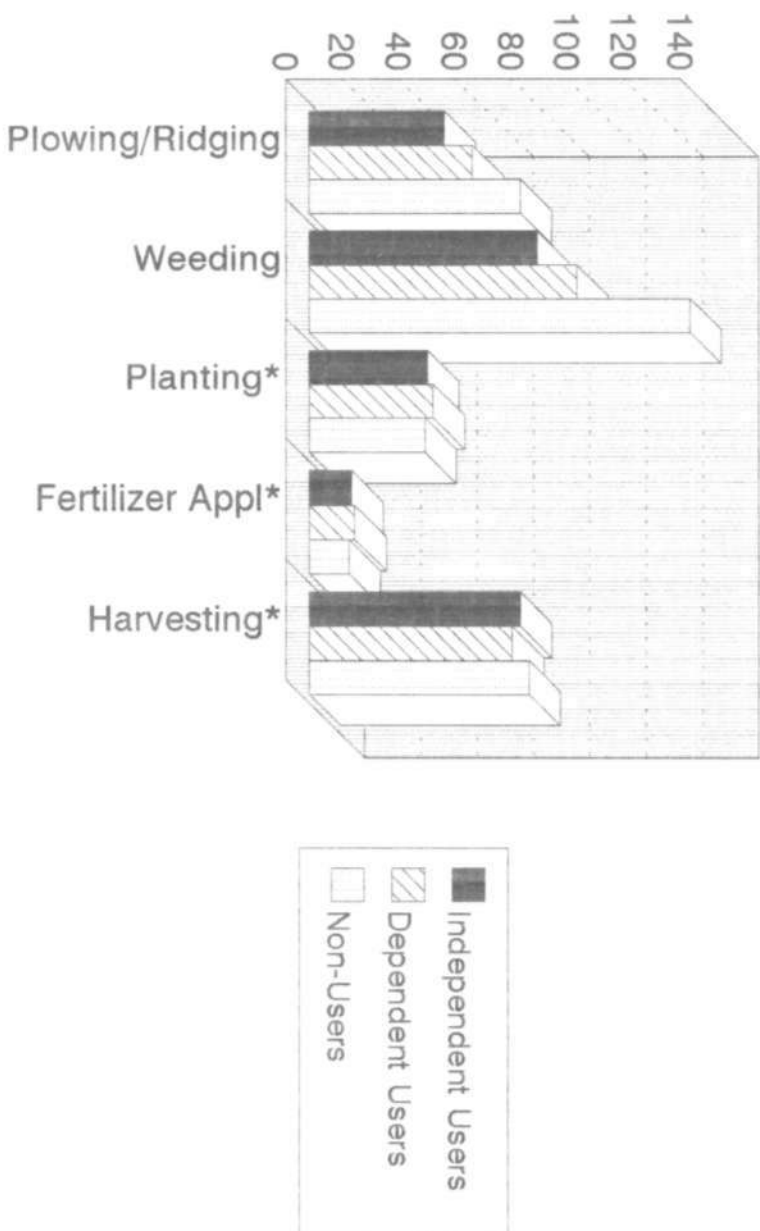
Activity	Independent Users	Dependent Users	Non-Users
Ploughing or Ridging	48	58	75
Weeding	81	95	135
Planting*	42	44	41
Fertilizer* Application	15	16	14
Harvesting*	75	72	78
Total	261	285	342

*\*Most of the activities were manually done by each household. The slight variations in ME-hours recorded among the households could be attributed to specific field level conditions and variations in household composition and management capability of the individual farmer.*

Table 18 shows that the use of animal traction for ridging significantly reduced the labour requirement per hectare from 75 ME-hours using the hand hoe, to 48 ME-hours using

animal traction. The same goes for weeding, reducing the ME-hours per hectare from 135 ME-hours under manual hoe weeding to 81 ME-hours per hectare using animal traction. The impact of animal traction use on labour time for planting, fertilizer application and harvesting could not be ascertained since most households included in the study carried out the operations manually. Figure 3 is a graphical representation of the information in Table 18.

Fig 3: Average Hours of Labour Per Hectare for Major Farm Activities.



\*Activities were done manually

Table 19 and Figure 4 show the average labour input by household members for all phases of farm activities by gender and age categories. The data show that the total labour input in man-equivalent hours was higher among non-users than users of animal traction. The age categorization analysis shows that male children of ages 15 years and below worked more ME-hours among Independent user households (121 ME-hours/ha) than among Dependent users (52 ME-hours/ha) and non-Users (51 ME-hours/ha). This could be attributed to the fact that children within this age bracket were more involved in handling work-bulls during work and were also involved in other phases of farm work that required manual labour input, such as planting, weeding, fertilizer application, harvesting and transport.

Table 19: Average Labour input By Household Members by Gender and Age Categories in ME-hours/hectare Among Users and Non-Users of Animal Traction

Age Category/Gender	Independent Users	Dependent Users	Non-Users
<u>Male:</u>			
9 years and below	26	15	12
10-15 years	95	37	39
16-49 years	120	240	280
50 years and above	130	80	50
<u>Female</u>			
9 years/below	10	12	15
10-15 years	14	12	9
16-49 years	115	151	162
50 years and above	56	38	72
<b>Total</b>	<b>566</b>	<b>585</b>	<b>639</b>

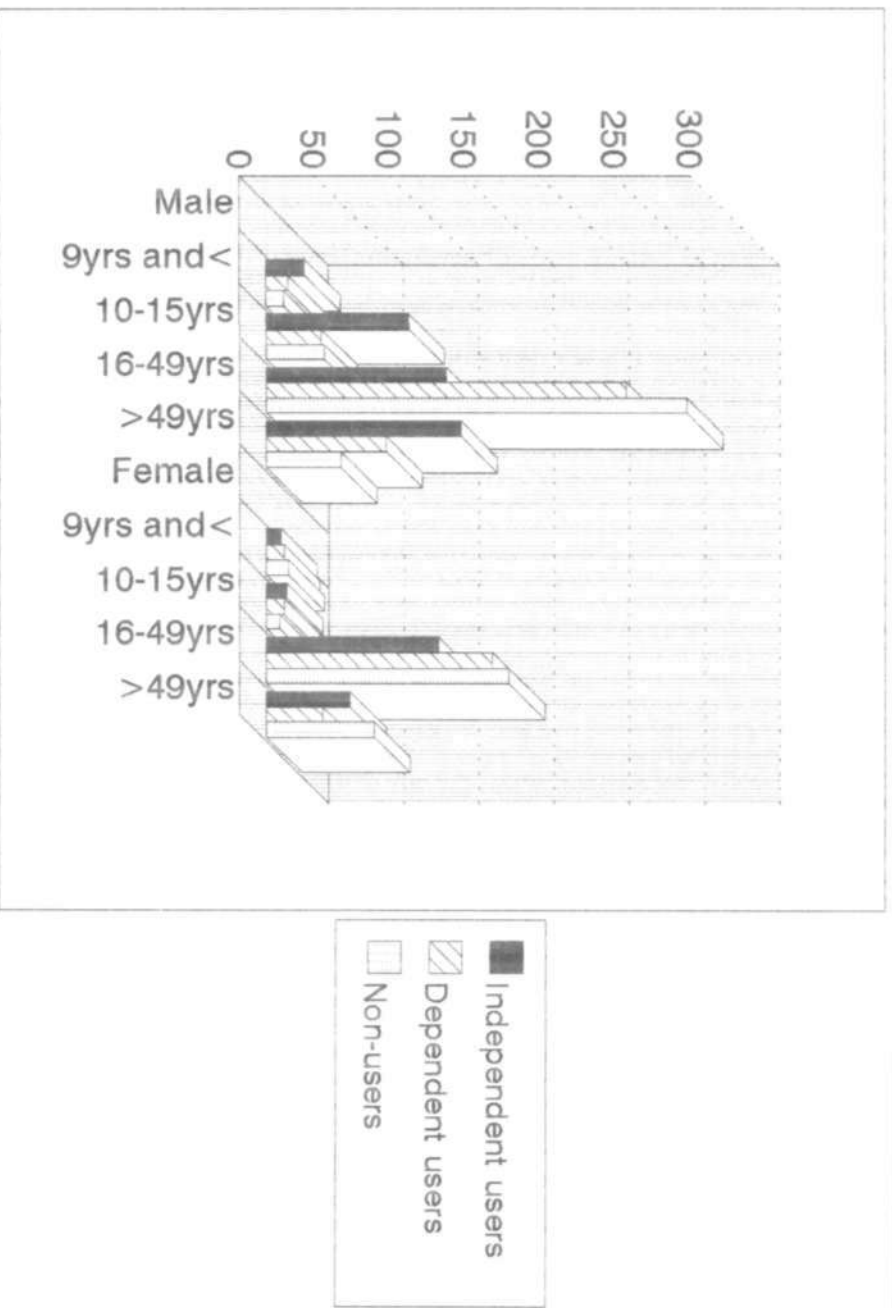
*Age categorization is based on conversion factor for household labour capacity*

The data in Table 19 also show that adult males from age 16 and above worked less ME-hours among Independent animal traction Users than dependent users and the non-users. Table 19 further show that there was generally no significant difference in the total labour input in ME-hours by females among the Independent, Dependent and non-user households. However, women between the ages of 16 and 49 among Independent user households, worked less ME-hours (115 ME-h/ha) than women in the same age bracket in the Dependent and non-user households, each recording 151 ME-hours and 162 ME-hours, respectively. The use of

animal traction seemed to free this category of women among the Independent user households from certain aspects of farm work such as weeding, ploughing and ridging, even though it is generally believed that women in this part of the country do not usually participate in such farm activities. Another farm activity in which the use of animal traction might have reduced the labour input by women is in the area of transport and carting of farm produce among Independent user households who owned carts.

