Sudan University of Science and technology

College of Agricultural Studies

كلية الدراسات العليا

PhD. In Agricultural Extension and Rural Development

Adoption of Draught Animals by Farmers in (West and South Kordofan State)

تبني حيوانات الجر بواسطة المزارعين في ولايتي غرب وجنوب كردفان

BY

EZDEHAR OMER MOHAMMED MUSA

B. Sc. Rural Extension, Education and Development (2008)

M.Sc in Sustainable Rural Development (2013)

Ahfad University for Women

Supervisor: Dr. Mohamed Badawi Hussain

Co-supervisor: Dr. Suad Ibrahim

A Dissertation Submitted to Sudan University in Fulfillment of the Requirements for the Degree of PhD. In Agricultural Extension and Rural Development

2018

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قال الله تعالي:-

(وَهُوَ الَّذِى أَنشَأَ جَنَّاتٍ مَعْرُوشَاتٍ وَغَيْرَ مَعْرُوشَاتٍ وَالنَّخْلَ وَالزَّرْعَ مُخْتَلِفاً أُكُلُهُ وَالزَّيْتُونَ وَالرُّمَّانَ مُتَشَابِهاً وَغَيْرَ مُتَشَابِهٍ)

صدق الله العظيم

سورة الانعام، الآية (141)

DEDICATION

I dedicate this work to my beloved family, especially kind parents, to my kind Dad who taught me how can achieve my goals and, my Mum who taught me the meaning of patience.

To my brothers and sisters for their encouragement and support and to all my lovely friends for help.

Acknowledgements

I would like to express my deep sincere appreciation and thanks to my supervisor Dr. Mohammed Badawi, for his guidance, infinite patience, encouragement, continuous advice and supervision throughout the preparation period of this work.

Great appreciation is expressed to Dr. Suad Ibrahim and Dr. AlNegomee for their continuous encouragement.

Special thanks to Dr. Anne Pearson from the University of Edinburgh for her encouragement.

I wish to thank Sudan University for providing a suitable and comfortable academic atmosphere.

Finally, acknowledgement of indebtedness is expressed to my relatives and all farmers in the study area, for their kindness in answering the questionnaire.

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List of Abbreviations

No	Terms	Definitions
1.	DAT	Draught Animal Technology
2.	AT	Animal Traction
3.	FAO	Food and Agriculture Organization
4	SPSS	Statistical Package for Social Sciences
5	VS	Veterinary services

ABSTRACT

This study was conducted in two localities in Kordofan State one of them En-nuhoud locality, West Kordofan State and Aldebibat locality South Kordofan state during 2015 - 2018 to Adoption of Draught Animals by Farmers. The study based on a cross-sectional survey with a sample of 200 farmers that was selected from ten different villages around En-nuhoud and Aldebibat areas. Villages were selected using the simple random sampling technique, while individuals from each village were selected using the systematic random sampling technique by selecting the first of each four farmers along a survey line across the area starting by the upper and of the farming area until ten farmers were selected.

Data were collected using a formal survey questionnaire. The questionnaire was filled by interview in a face to face for literacy reasons and by direct field measurements. Some information was recorded as observations to avoid farmers' bias on issues they can be considered "sensitive". Survey data were thereafter entered into SPSS 20.) Computer programme (Statistical Package for Social Sciences) and analysed to produce frequency tables and chart, also chi-square was calculated at level of significance 0.05 to measure the significant of the relation between farmers skills and adoption of animal traction technology.

The dominant type of harness was the collar and saddle. All most the farmers (80%) used light mouldboard plough.

The results showed that farmers in targeted area do not have extension services .Extension faces many constraints and problems; the most important of which are: Lack of development organization, service do not meet farmers need, neglecting the extension side, majority of services was provided by agriculture extension foundation. The agriculture extension concentrates in two activities service improve seed distribution and visit farm. This reflected on a weak role and negative impact on the farmers' and their husbandry and management practices were less than optimal and consequently field performance.

More than half of a respondent was cultivated groundnuts to increase their income.

All the farmers believe the use of animal traction useful for soil, convenient for small farmer, increase production, easy to use and available.

The result showed half of the target farmers use the animal traction for ploughing, while the rest for planting.