The use of hired labour was common among all the households. Nevertheless, dependent user households recorded the highest cost on hired labour. This may be due to the additional cost of hiring workbulls and the fact that most dependent users of animal traction were able to expand the area of land cultivated through use of animal traction for tillage but could not use the technology for other phases of farm operations and therefore resorted to the use of hired labour.

Fig 4: Average Labour Input in M-E Hours by Household Members by Gender and Age Category



Age categorization is based on conversion factor for household labour capacity

Impact on Farm Income

The general picture which emerged from the data in Table 20 is that all categories of households recorded very low incomes from farming. Among both users and non-users of animal traction, between 40 and 59% of the gross income represented the total value of crop produced. Other sources of income included hiring-out of work bulls and implements, hiring-out of carts, sale of livestock and other sources such as blacksmithing, agricultural trading, driving and tailoring. Nonetheless, crop production still represented the highest source of income among all households.

Independent animal traction users recorded slightly higher net incomes (N24, 682) than both Dependent users and non-users who recorded net incomes of N15,052 and N15,822 naira, respectively.

Expectedly, animal traction users recorded higher farm operational costs than non-users. Nevertheless, the costs incurred relative to the total value of crops produced was higher among dependent animal traction users than the Independent users and non-users. This was perhaps because, while dependent animal traction users spent over 58% of the farm operational costs on hired labour, the independent users spent just about 26% of farm operational

costs on hired labour. The Dependent Users spent such a large percentage of farm operational costs on hired labour probably because of the additional cost of hiring workbulls and because most of them could only use animal traction for land tillage (ploughing and ridging) and not for other phases of farm operations.

Table 20: Summary of the Average Costs and Income Statement For all Households included in the Study.

Item	Independent Animal Traction User	Dependent Users	Non Users
	<u>Costs (Naira)</u>	<u>Costs(Naira)</u>	<u>Costs(N)</u>
Seeds purchase	-1,780.00	-1,370.00	-730.00
Fertilizer	-7,215.00	-3,350.00	-1,980.00
Chemicals/Insecticides	-2,300.00	-820.00	-380.00
Hired Labour	-5,100.00	-8,200.00	-2,920.00
Cost of Feeding livestock	-750.00	-210.00	-200.00
Cost of vet. services/Drugs	-500.00	-58.00	-79.00
Repairs to traction implements including Replacements of parts	-975.00	00.00	00.00
Depreciation on traction animals (workbulls)*	+1,250.00	00.00	00.00
Depreciation on traction equipment	-958.00	00.00	00.00
	<u>Income</u>	<u>Income</u>	<u>Income</u>
Total value of crop produced	24,350.00	12,610.00	10,301.00
Income from Hiring out workbull and implements	+3,610.00	-	-
Income from Hiring out cart	+3,920.00	-	-
Sale of livestock including workbulls	+6,000.00	+5,000.00	+3,800.00
Income from Dry season farming	+2,000.00	+6,250.00	+3,810.00
Income from other sources+	+4,000.00	+5,200.00	+4,200.00
Gross Income	43,880.00	29,060.00	22,111.00
Total Cost	-18,328.00	-14,008.00	-6,289.00
Net Income	25,552.00	15,052.00	15,822.00

+ Other sources of income included selling of labour, blacksmithing, agricultural trading, tailoring, driving.  
\*Note that the value recorded for work bull is appreciation.

Table 21: Results of Multiple Regression Analysis to Determine the Impact of Animal Traction on Household Income.

Independent Variables	Regression Co-efficient	Standard Error	t-Values	Significance of t-Values
Total farm cultivated	7.9766	0.6289	12.684	.0001**
Income from off farm Employment	-66.0141	12.0710	-5.469	.0001**
Use of animal traction	16.7383	6.8539	2.442	.0163*
Access to credit	0.0010	9.7662	1.053	.2946
Constant	74.7603			
F- Value	49.140**			
R	.83188			
R <sup>2</sup>	.69202			
Adjusted R <sup>2</sup>	.67722			

\*\* =  $P < 0.01$

\* =  $P < 0.05$

+ = Dependent variable is gross farm Income.

Table 21 presents the results of the multiple regression analysis for determining the impact of animal traction on household income. The data in Table 21 show that the variables included in the regression model

explained about 69% ( $R^2 = 0.69202$ ) of the variations in income among the households included in the study.

Table 21 further shows that the level of use of animal traction had significant impact ( $P < 0.05$ , and  $P < 0.01$  respectively) on household income. The data also show that income from off-farm employment significantly ( $P < .01$ ) but negatively influenced household income. This indicated that farmers with higher off-farm income had lower household incomes. This result was at variance with that of Panin (1987) which indicated that income from off-farm employment was positively related to gross farm income.

#### Impact on Control of Resources Within Households

It is generally believed that certain decisions within farm households are almost always taken by household heads. Such decisions include among others, what to grow, when to plant, hiring-in labour, purchase of ox-plough, selling of household labour and household expenditures. Similarly decisions about who controls certain resources (e.g, cash income, land, livestock) within farm households are also generally presumed to be that of the household head. The key issue here was to examine whether the use of animal traction had some effects on who controls certain resources within households.

Table 22 presents the result of the multiple regression to determine the impact of animal traction on

control of resources within households. The data in Table 22 show that the use of animal traction had significant impact on who controlled what resources within the households studied, as the regression coefficient on this was significant at .05 level. The data show that the variables included in the regression model explained only about 38% ( $R^2 = .3756$ ) of variations in control of resources within households.

Table 22: Results of The Multiple Regression to Determine the Impact of Animal Traction on Control of Resources Within Households

Independent Variables	Regression Co-efficient	Standard Error	t-Values	Significance of t
Total farm size (ha)	0.0633	0.0152	4.172	.0001**
Income from off- farm employment	0.6656	0.3071	2.167	.0334*
Household labour capacity	0.1613	0.0777	2.075	.0414*
Total household size	-0.0032	0.0286	-0.114	.9098
Age of household Head	-0.0226	0.0228	-0.993	.3241
Education of household head	-0.0128	0.0530	-0.241	.8099
Use of traction	.0054	0.0024	2.233	.0317*
Constant =	8.5703			
F- Value =	5.0133**			
R =	0.6128			
R <sup>2</sup> =	0.3756			
Adjusted R <sup>2</sup>	0.3007			

\*\* =  $P < 0.01$  ;

\* =  $P < 0.05$

Since the regression coefficient carries a positive sign, the implication is that centralization of control of household resources was more among animal traction user households than non-user households. This is probably due to the fact that the household head in this society, which is typical of most Hausa societies, still retains the sole authority to determine what to do with household resources such as cattle, work bulls, income and crops. This result substantiates the common view that the head of household controls most of the production resources in traditional Hausa society.

#### The Animal Traction Knowledge System

One of the main purposes of any agricultural technology system is to ensure at least optimum utilization of innovations and a sustainable positive impact among the targeted clientele. This study has shown that some factors affect the utilization and impact of animal traction technology in Katsina State. These findings could only be properly appreciated when the animal traction knowledge system is examined as a functional unit and its interdependent component parts or sub-systems are critically examined. The objective of this part of the study was to examine the linkages and interactions among the functional components of the animal traction technology system and how these affected the

traction technology system and how these affected the utilization and impact of the technology.

The Policy Sub-System:

The focus in the analysis of this sub-system includes government pronouncements on, and investment in animal traction technology, pricing policy for agricultural products and inputs required in the utilization of the technology, policy on credit facilities and the agencies concerned, and the input of farmers in policy decisions concerning the technology.

The most recent policy document on agriculture in Nigeria is the one published in 1989. The document specified clearly that "the use of small motorized farm machines, ox-drawn equipment (animal traction) will receive greater attention than ever before" (Agricultural Policy For Nigeria, 1989). The Policy document also pointed to the intention of government to promote the privatization of government run tractor hiring units. Ironically however, two years later, (1991) the government established the National Agricultural Land Development Authority (NALDA) whose mandate was mainly mechanized clearing and development of agricultural land in all states of the federation. The mandate of NALDA was to supply four tractors with its complementary implements to each state and develop at least 1,000 hectares of land in each state. By 1993, NALDA was able to allocate "two

operational sites in 24 states of the Country". (NALDA 1994). So far, more than one billion naira had been spent on NALDA activities between 1991 and 1994 nationwide, mainly on heavy mechanization equipment. Laudable as the activities and objectives of NALDA are, the problem is the sustainability of NALDA's operations and the negative impact of its operations on the development of animal traction, since very little emphasis is placed on the use of animal traction under NALDA activities.

The Federal government's policy of deregulation under the Structural Adjustment Programme has not favoured the pricing of animal traction inputs. The 1994 price for animal traction implements at the Katsina State Farmers Supply Company ranged between ₦4,500 and ₦5,000 for the Emcot plough and ridger. In 1991 the price was ₦1,375.00, an increase of over 200% within a period of three years. This may be the reason why more than 90% of the households surveyed acquired their implements and workbulls more than five years ago. Only about 10% of users of the technology acquired their package within the last four years.

The Nigerian government has a liberal agricultural credit policy. Apart from the Agricultural Credit Guarantee Scheme (ACGS) which is administered through commercial banks, the Nigeria Agricultural and Co-operative Bank (NACB) also finances investments in agriculture through a subsidized loan scheme. The

interest rates for agricultural credit in 1994 was between 16 and 20%. This is about 8% lower than interest rates on loans to other sub-sectors of the economy. Nevertheless, only about 35% of farmers surveyed obtained agricultural credit. None of such loans was specifically for the acquisition of animal traction technology package, even though the National Livestock Projects Department (NLDP) indicated that it administered a loan package for animal traction through the NACB.

Generally, farmers have very little contribution to policy formulation in Nigeria. Although a number of farmers' organizations do exist in the rural areas in Nigeria, and even though more than 85% of farmers in the sample surveyed indicated that they belonged to one farmer's association or the other, farmers' associations are yet to acquire the necessary clout to influence government policy decisions.

#### The Technology Generation and Development Sub-System

The analysis under this sub-system focuses on research and research agencies in animal traction in Nigeria, the role of blacksmiths, equipment manufacturing companies, and farmers' contribution in the generation and development of animal traction technology.

Research in animal traction has three main components; namely: the physical, biological and socioeconomic components. The Institute for Agricultural

Research (IAR) Samaru, The National Animal Production Research Institute (NAPRI) and some International research agencies such as the International Livestock Center for Africa (ILCA) and the Canadian International Development and Research Center (IDRC), are supporting research on animal traction in Nigeria.

The Agricultural Mechanization Programme of IAR and the Agricultural Engineering Department of the Faculty of Agriculture Ahmadu Bello University, Zaria have done a lot of work in the area of designing and testing of animal traction equipment in Nigeria. As far back as in the 1970's, the unit designed and tested the rotary animal drawn weeder or cultivator. This equipment never made it to the farmers' field. Currently the research thrust of the unit does not give much priority to the testing and development of animal drawn implements even though government policy ostensibly favours the development of animal traction.

NAPRI has done a lot of work in the biological aspect of research in animal traction. Research into the nutrition of workbulls, work productivity of some breeds of cattle and the health of work animals are a few among the biological research on animal traction at NAPRI. The livestock systems research of NAPRI and the Farming systems Research programmes of IAR have independently and

jointly conducted studies on socio-economic aspects of animal traction in the Northern part of the country.

Although ILCA's research thrust on animal traction is in the sub-humid zone of Nigeria, there has been a considerable measure of collaboration between ILCA and NAPRI on animal traction research. Currently, IDRC is financing research in ethno-veterinary medicine through NAPRI. This research has come up with a number of interesting documentation of indigenous treatment and management of livestock diseases including those ones that affect work animals. A positive dimension to this is the strong linkage between national and international research scientists on the one hand, and the scientists and local people (farmers) on the other hand. However, it must be noted that most of these research activities did not emanate in the first instance, from farmers' identified problems. Rather, most of them emerged out of donor's agenda and what research scientists considered as important to work on.

John Holt Agricultural Engineers Limited (JHAEL) is the major producer of ox-drawn implements in Nigeria. More than 90% of the Emcot ridgers in use in Katsina State are from this company. This company receives feedback from farmers mainly through the number or quantity of implements they are able to sell annually. The company attempted to popularize three other implements namely; the

cultivator, weeder and the groundnut lifter in the past but had to stop their production because of very low demand for those implements. Even though farmers look elsewhere (mainly import from neighbouring countries) now to obtain these implements, JHAEL does not believe that there is enough demand to resume the production of these implements in commercial quantity. This is an example of a situation where inadequate interaction or lack of linkage creates information gap.

Blacksmiths have been the major force sustaining the use of animal traction in the rural areas in Nigeria over the years. They under-take repairs on the Emcot ridger and plough and in some cases fabricate parts and attachments for various tillage operations including weeding. About 18% of the farmers surveyed for this study had blacksmithing as a secondary occupation, and others who were not blacksmiths had close interaction with blacksmiths in their villages for the maintenance of animal traction equipment. Spare parts and attachments were fabricated by blacksmiths. The cost of spare parts fabricated by blacksmiths was about half of those imported or manufactured by JHAEL. Most blacksmiths relied on scrap metals, home made anvils, local charcoal and home made mechanical bellows for their fabrication and repair activities. None of the blacksmiths interviewed had welding machines or knew how to weld. Some of the

important tools in most blacksmiths shops were pliers, punches, chisels, hammers, gravers, files and tongs. The activities of the village blacksmiths have been responsible mainly for the extension of the working life of the Emcot ridger and plough from about 7 years to between 10 and 12 years.

#### The Technology Transfer Sub-System

The focus here is on the transfer activities in the area of knowledge and inputs, training and training institutions, methods of technology dissemination, access of farmers to technology and human/material resources availability for technology transfer.

The major transfer activities related to knowledge and inputs are in the area of nutrition of work animals, health and management of work animals, training of animals for work, care and maintenance of implements. Farmers themselves were the major actors involved in most technology transfer activities on knowledge and inputs related to animal traction. Farmers in the study area seemed to be far ahead of organized extension in the area of training of work bulls, and management of work animals. The technologies available to farmers in this regard were mainly indigenous and they passed information and skills to each other orally and through apprenticeship training. The agencies responsible for organized extension activities on animal traction are the ADPs, the National

Agricultural Extension and Research Liaison Services (NAERLS), the Federal Agricultural Co-ordinating Unit (FACU) and the extension arms of IAR and NAPRI. The Katsina Agricultural and Rural Development Authority (KTARDA) had two animal traction training centers; one at Layin Minista (Zone II) and the other at Tembu near Daura (Zone I). The records of the two Centers showed that a total of 352 farmers were trained between 1990 and 1994 on the use of animal traction. The training in the two centers is a residential 2 - week intensive course which covers selection of work bulls and implements, training and management of work bulls, health and diseases of work animals, record keeping, and sources of loan for small scale farmers. Less than 10% of the farmers surveyed for this study benefitted from the training at the two training centers. About 90% of the users acquired their skills and experience on animal traction from parents, friends and neighbours, while the remaining 10% received their own training from government-run training centers.

The NAERLS has the mandate for specialised extension support to the ADPs and other agencies nation wide. They do this through production of extension publications, media support and training/conferences. In collaboration with the Agricultural Engineering Programme of IAR, NAERLS had produced and distributed about 2,000 copies of extension guides on selection and management of workbulls.

Currently, animal traction technology is supposed to be disseminated through the Training and Visit (T&V) extension system. A look at the Monthly Technology Review Meetings (MTRM) topics in the last three years revealed that apart from general topics on livestock management, only two topics were taught at MTRMs at KTARDA which addressed animal traction problems specifically. This does not necessarily mean that farmers did not report problems related to animal traction, rather it may be that both the village extension agents and their supervisors lacked adequate skill and knowledge to help diagnose farmers problems related to animal traction.

Another problem with technology transfer on animal traction was that at the two zones of KTARDA, where this study was carried out, there were no Subject Matter Specialists (SMSs) specifically on animal traction. This may be one of the reasons why only two topics in three years, related to animal traction were addressed at MTRMS. Even at the research institute levels, some scientists admitted that they had never seen animal drawn seeders and groundnut lifters. There seemed to be a shortage of specialist personnel and resources on technology transfer on animal traction. All these made it difficult to reap the benefits of a potentially strong linkage between research, extension and farmer inherent in the T&V extension system.

The Technology Utilization Sub-system

The focus in this section is on user characteristics, farmers' access to animal traction technology and the existing linkages and interactions between farmers and the other subsystems.

Most of the users of animal traction surveyed were small-scale farmers. Nevertheless a considerable number of medium and large scale farmers were among the sample of farmers surveyed using the technology. Independent animal traction users owned between one and five teams of work bulls. Among the medium and large scale farmers, ownership of more than one team of work bulls was common. Both the Independent and Dependent users of the technology were older, had larger farm sizes, higher household labour capacity, and wealthier (mean wealth status score was 20.5 as against 16.8 among non-users) than non users of the technology. Even though farmers were taught how to use animal drawn weeders and seed planters at the two training centers in Katsina State, most farmers did not have access to the implements. Animal drawn seed planters in particular were not common in the market.

All the farmers had interest in the use of animal traction. Those who were not using the technology indicated that they intended to use it later if there would be credit for the acquisition of the package. Some of the Dependent users once owned workbulls and implements

but could not continue keeping them because of lack of money to acquire workbulls and implements after they sold their old oxen team.

Farmers maintained a very strong linkage between themselves and blacksmiths. Some of the farmers were also blacksmiths. Linkages with formal agencies such as KTARDA, credit Institutions, researchers, manufacturers of implements and veterinary service agencies varied considerably. Some farmers reported lack of knowledge of existence of some of the agencies while some reported occasional encounters with individuals from the agencies. These agencies were rated in order of familiarity and level of interaction as follows:

1. Blacksmiths,
2. KTARDA - Extension Agent,
3. Credit Institutions (NACB),
4. Veterinary services,
5. Researchers, and
6. Manufacturers of implements.

It is noteworthy that researchers and manufacturers of implements had the least interaction with farmers according to the perception of farmers. Similarly, manufacturers did not work closely with researchers because, according to JHAEL, they manufactured to make profit.

A look at the sub-systems of the animal traction knowledge system showed that it did not agree with the two-way model of AKIS developed by Havelock. As it could be seen, the Resource Community of the Animal traction technology system comprising mainly of researchers, implement manufacturers, blacksmiths, credit institutions, the extension agency and policy seemed to work independently of each other and without interchange of roles with the User Community. Furthermore the technology User Community for animal traction is dominated by small-scale producers. Again, even though the T&V extension system provides the necessary framework for constant interchange of roles between the Technology Resource Community and The User Community through feedback from farmers and incorporation of farmers problems and ideas into technology generation, development and transfer, this did not work with animal traction as each unit worked independently of each other.

## CHAPTER SIX

### SUMMARY, RECOMMENDATIONS AND CONCLUSION

#### Summary of Findings

The premise upon which this study was initiated is that even though animal traction has been in use in the Northern part of Nigeria for over seventy years, not much is known about its level of utilization and impact. It was also noted that views and policy pronouncements on animal traction had been inconsistent over the years either because of inadequate knowledge of the social and economic structure underlying the observed pattern of use of the technology, or because of lack of reliable information on which to base an overall evaluation of problems facing agricultural production as it relates to farm mechanization.

This study responded to this gap of knowledge by examining the various uses of animal traction and assessing its impact at the farm household level. The primary objective of the study was to determine the level of use of the technology and its impact on crop yield, farm income, labour utilization and control of resources within households. The study used the theoretical model of

an Agricultural Knowledge and Information System (AKIS) as an overlay to identify the institutional and functional gaps (Roling, 1989) in the animal traction technology system in the area.