Farmers owned their knowledge and received training about animal traction for long time by different institution and NGOs and peer farmers.

The poor management of draught animals and the technology resulted in low work rates and masked the positive impact that could be brought by good management. However, in all the parameters tested there was no significant difference resulting from management on both field capacity and efficiency. The study recommended intensive farmers for adopting the technology by providing tools and credits also to raise farmers' knowledge through extension programs and encourage them to adopt the technology, formal and informal education should be provided to facilitate training process

مستخلص البحث

تم اجراء هذه الدراسة فى محليتي النهود والدبيبات بولايتي غرب وجنوب كردفان خلال شهرى يونيو ويوليو 2015 بغرض تبني حيوانات الجر بواسطة المزارعين، اعتمدت الدراسة على مسح عينة من (200) مزارع تم اختيارهم من بين القرى حول محليتي النهود والدبيبات. وقد تم اختيار القرى بطريقة العينة العشوائية البسيطة بينما تم اختيار المزارعين من كل قرية بطريقة العينة العشوائية المنتظمة عبر اختيار الأول من كل عشرة مزارعين على امتداد القرية ابتداءا من صدر منطقة الزراعة وحتى اكتمال اختيار عشرة مزارعين.

تم جمع البيانات بأستخدام الاستبيان ، تم ملء الاستبانة فى مقابلة مباشرة وجهاً لوجه مع المزارعين (لأسباب تتعلق بالأمية) اضافة للقياسات الحقلية المباشرة. تم رصد بعض البيانات عبر الملاحظة لتجنب تحيز المزارعين تجاه أمور قد تبدو حساسة بالنسبة لهم. أدخلت البيانات فى برنامج الحاسوب عن طريق برنامج تحليل الحزم التقنية للعلوم الإحصائية وتم تحليلها للخروج بجداول تكرارية ورسومات بيانية بينما تم تحليل المؤشرات المتعلقة بالفرضيات عبر الأختبار الأحصائى "مربع كاى".

كانت "الرقبية" والحبال والسرج هى وسيلة السبك الأكثر شيوعاً كما وقد كان المحراث المطرحى الخفيف هو الالة الاكثر استخداماً بواسطة المزارعين (80%).

أوضحت النتائج أن المزارعين في المناطق المستهدفة لايحصلون على خدمات الإرشادية.الإرشاد بتلك المناطق يواجه العديد من المشاكل والمعوقات أهمها : عدم وجود منظمات أو جهات خاصة بالتنمية، عدم توفير احتياجات المزارع، إهمال الجانب الإرشادي. الغالبيه العظمي من الخدمات تتوفر بواسطة الإرشاد الزراعي ويركز الارشاد في جانبين فقط توفير البذور المحسنة وزيارة المزارع. وقد انعكس ذلك على ضعف دور الإرشاد وتأثيره على جانب المزارعين. هنالك نواقص فى المعرفة والاتجاهات والتطبيق من جانب المزارعين فيما يتعلق بكل مناحى رعاية وادارة حيوانات الجر. وقد ظهر ذلك بصورة اكثر حدة فى شئون تتعلق بالرعاية الصحية للحيوانات، تغذية الحيوانات وشبك الحيوانات.

أظهرت النتائج وجود ثغرات في معرفة المزارعين ومواقفهم وممارساتهم فيما يتعلق بجميع جوانب تبني تقانة حيوانات الجر، وقد بدأ ذلك أكثر حدة في القضايا المتعلقة بالرعاية الصحية الحيوانية، والتغذية وسقيها، وتسخيرها. وقد كان أكثر من نصف المزارعين يزرعون الفول السوداني لزيادة دخلهم. ويعتقد جميع المزارعين استخدام حيوانات الجر مفيدة للتربة، ومريحة للمزارع الصغيرة، وتزيد الإنتاج، وسهلة الاستخدام ومتوفرة.

أظهرت النتائج أن نصف المزارعين المستهدفين يستخدمون حيوانات الجر للحراثة. يمتلك المزارعون المعرفة عن حيوانات الجر لفترة طويلة من قبل المزارعين والقري المجاورة.

أدى سوء إدارة حيوانات الجر إلى انخفاض معدلات العمل وإخفاء الأثر الإيجابي الذي يمكن أن تحققه الإدارة الجيدة.