One hundred and seventy farm households were selected for the study using a combination of purposive sampling and systematic random sampling techniques. The data was analysed using descriptive statistics, simple correlation and multiple regression techniques.

#### Diversified uses of animal traction

Three distinctive types of farm households were identified, namely; those who owned work bulls and implements, (Independent users of animal traction), households who used animal traction but did not own the package (Dependent users of animal traction) and households who depended wholly on hoe cultivation (non-users of animal traction). Among the users of the technology, land tillage (ploughing and ridging) were the most common use to which animal traction was applied. A large number of households also used animal traction in weeding. However, weeding implements or attachments were not very common. The weeder commonly in use was a local adaptation of the Emcot plough or ridger. Nonetheless, in the border towns in the northern most part of the state particularly around Jibiya, farmers used cultivators and weeders imported from Niger Republic.

Animal traction was used extensively in the study area for carting. Oxen carts were common among Independent user households. Donkeys and camels were used mainly as pack animals. Donkey and camel traction was not known in the study area. Donkey carts were also not known. Although farmers around the border towns with Niger Republic were aware of the use of camels and donkeys for ploughing and ridging in the neighbouring country, none of the households had attempted to use camels and donkeys for ploughing even though ownership of these animals were widespread particularly in the northern parts of the state. Ownership of horses was not as widespread as the ownership of the other animals and as such their use for traction purposes might not be feasible.

The use of cows for traction purposes was also not known in the study area. Farmers were not aware of the numerous advantages of cow traction over the use of bulls. Ownership of cattle was common among users and non-users of the technology. Nevertheless, animal traction users owned higher (10.5 ) number of cattle heads than non users (5.7 for non users).

The use of animal traction for driving stationery processes such as grinding, water lifting and sugarcane crushing and other food processing devices were not common even though such labour intensive activities were daily routine among households using animal traction.

Animal traction user household heads were generally older, cultivated larger farm sizes and they were less educated than non-user household heads. All the households surveyed operated under relatively secure tenurial arrangements since most of them owned the land they cultivated. Both user and non-user households had large household sizes.

Factors affecting the level of use of animal traction

The study showed that among factors which affect the level of use of animal traction, age, having training on animal traction and farm size were positively correlated with level of use of the technology. On the other hand, income from off-farm employment and education were negatively and significantly correlated with the level of use of animal traction. Other variables such as access to credit, ownership of cattle, extension contact, household labour capacity, leadership status, traction access status and membership in associations were not significantly correlated with the level of use of the technology as both the correlation and regression coefficients indicated.

Impact of animal traction.

The study showed that there was no significant difference between the yields of major crops among users and non-users of animal traction. However, animal traction users recorded significantly higher yields for cotton than non-users of animal traction. Furthermore the

results of the regression analysis showed that the use of animal traction did not have any significant impact on crop yield.

On labour utilization, the study showed that the average labour use per hectare for major farm activities, was greater among non-users (342 M-E/ha) than users of animal traction (273 ME/ha). Furthermore, age and gender categorization of labour utilization revealed that male children 15 years and under, worked more ME-hours/ha among Independent user households (121 ME hours/ha) than among dependent users (52 ME-hours/ha) and non users (51 ME hours/ha). The study also indicated that women were involved in farm level activities in all the households. However, women between the ages of 16 and 49 among Independent User Households, on the average, worked less ME-hours per hectare (115 ME-hours/ha) than women in the same age bracket in the Dependent and Non-user Households, each recording an average of 151 ME-hours/ha and 162 ME-hours per hectare, respectively.

The study revealed that independent animal traction users recorded slightly higher average net income (₦24,682.00) than both dependent users and non-users of the technology who recorded average net incomes of ₦15,052 and ₦15,822, respectively. The regression analysis showed that the level of use of annual traction had a positive impact on income. Furthermore the study showed that the

use of animal traction had significant impact on control of resources within the households surveyed.

Finally, a detailed examination of the animal traction knowledge system provided useful insights into the reasons for the low level of utilization of the technology and its trend of impact. The analysis of the animal traction knowledge system showed that the "resource community" i.e, policy, research, extension, implement manufactures, blacksmiths and fabricators, operated relatively independently of each other, and of the "user community" i.e. farmers. In other words the linkages between the various subsystems of the animal traction knowledge system were not strong enough and as such interactions between the subsystems were limited and in some cases non-existent. Similarly, the strong research-extension-farmer linkage forged through the adoption of Farming Systems Research (FSR) and the Training and Visit (T&V) extension system in the crop sub-sector had not been fully extended to animal traction technology system.

#### Recommendations

Based on the results, the following recommendations were made:

1. The use of animal traction is currently restricted to land tillage particularly ploughing and ridging. This creates unnecessary burden for farmers in the other phases of farm work particularly weeding,

planting, and harvesting. Animal drawn implements do exist for these other phases of farm work. It is therefore suggested that such technologies should be adapted to our local conditions and be introduced to farmers who can adopt them. Furthermore, this study has shown that farmers' in Katsina State have demonstrated considerable imagination and creativity over the years in the adaptation of the available animal drawn ploughs and ridgers for weeding. These farmers' practice and creativity should be carefully studied and be incorporated into the design of acceptable cultivators and weeders;

2. The use of donkeys and camels for traction purposes should be explored. Donkeys in particular are widespread and cheaper to acquire and maintain than bulls. Since donkey traction is common in neighbouring countries, efforts should be made to transfer these technologies from such countries and adapt them to our conditions in Nigeria.

Similarly, the use of single animals as against paired animals should be explored and introduced to reduce the initial cost of acquiring the animal traction package. The use of single animals for traction is known to be popular in Senegal. The technology can be carefully studied and transferred to Nigeria;

3. The use of cows for traction purposes is also known to have numerous advantages. These have been highlighted extensively in this study. Nonetheless, there are fears that cows may not be useful for work during late pregnancy, work output may be lower than that of oxen and that nutrient requirements of cows used for traction purposes may interfere with growth, lactation and reproductive cycle. However a study by Agyemang et al (1985) on the effect of work on the productive and reproductive performance of crossbred dairy cows in the Ethiopian highlands indicates that work had no significant effect on milk production, lactation length, calving interval, days open and services per conception when animals received adequate feeding and worked for short periods. Cow traction should therefore be promoted particularly among households who own cows but could not adopt animal traction because they do not own bulls;
4. The use of animals for carting is a very important source of revenue to farmers and can ensure year round utilization of the technology. This study revealed that only a small percentage of animal traction users owned carts. Rural transportation, particularly for the timely evacuation of farm produce and transportation of farm inputs is still a big problem in Nigeria. It is therefore suggested

that animal traction credit package should include the purchase of a cart for each loan beneficiary. It is further suggested that farmers' practice in building carts locally should be studied and extended to other farmers in different parts of the state and country;

5. The sustained use of animal traction in Katsina state and other parts of the country over the years has been ensured by local blacksmiths. This study showed that blacksmiths were constrained mainly by poor working tools, access to raw materials, particularly metals and limited or no experience at all in the use of modern welding and metal working equipment. In order to exploit the abundant ingenuity of our blacksmiths, it is suggested that trainings should be organized for them in the use of modern metal working equipment. The animal traction loan package should also be extended to blacksmiths to enable them acquire modern metal working equipment and tools so that they can continue to give the necessary maintenance backup to the animal traction technology in rural areas;
6. This study showed that women take part in many farm level activities and are responsible for most off-farm level household activities particularly food processing. The use of animal traction for driving

food processing devices such as grinding mills and oil extraction devices should be explored and introduced to reduce the drudgery of such activities at the household farm level and to ensure optimum utilization of traction animals by owners of the technology;

7. Two major policy decisions of government in the recent past would have had far reaching positive effects on the use of animal traction if such policy decisions had been properly articulated and implemented. First, is the introduction of animal traction credit package under the National Livestock Projects Department (NLPD) which stated clearly that "farmers will receive a loan enabling them to purchase two bulls which can be trained, a plough, a cultivator, supplementary feed to maintain their stock during the initial dry season period, seed and fertilizer to establish a fodder bank and a young cow". This policy decision was taken in 1989. But as had been seen in this study, in Katsina State even the very few farmers who obtained credit sourced their credit in agencies other than the NLPD. Although NLPD management explained that the loan is administered through the NACB, the very negligible number of farmers benefitting from credit facilities point to a poor administration of the scheme; The

frameworks for an effective credit administration to improve the utilization of animal traction do already exist in the rural areas through the ADPs, the Peoples Banks, Community Banks, the NACB and other commercial banks. Also the NLPD loan package as described above looks adequate. However, past experiences concerning loan administration to rural dwellers, particularly farmers in Nigeria, point to the possibility of diversion of the expenditure of the credit facilities to other household needs especially if the loan is in cash form. It is therefore suggested that animal traction loans to farmers should essentially be in kind. Consisting mainly of workbulls, implements, a cart, supplementary feed, seed and fertilizer to establish fodder bank. The cash transactions that should be included in the loan package should be very minimal. This type of loan is best administered either through the Farmers' supply company or through the commercial departments of the state ADPs. To ensure that all categories of farmers benefit, the loan scheme can be graded to address the problems of small, medium and large scale farmers separately;

8. The second major recent policy decision which should have had positive impact on the utilization of animal traction in Nigeria is the establishment of the

National Agricultural Land Development Authority (NALDA) in 1990. NALDA's mandate, which is mainly land development for farmers in all states of the federation has hitherto placed too much emphasis on tractorization even though the realities of the present economic situation in the country and past experiences with similar schemes give clear negative signals. It is therefore suggested that NALDA's emphasis with regards to land development should shift in favour of animal traction as soon as the first phase of opening up the land is accomplished. NALDA should continue to work in close liaison with the ADPs for the promotion of the use of animal traction. NALDA should also explore the possibility of introducing Animal Traction Hiring scheme (ATHS) to its project farmers. This can later be extended to all farmers;

9. This study showed that even though most farmers belonged to various farmers organizations, there is no indication that animal traction users' or owners' group do exist in the study area. The ADPs should encourage the formation of Animal Traction Owners groups. These groups could be useful in disseminating extension messages, administration of animal traction loan package and other farm inputs; and

10. Farmers are clearly ahead of organized research and extension in Nigeria in terms of knowledge of the technologies involved in effective animal traction utilization. This seems to limit extension efforts related to animal traction. Furthermore, even though the introduction of the T&V extension system and Farming Systems Research (FSR) seem to have worked in favour of a strong Research-Extension-Farmer linkage system in the very recent past in Nigeria, particularly in the crop subsector, such linkage has clearly not been forged as far as animal traction is concerned. It is suggested therefore that, while the T&V extension system and FSR should continue to be the context within which animal traction is being promoted, FACU, NAERLS, IAR, and NAPRI should organize series of specialized trainings for extension staff of the ADPs to strengthen their skills and knowledge on animal traction so that they can continue to provide the necessary backup to farmers in the utilization of the technology.