أوصت الدراسة بتحفيز المزراعيين لتبني التقنية بتوفير ادوات الجر والقروض ورفع معارف المزارعين وتشجيعهم على تبني تقنية حيوان الجر كما أوصت بتوفير التعليم الرسمي وغير الرسمي لرفع مستوي التعليم وسط المزراعين لتسهيل عملية التدريب.

CHAPTER ONE

INTRODUCTION

Chapter One
Introduction

1.1 Background

Throughout the developing world and in many developed countries, draught animals are an inseparable part of agriculture and in many countries, particularly in sub-Saharan Africa; the use of work animals for agriculture and rural transport is increasing every year (FAO, 2000).

Animal traction technology is particularly important to the traditional rain-fed farming in the Sudan and neighboring countries as many experts count on it for solving the food insecurity problem of the rural farmers. The technology constitutes one of the major solutions to the low productivity and the expansion of the production area associated with the traditional hand tools used by the rural farmers (Makki and Mohamed, 2011).

The use of animal technology for agricultural practices is potentially useful and is also an appropriate means of improving the efficiency of the traditional farming system.

Draught animals play a major role in smallholder semi-arid crop/livestock farming system. Agriculture under this system increasingly relies on animal traction power for most farm activities. The technology continues to make significant contribution to many rural and urban economies (Dijkman et al., 2007).

In some farming systems timely execution of field operations is a major concern for farmers especially when pressure of catching the planting season is the key to future yields and the limited capacity of hand tools become apparent. Farmers in this situations need to improve /increase the performance (speed of operations) to meet time requirements for a successful cropping season (Makki and Pearson, 2012)

Animal power is a renewable energy source that is particularly suited to small scale family farming systems and to local transport. Animal power is generally affordable and accessible to the small holder farmers, who are responsible for much of the world's food production. Compared with manual alternatives, the use of animal power allows rural farming households to increase their efficiency and reduce their drudgery. The combination of timeliness and time saving in field operations promotes the achievement of higher and more reliable crops yield (FAO, 2007).Also, the transport role of animals is important for carrying farm inputs (seeds, fertilizers etc…) and outputs (harvested crops).

Animal traction is seen by farmers and policy makers in many parts of the world as an appropriate, affordable and sustainable technology, which requires few external input (Starkey *et al*., 1995).

Animal traction (as intermediate technology) has been widely spread since a long time throughout Africa, Asia, and Latin America. There are considerable differences in level of development and types of the technology as well as differences between the areas in which it has been introduced. In the last three decades, animal traction technology has been adopted in different rural development projects in Sudan, as an intermediate alternative to the very traditional and modern technologies. The idea mainly aimed at introducing simple, efficient, low–cost appropriate technology to increase the agricultural productivity, and the cultivated area as well as to promote off-farm activities in the rural areas.

Animal traction in Sudan has a long history in Sudanese agriculture. The technology dates back to the ancient paranoiac kingdoms of North Sudan today, animals are successfully used in land preparation by many farmers along the Nile valley.

Nevertheless, this technology was not common in the traditional rain-fed farming system in the country, except for a few migrant who introduced in to some parts of Darfur region. This motivated some national and international agencies like practical action formerly "Intermediate technology Development Group", and the Western Savannah Development Project to consider diffusing the technology to local farmers in the region.

The success of the experience in Darfur motivated the attempts of many projects introduced the technology to Kordofan where the farming system is almost similar.

1.2 Previous Studies

1. Husbandry, working practices and field performance when using draught oxen in land preparation in Shambat, Nile Valley, Sudan (Alsamawal Khalil Makki) Journal of Agriculture Extension and Rural Development.

Little quantitative information is available on animal power in the Nile Valley in Sudan, despite that it is being used in the area for centuries and playing an important role in agriculture in the present day. A survey was conducted to assess draught oxen management and its association with field capacity and efficiency at the farm level and to identify potential areas for intervention. A sample of 50 farmers was selected for this purpose using the systematic random sampling technique. The main management parameters discussed were animal health, feeding, housing, work strategy and care for yoke and plough. The results showed that most of the farmers

poorly manage their animals, and this was reflected in low working speeds and field efficiencies. The main dimensions of poor management were in veterinary care (78 % did not take their animals to the veterinary centre), feeding (66 % feed their animals shortly before work) and care for yoke (80 % did not follow daily care measures for their yokes) and plough (74 % did not follow plough care measure before and after work). Low working speeds (0.90–2.0 km/h) were recorded by the majority of the farmers (64 %). The majority of the farmers (70 %) recorded field capacities between 0.06 and 0.10 ha/h, while all of them worked at high field efficiencies of >86 %. The only parameter that significantly affected field capacity was the yoke-related wounds ($p = 0.019$). Extension advice and capacity building in husbandry and working practices were identified as principal entry points for intervention.