Conclusion.

This study has shown that animal traction technology is being used widely particularly for farm tillage operations. It has been shown that older, wealthier, and farmers with larger farms use the technology more than the others. This suggests that if adequate promotion is

carried out and sufficient incentives are provided, there is a huge potential for greater adoption of the technology among young farmers. Furthermore, the study showed a positive correlation between training on animal traction and the level of use of the technology. Revitalization of the existing animal traction training centers and the careful targeting of training to specific audience among the non-users of the technology in the state seems to hold a great promise for a more widespread use of the technology.

Finally, the study showed that animal traction utilization had a positive impact on household income. This, in addition to the other benefits derivable from the technology, necessarily makes it a technology that must be endorsed by policy makers in Nigeria. Nigeria's quest for a sustainable self-sufficiency in food production seem to be strongly hinged, for now, on the nation's effort at ensuring a wider and more efficient application of the technology at the small-holder level.

It has become very obvious that tractorization is no longer economically feasible under the small-holder production system. Effort should therefore be intensified to ensure a widespread use of the technology among farmers in Nigeria.

Suggestions for Further Research.

The utilization and impact of animal traction is a very interesting aspect of innovation adoption study which has not been adequately focused on in Nigeria. This present study seems a humble start. Future work on the utilization of animal traction should explore farmer behaviour, his production objectives and the relationship between the utilization of the technology and the adoption of other farm innovations. Furthermore, a detailed economic analysis of animal traction requiring more rigorous data for assessing the profitability of the technology under different scales of operation should be carried out. Finally, intra-household relations and other aspects of the social system which seem to have led to the modification of old agricultural practices particularly with regards to the introduction of animal traction should be explored using the knowledge systems perspective as a framework.

REFERENCES

- Abalu, G. O. I. (1976) "A Note on crop mixtures Under Indigenous Conditions in Northern Nigeria" Journal of Development Studies, 12: 214
- Abalu, G.O.I. and D'Silver, B.(1979)"Socio-economic Analysis of Existing Farming Systems and Practices in Northern Nigeria" Paper presented at the Workshop on Socioeconomic Constraints to the Development of Semi-arid Tropical Agriculture. ICRISAT, 19-23 February.
- Abubakar, A (1990): "Development and Sale of Ox-Drawn Implements". In Gefu J.O. and Otchere E.O. (Editors) Draught Animal Research and Development in Nigeria, NAPRI, ABU, Shika; pp. 94 - 96
- Alhassan, W.S. Ehoche, O.W. Adu, I.F. and Obilana, A.T. (1983): Crop residue potential of agricultural development projects: Chemical composition of crop residues, NAPRI, ABU, Shika. 60 - 62.
- Adeoti, J.S.(1990):"Animal Power for Rural Transportation" In Gefu J.O.and E.O. Otchere (Editors) Draught Animal Power Research and Development in Nigeria: NAPRI, ABU, Shika.
- Agyemang, K., Abiye, A., Anderson, F.M., and Woldeab M.N. (1995) "Early Indicators of effect of Work on Reproductive Performance of Crossbred dairy Cows in the Ethiopian Highlands" Highland Programme Working Document.ILCA. Adis Ababa Ethiopia.
- Anderson, F.M.(1985) "Draught Animal Power system in Sub-Saharan Africa: Their Production Impact and Research Needs" In Copland,J.W.(Editor) Draught Animal Power for Production; Proceedings of an International Workshop Held at James Cook University, Townsville, Queensland, Australia. pp 26-31.
- Atala, T.K. (1981):Factors Affecting Adoption of Agricultural Innovations, Usage of Sources of Information and Level of Living in Two Nigerian Villages. Unpublished thesis, Iowa State University, Ames, Iowa, U.S.A.

- Atala, T.K. (1986): "The Role and Impact of Extension Agents in Kaduna State of Nigeria". Unpublished Ph.D thesis, Iowa State University, Ames.
- Artur Runge-Metzger and Lothar Diehl (1993) (Editors) Farm Household Systems in Northern Ghana: A case study in Farming Systems oriented research for the Development of Improved Crop Production System. Nyankpala Agricultural Research Report Verlag Josef Margraf Publishers, Weikersheim, Germany.
- Anonymous (1989) Agricultural Policy for Nigeria. Published by Federal Ministry of Agriculture and Natural Resources, Lagos, Nigeria.
- Badawi, M. (1990): "Draught Animal Power in Kano State: The KNARDA experience; in J.O. Gefu and E.O. Otchere (Editors). Draught Animal Power Research and Development in Nigeria, NAPRI, ABU, Shika; pp. 60 - 70.
- Baker, D.C. and Feldstein, H.S. (1990): "Farming Systems Research in a Draught Prone Environment", H. S. Feldstein and S.V. Poats (Ed) Working Together, Gender Analysis in Agriculture, Vol. I Case Studies. Kumarian Press, Connecticut, U.S.A. Pages 43 - 74.
- Balacet, Jean - Claude and Wilfred Candler (1982) Farm Technology Adoption in Northern Nigeria; Report of World Bank Commissioned Research. Department of West Africa Projects, Agricultural Division, The World Bank Washington D.C.
- Bangura, A.B. (1990): "Constraints to the extension of draft animal technology in the farming systems of Sierra Leone" In: Animal Traction for Agricultural Development Starkey P and Faye A. (Ed), Wageningen, C.T.A; PP. 324 - 327.
- Barret, V., Lassiter, G., Wilcock, D., Baker, D., and Crawford, E. (1982): Animal Traction in Eastern Upper Volta: a technical, economic and institutional analysis. International; Development Paper at Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, U.S.A.; pp 118.
- Becker, G.S. (1965): "A Theory of the Allocation of Time". Economic Journal; 75 p. 493 - 517.

- Behnke, R. and C. Kerven (1983): Farming System Research the Attempt to Understand the Goals and Motivations of Farmers. Culture and Agriculture; 19: 9 - 16.
- Biggs, S.D. (1990): "A multiple source of Innovation Model of Agricultural Research and Technology Promotion". World Development; 18: 1481-1499.
- Biggs, S.D., and J. Ferrington (1993): "Farming Systems Research and the Rural Poor" Journal for Farming Systems Research-Extension 3 (2) pp. 59 - 80).
- Blench, R.M. (1989): Social determinants of animal traction in Central Nigeria. Report submitted to the Agricultural Research Unit of the World Bank and the International Livestock Centre for Africa; pp. 82.
- Blumer, H. (1969): Symbolic Interactionism, Perspective and Method: Englewood Cliffs, New Jersey, Prentice Hall.
- Blumer, H. (1980): "Social Behaviorism and Symbolic Interactionism". American Sociological Review: 45 (3); 409 - 419.
- Bogunjoko, I.O. "Sources of Information on: Improved Farm Practices. A study of Farmers in Giwa District of Kaduna State. Nigerian Journal of Agricultural Extension (1) (2) pp. 64.
- Boyd, J.E.L and Ayok, E.A. (1974) Report on Farm Development Project, Daudawa, N.C.S. Nigeria. Intermediate Technology Development Group. London. U.K.
- Clark, R.C. and Akinbode AI (1968) Factors Associated with Adoption of Three Farm Practices in Western Nigeria. Research Bulletin No.1; Faculty of Agriculture, University of Ife Ile-Ife.
- Coser, Lewis A. (1967): "Continuities in the Study of Social Conflict", New York, Free Press.
- Dahrendorf, R. (1959): "Class and Class Conflict in Industrial Society", Standford Calif: Stanford University Press.
- Duncan, O. D. (1964): "Social Organization and the Ecosystem" in Handbook of Modern Sociology ed. Robert Faris, Chicago, Rand Mc Nally and co; pp. 36 - 82.
- Durkheim, E. (1933): The Division of Labour in Society: The Free Press, New York; pp. 149.

- Ega L. A. (1980): "Status, Problems and Prospects of Rural Land Tenure Policies in Nigeria". Unpublished Ph.D Thesis, Cornell University, Ithaca.
- Ega L.A.(1990) Research For Agricultural Development in Nigeria: The Role of Rural Sociology: Paper presented to the Department of Rural Sociology of the tropics and sub-tropics, Wageningen Agricultural University, the Netherlands.
- Etzioni, A and Etzioni, E. (Ed) (1966): Social Change: Sources, Patterns and Consequences. Basic Books Inc., New York.
- Feder, G., R. Just and D. Silberman (1981): "Adoption of Agricultural Innovations in Developing Countries: A Survey World Bank Staff Working Paper No. 444, Washington, D.C., The World Bank.
- Fitzsimmons, S. J.; L. I. Stuart, and P.C. Wolf (1975): Social Assessment Manual: A guide to the preparation of the Social well Being Account: Washington, D.C., U.S. Bureau of Reclamation.
- Hagen, E.E. (1962): On the Theory of Social Change: Vakils, Feffer and Simons Private Ltd., Bombay, India.
- Haswell, M. (1979): Economic Choice of Appropriate Technology by Peasant Farmers. Report of the West African Rural Technology Meeting at Yundum, The Gambia and Dakar, Senegal, May 14 - 22. Commonwealth Secretariat, London, U.K.
- Havelock, R.G. (1986): "Linkage: A key to understanding the 'knowledge System'" Knowledge, Generation, Exchange and Utilization. Beal, G.M. Dissanayake, W. and Konoshima, S. (Ed) Westview Press, Boulder, Colorado.
- Hill, Polly (1975): "West African Farming Household". In Jack Goody (Ed) Changing Social Structure in Ghana: Essays in the Comparative Sociology of a New State and an Old Tradition. International African Institute, London.
- Herton, P.B. and Hunt, C.L. (1980): Sociology: McGraw-Hill, Inc., New York, U.D.S.

- Jones, C.W. (1986): "Intra-household Bargaining in Response to the Introduction of New Crops: A case study from North Cameroon". In J.L. Mook (ed) Understanding Africa's Rural Households and Farming Systems. Westview Press/Boulder and London, pp. 133
- Jones, A. (1990) "Socio-economic Constraints to the Use of Animal traction for rainfed rice production in the Gambia" In Starkey, P. and Faye A. (Editors) Animal traction for Agricultural Development. Proceedings of the 3rd Workshop of the West African Animal Traction Network, held on 7-12 July, 1988 Salay Senegal, published by CTA, Ede Wageningen, the Netherlands.
- Kalkat, H.S., and Kaul, R.N. (undated): Interim report on the assessment of animal drawn tool bars in local farming systems. Agricultural Mechanization Research Programme, IAR, Samaru.
- Kaul, R.N. (1990): Animal Powered equipment: Some factors & their design. In Gefu, J.O. and Otchere, E.O. (ed). Draught animal power research and development in Nigeria. Proceedings of the First National Workshop on Draught Animal Power Research and Development in Nigeria, NAPRI, ABU, Zaria, Nigeria.
- Lancaster, K. (1966): "Change and Innovation in the Technology of Consumption". American Economics Review/Supplement, May; p. 14-23.
- Letstritz, F.L.; Murdock, S.H. (1981): The socio-economic impact of resource development methods for assessment. Westview Press, Boulder Colorado; pp. 257 - 281.
- Louk Box (1989): "Knowledge, Networks and Cultivators: Cassava in the Dominican Republic". In Encounters at the Interface: A Perspective on social discontinuities in Rural Development. Norman Long (ed) Wageningen: Agricultural University, Wageningen; pp. 165.
- Lippit, R., Watson J. and Wostley B. (1958): Dynamics of planned change: A comparative study of principles and techniques. Brace and World Co., New York.

- Long, Norman (1989): "Theoretical Reflections on Actor, Structure and Interface". In Encounters at the Interface: A Perspective on social discontinuities in rural development: Norman Long (ed) Wageningen Agricultural University, Wageningen; pp. 221.
- Low, A. (1986): "On-farm Research and Household Economics". In: J.L. Mook (ed) Understanding Africa's Rural Households and Farming Systems. Westview Press/Boulder and London; Page 71.
- Makanjuola, G.A., Abimbola, T.O., Anazodo U.G.N., (1991) "Agricultural Mechanization Policies and Strategies in Nigeria." Proceedings of a Workshop held at the institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 13th - 17th August, 1990. pp 233.
- Manuel, B. Garcia (1985): Sociology of Development: Perspectives and Issues. National Book Store Publishers; Metr. Manika, Philippines.
- Mathewman, R.W., Dijkman J.T., and Zerbini, E. (1993) "The Management and Husbandry of Male and Female Draught Animals: Research Achievements and Needs". In Lawrence, P.R. Lawrence, K., Dijkman, J.T. and Starkey, P.H. (Editors) Research for the Development of Animal Traction in Africa; Proceedings of the 4th Workshop of the West African Animal traction Network Published by CTA, Ede, Wageningen, The Netherlands.
- Mead, G.H. (1934): "Mind, self and society". Chicago, The University of Chicago Press.
- Merton, Robert K. (1968): Social theory and social structure, New York: Free Press.
- Mickling, Michael (1973): Population, Environment and Social Organization, Hinsdale, Illinois: Dryden Press.
- Monu, E.D. and Omole, M.M. (1983) Adoption of Recommended Farm Practices by Nigerian Cocoa farmers. Nigeria Journal of Agricultural Extension 1 (2) pp. 54.
- Mook, L.J. (Editor) Understanding Africa's Rural Households and Farming Systems: Boulder West view Press pp. 155 - 165.
- Murdock, S.H. (1979): "The Potential Role of the Ecological Framework in Impact Analysis" Rural Sociology, 44(3) 543 - 565.

- Musa, H.Z. (1990): Development and use of Animal Drawn Implements in Nigeria: In J.O. Gefu and E.O. Otchere (Ed) Draught Animal Power Research and Development in Nigeria NAPRI, ABU, Shika, pp. 102 - 119.
- Muth, R.F. (1966): "Household Production and Consumer Demand Functions". Econometrical 34: p. 699.
- Panin, A (1987): The use of Bullock Traction Technology for crop cultivation in Northern Ghana: An Empirical Economic Analysis ILCA Bulletin 29: pp 2 - 8.
- Pannin, A (1988) "Hoe and Bullock Farming Systems in Northern Ghana: a Comparative Socio-economic Analysis" Nyankpala Agricultural Research Report 1 TRIOPS, Verlag Langen, Federal Republic of Germany
- Osuji, L.O. (1983): Institutional factors Associated with Adoption of New Farm Techniques among Farmers in Eastern Nigeria: Nigerian Journal of Agricultural Extension 1(2).pp. 43
- Parsons, Talcott (1951): The social system, New York: The Free Press.
- Peters, P.E.(1986) "Household Management in Botswana: Cattle,Crops and Wage Labour" In Mook J.L. (Editor) Understanding Africa's Rural Household and Farming Systems Westview Press,Boulder and London. pp 133
- Phillip, D.O.A., Abalu, G.O.F., and Ingawa, S.A.(1988): Economic implications of animal power at the small scalelevel in the Savanna Zone of Northern Nigeria: a linear programming simulation of farmer circumstances. In Starkey, P. and Ndiame, F. Animal Power in Farming System. Proceedings of workshop held 19 - 26 Sept., 1986, Freetown, Sierra Leone. Published by German Appropriate Technology Exchange (GATE), GTZ, Eschborn, German 351 p. (E/F).
- Phillip, D.O.A., Abalu, G.O.I. Aganga, A.A. and Aduku, A.O. (1990): Animal Traction Technology in Northern Nigeria: A survey of constraints and A model of Prospects. In Starkey, P.H. and Faye, A (ed) Animal Traction for Agricultural Development. Proceedings of the Third workshop of the West African Animal Traction Network held 7 - 12 July, 1988, Saly, Senegal. Published by GTA, Ede, Wageningen, The Netherlands; p.370 - 375.

- Pingali P.L, Bigot Y and Binswager H (1987) Agricultural Mechanization and the evolution of farming Systems in Sub-saharan Africa: John Hopkins University Press, Baltimore.
- Preston, T.R. and Long R.A. (1984): "Supplementation of diets based on fibrous residues and by-products". In Straw and other fibrous by-products as feed. Elsevier Press, Amsterdam, the Netherlands; pp. 373 - 413.
- Reddy, S.K.(19988)"Use of Animal Power in west Africa Farming systems: Farm Level Problems and Implications for Research: Perspective from Mali". In Starkey P.H. and Ndiame, F. (Editors) Animal Power in Farming Systems; Proceedings of the Second Workshop of the West African Animal Traction Network Held September 19-25, 1986, Freetown, Sierra Leone
- Roling, Niels (1989): "The Agricultural Research Technology Transfer Interface: A knowledge systems perspective: Linkage Theme paper 6: ISNAR.
- Savane, M.A.(1986) "The Effects of Social and Economic changes on the Role and Status of Women in Sub-Saharan Africa" In Mook, J.L. (Editor) Understanding Africa's Rural Households and Farming Systems. Westview Press, Boulder and London, pp 124.
- Smith, A.J.(1981) "The role of Draught Animals in Agricultural Systems in developing countries". In C.R.W. Spedding (Editor) Vegetable Productivity; London, Macmillan pp 247-262
- Spenser D.S.C. and Byerlee D(1976) "Technical change-Labour use and Small Farmer Development: Evidence from Sierra Leone, "American Journal of Agricultural Economics 58: 874-880.
- Starkey, P.(1986)"Animal-Drawn wheeled Too/Carriers: Perfected Yet Rejected. A Cautionary Tale of Development. Braun Schevery, Vieweg & So'hn Verlags. pp. 80 - 81.
- Thomas, T., Oram, C. and Tembo, G.(1990)"Research on Diversified Uses of Work Animals: Needs, Experiences and Methods. In Lawrence, P.R., Lawrence, K., Dijkman, J.T. and Starkey, P.H. (Editors) Research for the Development of Animal Traction in Africa; Proceedings of the 4th workshop of the west African Animal Traction Network Held in Kano, Nigeria.

- Twomlow, R. (1994) Agricultural Machinery; From Local forge or foreign factory? Spore (52) C.T.A., Wageningen.
- Vierich, Helga (1986) "Agricultural Production, Social Status and Intra-Compound Relationships" In Moock L.J. (Editor) Understanding Africa's Rural Households and Farming Systems. Westview Press, Boulder and London pp 155
- Voh, J.P.(1982)"A study of Factors Associated with the Adoption of Recommended Farm Practices in a Nigeria Village" Agricultural Administration. 9 (1) pp 17 - 27.
- Voh, J.P.(1979) "An exploratory study of factors Associated with Adoption of recommended Farm practices among Giwa farmers": Samaru Miscellaneous Paper 73: Institute for Agricultural Research, Ahmadu Bello University, Zaria.
- Weil P.M. (1970): The Introduction of the Ox-plow in central Gambia", in African Food Production Systems: Cases and Theory. Peter F. Mdaughlin. (ed) Baltimore. The Johns Hopkins University Press.
- Westneat, A.S., Klutse, A. and Amegbeto, K.N. (1988) "Features of Animal Traction Adoption in Togo" In Starkey, P.H. and Ndiame, F. (Editors) Animal Power in Farming Systems; Proceedings of the second workshop of the West African Animal Traction Network Held September 19-25, 1986, Freetown Sierra Leone pp 331.
- Zana Ouattara (1990) Impact of Animal Traction, In Cote d'Ivoire" In Starkey P and A, Faye (ed.) Animal Traction for Agricultural Development. CTA, Ede - Wageningen, The Netherlands pp. 359 - 363.

APPENDIX AQUESTIONNAIRE/INTERVIEW SCHEDULE FOR USERS OF ANIMAL TRACTIONGeneral Characteristics of Households

1. Name .....
2. Age .....
3. Town/Village .....
4. Local Government Area .....
5. Tribe of farmer .....
6. Level of Education .....
- i) No formal school .....
- ii. Quaranic school .....
- iii. Less than first school leaving certificate...
- iv. Primary six/seven .....
- v. WASC/Equivalent .....
- vi. Above Secondary School .....
7. What is the total number of people in your household?
8. Household Composition
  - Male:
    - 0 - 9
    - 10 - 15
    - 16 - 49
    - 50 and above
  - Female:
    - 0 - 9
    - 10 - 15
    - 16 - 49
    - 50 and above
9. Are you a community leader? i,e, ward head, village head, chief or emir? .....

Land Acquisition

10. How did you acquire your land?
  - i. Inheritance .....
  - ii. Purchase .....
  - iii. Less or rent .....
11. What is the total size of your farm land?.....(Ha)

12. What is the total size of your farm plots under cultivation this farming season?.....(Hectares)

Use of Animal Traction

13. Do you use work bulls for farm work? Yes ..... No ....

14. If yes, do you own your own work bulls and implements?  
Yes ..... No .....

15. If you do not own your work bulls and implements, do you (i) Borrow? (ii) Hire or rent?

16. If you hire or rent, how much do you usually pay?  
.....

17. a) If payment is not in monetary terms, how else do you pay?  
.....

b) If you do not own work bulls and animal, what are your reasons?  
.....  
.....  
.....

18. If you own work animals and implements, what  
a) Type of animals and equipments do you have?

	<u>Type of animal</u>	<u>Number/Teams</u>
i.	Work bulls.....	
ii.	Donkeys .....	
iii.	Camels .....	
iv.	Others .....	

	<u>Type of implements</u>	<u>Number</u>
i.	Ridger	
ii.	Plough	
iii.	Groundnut lifter	
iv.	Weeder/Cultivator	
v.	Others	

a. Do you use cows for traction purposes? a.  
b. If yes, what are the benefits you derive from using female animal for traction purposes?  
.....

c. Do you use female animal (cow) for traction?

- .....  
 .....
- 18b Who trains your work animals?  
 At what age do you select your animals for training?  
Animal                      Age(Years\Months)  
 Bull.....  
 Donkey.....  
 Camel.....  
 Others.....
- 18c How long did it take to train your animal for work?  
Animal                      Duration of training (Days\Weeks)  
 Bull.....  
 Donkey.....  
  
 Camel.....  
 Others.....
19. For how long have you been using animal traction?.....
20. Which of the following farm operations do you usually perform with animal traction?
- i. Ploughing
  - ii. Ridging
  - iii. Weeding
  - iv. Groundnut harvesting
  - v. Packing
  - vi. Others (please specify)
- b. Apart from using animal traction for farm cultivation, are you aware of the use of animal traction for the following?
- i. Water lifting: Yes..... No....
  - ii. Threshing: Yes .... No.....
  - iii. Sugarcane crushing: Yes... No...
  - iv. Harvesting: Yes ..... No....
21. Do you own a cart? Yes..... No.....
22. If yes, what are the things you transport with the cart?
- i. ....
  - ii. ....
  - iii. ....
  - iv. ....
23. Do you hire-out your cart? Yes..... No.....

- 2  
24. How much do you charge, per trip?.....
25. Approximately how many trip did you make last farming season?
26. How much did you make from hiring out your cart during the last farming season?  
Cart #.....
27. How much did you make from hiring our work bulls and implements

Access to Credit

28. Did you borrow money in the last five years for farming purposes? Yes ..... No .....
29. If yes how much did you borrow?  
.....
30. From where did you borrow the money?  
.....
31. How much have you paid back?  
.....
32. How much are you owning currently?  
.....
33. Do you belong to any farmers organization or cooperative?  
Yes ..... No .....
34. If yes, what is the name of the organization?  
.....

Ownership of livestock

35. How many heads of cattle do you have?.....
36. How many of the following livestock do you have?  
Goats .....  
Sheep .....  
Camels.....  
Donkeys .....  
Chickens .....  
Others .....

Maintenance of Animal Traction

37. How much did you spend on maintaining your work animals during the last farming season?  
 i. Feeding .....  
 ii. Drugs/Veterinary services .....  
 iii. Housing and Management .....  
 iv. Other (Please specify).

38. How much did you spend on maintaining your traction implements during the last farming season? N..... and which parts of the implement require frequent maintenance work? .....

Cropping System

39. Which crops do you grow? .....  
 40. What size of your land did you devote to the following crops during the last farming season?

<u>Crop</u>	<u>Size (Ha)</u>
Sorghum	
Maize	
Millet	
Cowpea	
Groundnut	
Cotton	
Rice	
Others	

41. Do you grow the following non-food crops: Cotton  
 Yes.... No... Rama/Jute?Kenaf: Yes .....  
 No.....

42. Do you grow crops (a) mixture? ..... ( b )  
 sole?.....  
 (c) Or both? .....

43. If in mixture approximately how many crops in each plot?.....

Extension Contact on AT

44. How many times have you been visited by extension workers within the last two years with information animal traction?.....  
 .....

45. Have you ever received training on animal traction?  
Yes..... No.....

Record of Input

46. How much did you spend on acquiring the following during the last farming season?

	<u>Quantity</u>	<u>Cost</u>
i. Fertilizer.....		
ii. Seeds .....		
iii. Herbicides.....		
iv. Insecticides .....		
v. Others		

Family Labour Records

47. Please indicate which members of your family or the category of lined labourers who are involved in the following activities:

	Men	Women	Children	Hired labor Total cost
i. Land clearing				
ii. Ploughing				
iii. Weeding				
iv. Harvesting				
v. Livestock tending				
vi. Fetching feed for livestock				
vii. Processing of farm produce				
viii. Marketing of farm produce				
ix. Transport of farm produce				
x. Planting				

48. Do you use hired labour on your farm?
49. If yes, please indicate the activities you use hired labour for and the total cost for each activity during last farming season.
50. Please tell us the total output of the following crops in the last farming season in bags or kilogrammes. (Indicate whether it is the camel bag or the big bag).

Records of Outputs

Crop	Output in bags/Kg
Millet	
Sorghum	
Maize	
Groundnut	
Cowpea	
Cotton	
Rice	
Other (specify)	

Off - Farm Employment

51. Do you have any off farm employment?  
Yes.....No.....
52. If yes what is the off farm job?

- .....
53. Does any other member of your household have of farm job?  
.....
54. If yes, what is the job?  
.....
55. How much did you or any member of your household made from off farm employment last year? You  
N \_\_\_\_\_ Household members \_\_\_\_\_

Household Decision Making

56. (Enumerator) Ask members of the household to indicate their levels of involvement in the following decisions. (Ask the household head first and then check with other members of the household).

Task	I decide alone	Jointly by household members	By wife, son/daughter
a. Hire in labour for farm work			
b. Hire-out work bulls			
c. Hire-in work bulls			
d. Sell crops/livestock			
e. Obtain loan/what to do with loan			
f. Use household member in farm work			
g. Allow household member			
h. What to consume			
i. What to do with farm income			
j. What to do with off-farm income			
k. What to do with off farm income of other household members i.e wife/children			
l. What to store			
m. Allow other household members to own separate plots			
n. What to do with farm incomes of household member			

Household Control of Resources

57. Does any other member of your household own separate plots and livestock? Plots Yes \_\_\_\_\_ No \_\_\_\_\_  
Livestock Yes \_\_\_\_\_ No \_\_\_\_\_

59. If yes who uses the proceeds from the separate plots owned by the household member?  
 a) By the household member wife/children  
 b) By me (household head)  
 c) Jointly utilized by household
60. Who controls the proceeds from livestock owned by wife and children?  
 a) The household head (b) The child or wife  
 c) Jointly controlled by the entire household
61. Does any member of the household, apart from household head have an off-farm enterprise or job? Yes \_\_\_\_\_  
 No \_\_\_\_\_
62. Who controls the income from such off-farm enterprise or job?  
 a) The household head (b) The household member who owns the job or enterprise
63. In your opinion, which member of the household has more work to do on the farm now that you use work bulls for farm work?  
 a) Household head (b) Wives (c) Children
64. Whose farm work is reduced by the use of animal traction?  
 a) Household head's work (b) Wife's work (c) Children's work
65. From your own assessment, is there a difference in the area of land you now cultivate than when you were using hoes?  
 Yes \_\_\_\_\_ No \_\_\_\_\_
66. If yes how? (a) Reduced (b) Increased (c) Equal to now
67. Do you grow any crops now which you did not grow before using animal traction? Yes \_\_\_\_\_  
 No \_\_\_\_\_
68. If yes what is/are the name's of the crop/s  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Other Information

69. In your opinion, what are the benefits of using animal traction?

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70. What are the disadvantages of using animal traction?

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71. What are the specific problems you encounter in using animal traction?

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72. Please indicate whether  
a) You will continue to use animal traction for many more years ahead.  
b) Discontinue using it and change to hoe (reason)  
c) Discontinue using it and change to tractor (reason)

73. What suggestions do you have for improved use of animal traction by farmers?

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Appendix BQUESTIONNAIRE/INTERVIEW SCHEDULE FOR NON-TRACTION  
HOUSEHOLDSGeneral Characteristics of Households:

1. Name: .....
2. Age:.....
3. Town/Village:.....
4. Local Government Area:.....
5. Tribe of farmer:.....
6. Level of Education:.....
  - i. No formal schooling:.....
  - ii. Quoranic school:.....
  - iii. Primary six/seven (First School leaving Certificate):.....
  - iv. WASC/Equivalent:.....
  - v. Above secondary:.....
7. What is the total number of people in your household?.....
8. Households composition
  - Male Age
    - 0 - 9 years
    - 10 - 15 years
    - 16 - 49 "
    - 50 and above
  - Female
    - 0 - 9 years
    - 10 - 15 years
    - 16 - 49 "
    - 50 and above

Land Acquisition and Land Use

9. How long have you been farming?.....
10. Are you a community leader? i.e. Ward head, village head, chief or emir? Yes ..... No.....
11. How did you acquire your land?
  - i. Inheritance
  - ii. Purchase
  - iii. Lease/rent
12. What is the total size of your farm?.....(Ha)
13. What is the total size of your farm plots under cultivation this farming season? .....(Hectares)

Awareness about use of Animal Traction

14. Do you know about the use of work bulls for farm work?  
Yes.... No....
15. If yes, have you used it before?.....
16. Which farm activities did you use it for before?  
.....
17. If yes, why are you not using it now?.....
18. If you have never used it before, why? .....

Access to Credit

19. Did you borrow any money in the last five years?  
Yes..... No.....
20. If yes, how much did you borrow: N.....
21. From where did you borrow:.....
22. How much have you paid back? N.....
23. How much are you owing currently N.....
24. Do you belong to any farmers organization or  
cooperative? Yes..... No.....
25. If yes, what is the name of the organization?  
.....

Ownership of Livestock

26. Do you have cattle? Yes ..... No.....
27. If yes, how many heads of cattle do you have? .....
28. How many of the following livestock do you have?  
Goats .....  
Sheep .....  
Camels .....  
Donkeys .....  
Chickens .....  
Others .....

Crops grown and Cropping System

29. List the crops you grow? .....
30. What size of your land did you devote to the  
cultivation of the following crops during the last  
farming season?  
Sorghum .....

Millet .....  
 Maize .....  
 Cowpea .....  
 Groundnut.....  
 Cotton .....  
 Others .....

31. Do you grow any of the following non food crops?  
 Cotton ..... Yes/No  
 Rama or Jute or Kenaf.... Yes/No

32. Do you grow your crops  
 a) Sole  
 b) in mixture  
 c) both mixture and sole?

If in mixture, approximately how many crops per plot?.....

Extension contact on Animal Traction

33. How many times have you been visited within the last two years by extension workers with information on animal traction?.....
34. Have you ever received training on animal traction?  
 Yes ..... No.....

Records of Output

35. Please indicate the output of the major crops you cultivated last year:

Crop	Output in Bags/kg
Sorghum	
Millet	
Maize	
Groundnut	
Cowpea	
Cotton	
Rice	
Others	

Dry Season farming

36. Do you farm during the dry season? Yes..... No.....

37. If yes, how much did you make during the last farming season from dry season farming? ₦.....

Records of farm input

38. How much did you spend on acquiring the following inputs during the last farming season?

<u>Inputs</u>	<u>Quantity (bags)</u>	<u>Cost</u>
i. Fertilizer		
ii. Seeds		
iii. Herbicides		
iv. Insecticides		
v. Others (please name and put amount .....)		

Family/Hired labour records

39. Please indicate which members of your family or category of hired labourers, are mainly involved in the following farm activities?

<u>Activity</u>	<u>Men</u>	<u>Women</u>	<u>Children</u>	<u>Hired labour</u>	<u>cost</u>
Land clearing					
Ploughing					
Planting					
Weeding					
Fertilizer application					
Harvesting					
Livestock tending					
Transport of farm produce					
Marketing of farm produce					
Others					

40. Do you use hired labour on your farm?  
Yes ..... No.....

41. If yes, please indicate in the table in No. (39) above the activities you use hired labour for during the last farming season and the total cost for each activity.

42. Do you have any non-farm employment or job? Yes.....  
No....

43. If yes, what is the job?.....

44. How much did you make from non-farm job last year?  
₦.....

Household Decision Making

45. (Enumerator) Ask members of the household to indicate their levels of involvement in the following decisions. Ask the household head first and then check with other members of the household.

Decision	Decide alone	Jointly done by household members	By wife son/Daughter
a. Hire-in labour			
b. Allow household member to sell labour			
c. Use household member in farm work			
d. Allow household member to take non-farm job			
e. Obtain loan			
f. What to do with loan			
g. Sell crops/livestock to loan			
h. What to consume			
i. What to do with farm income			
j. What to do with non-farm income			
k. What to store			
l. Allow household members to own separate plots			
m.			

Control of resources within households

47. Does any other member of your household own separate farm plots and livestock? Yes.... No....
48. If no, can any of your wives/children own separate farm plots and livestock? Yes..... No.....
49. If yes, who controls the proceeds from such separate plots owned by the household member: (a) The household member (b) the household head (c) jointly controlled by me and the household member.
50. Who controls the proceeds from livestock by wife or child/  
(a) the household member owner (b) the household head  
(c) jointly controlled.
51. Does any member of the household apart from household head have an off-farm enterprise or job? Yes or No

- 52. If yes, who controls the income from such enterprise or job (a) the member (b) the household head (c) jointly controlled.
- 53. What is the name of the off-farm job?.....
- 54. How much did you/or any member of the household make from off-farm employment last year? =#.....
- 55. In your opinion, what are the benefits of using animal traction?  
.....  
.....  
.....  
.....
- 56. What are the disadvantage of using animal traction?  
.....  
.....  
.....
- 57. Do you intend to use animal traction in the future? Next year? Yes..... No..... Two years from now Yes..... No.....
- 58. If yes, what do you think you need, which you don't have now, which is important for you to adopt animal traction?
  - i. ....
  - ii. ....
  - iii. ....
  - iv. ....
- 59. If you do not intend to use AT in the future, what are your reasons?
  - i. ....
  - ii. ....
  - iii. ....
  - iv. ....

Household Labour Record Form

Date: \_\_\_\_\_  
Name of Household Head \_\_\_\_\_  
Town or Village \_\_\_\_\_  
Farm size \_\_\_\_\_  
Age of Household head \_\_\_\_\_  
Sex of Household Head \_\_\_\_\_

## Household composition:

## Male/Age Category

- (a) 0 - 9 years
- (b) 10 - 15 years
- (c) 16 - 49 "
- (d) 50 and above

## Female/Age Category

- (e) 0 - 9 years
- (f) 10 - 15 years
- (g) 16 - 49 years
- (h) 50 and above.

## Record of Farm Activities

Activity	Household Member state category (a - h)	Time of arrival	Time of Departure	Total Hours Spent	Mode of work. Animal Traction /Manual
Ploughing Ridging Weeding (1st,2nd,3rd) Planting Fertilizer application Mounding Remolding Harvesting Livestock tending Transport/Carting Others/specify please.					

*N.B/Write the Names of the crop or crops for which these activities were carried out.*

## Appendix C: Grains Weight Conversion

Grains	Tiya	Standard Unit (Kg)
Cowpea	1	2.59
Unshelled G/Nut	1	1.16
Shelled G/Nut	1	2.13
Guinea Corn/Sorg.	1	2.74
Maize	1	2.63
Millet	1	2.65
Rice (Milled)	1	2.80
Rice (Paddy)	1	2.08

1 Bag (100kg Bag) = 40 tiyas.

Source: Averages of Measurement taken in three locations in Katsina state converted to standard units (Field work 1994).

## Appendix D: CONVERSION FACTORS FOR CONSUMER UNITS AND MAN-EQUIVALENT LABOUR INPUT

Male	Age	Consumer Units	ME potential	ME actual
	0-9	0.6	0.1	0.25
	10-15	0.9	0.8	0.8
	16-49	1.0	1.0	1.0
	>49	0.9	0.7	0.7
Female	0-9	0.6	0.05	0.25
	10-15	0.9	0.4	0.8
	16-49	0.75	0.5	1.0
	>49	0.65	0.1	0.7

Source: Artur Runge - Metzger and Lothar Diehl (Editors), 1993.

## Appendix E: Conversion Factor For Tropical Livestock Units

Name of Livestock	Weighting /Conversion Factor Per Unit
Cattle	.70
Oxen (trained)	.80
Sheep	.10
Goats	.10
Horse	.35
Donkey	.25
Chicken	.01
Guinea fowl	.01
Duck	.01
Turkey	.02
Rabbits	.01

Source: Artur Runge - Metzger and Lothar Diehl (Editors) (1993).

## Appendix F: CROPPED AREA AND PRODUCTION FIGURES FROM THE 1993/94 CAYS SURVEY

CROP	AREA IN '000 Ha	PRODUCTION IN '000 TONS
MILLET	361.834	197.561
SORGHUM	619.681	546.559
MAIZE	86.668	136.675
COWPEA	470.549	166.104
G/NUTS	184.994	91.387
COTTON	125.179	74.732
COCOYAM	.473	1.728
YAM	-	-
SWT. POTATOES	0.294	0.677
PEPPERS	0.836	0.605
SOYABEANS	1.191	0.772
ONIONS	0.237	1.067
OKRA	3.865	1.929
RICE	10.980	18.446
TOBACCO	1.152	2.938
BAMBARANUT	4.860	3.990

Source: Annual Report of Katsina State Agricultural and Rural Development Authority (KTARDA) (1993), Katsina.