2. The Effect of Using Animal Traction on Farm Efficiency and Household Labour Allocation on Smallholder Farm in Kenya: A case Of Kirinyaga District.

Paul Guthiga Maina.

The continued sub-division of land due to population pressure coupled with traditional inheritance patterns has led to an accelerated decrease in individual land holdings. The small-scale farm will therefore remain the model farm in Kenya in the foreseeable future. To meet the food demand of the increasing population, increasing productivity of small-scale farms is paramount. Appropriate mechanization of the small farm is one of the ways of increasing farm production.

In addition to allowing for expansion of cultivable land, the use of animal traction has the advantages of deeper ploughing and greater timeliness in carrying out field operations. However, when introduced into a household, animal traction can affect the labour allocation patterns of the whole household. Furthermore, with the existing patterns of labour allocation by gender, the increase in labour demands may imply shifts in workloads between gender categories and also between agricultural operations. The current study analysed the effect of using animal traction on maize production efficiency and on inter-gender labour allocation.

A multi-stage sampling approach was used to select 80 farmers in Kirinyaga district from whom data were collected using a structured questionnaire. A profit function was estimated to test the hypothesis of equal economic efficiency between “traction” and “hoe” farms. Farm labour-time allocation models were estimated and used to test hypotheses regarding inters gender labour allocation patterns.

The results indicated that farmers who used animal traction obtained maize profits that were 86% (CONFIRM THE FIGURE) higher than those who used the hoe.

‘Traction’ farmers obtained an average profit of Kshs 6,423.00/acre from the maize enterprise while their ‘hoe’ counterparts achieved an average of Kshs 1,342.53 from maize enterprise. This was so in spite of the ‘traction’ farmers having used lesser amounts of fertilizers in maize production. Farmers who used animal traction had more land under maize and hired more labour than those that used the hoe.

However, use of animal traction was accompanied by increased labour requirements that were in this case met through hiring. The factors that were found to influence the female farm labour- time allocation were the education level of the female farmers, the number of dependants in the household and the amount of hired labour. On the other hand, hired farm labour and farm income were significant in the male farm labour-time allocation model. The significance of these coefficients implies that, labour time allocation of the different gender groups can be altered if any interventions affecting the corresponding variables are undertaken. The study underscores the viability of animal traction in increasing efficiency of small-scale farms. The results showed that with the use of animal traction, there was an increase in farm labour requirements but there was no overburdening of any particular gender group in the household. The extra labour requirements were largely met through hiring. Animal traction was largely used by men at the land preparation stage with little application during weeding.

The government and other agencies should continue with their efforts in advocating the use of animal traction in the smallholder farms. But there is need to consider intensifying mechanization beyond the land preparation stage.

Financial assistance and training should be considered for helping farmers acquire and learn to use weeding implements. This would ease the problem of extra labour needs that arise with the use of animal traction. However, given the ability of households to hire more labour, use of animal traction can be viewed a good source of rural employment.

3. Relationship between management and field performance of draught animals used for land preparation. An example from South Kordofan State, Sudan

Elsamawal Khalil Makki1 and Samia Abu-Elgasim Manzool.

Journal of Agriculture Extension and Rural Development

This study was conducted to investigate the association between animal work hours, feeding and other aspects of animal management and care on the field capacity and efficiency recorded by these working animals in Adilling, South Kordofan State, Sudan. The study followed the cross-sectional survey design with a sample of 100 farmers from 10 villages in the locality following the systematic random sampling

technique based on geographical location. Data were collected using a formal survey questionnaire in a face to face interview, for literacy reasons, combined with direct field measurements during land preparation. The results revealed that field capacity was significantly related to veterinary care of draught animals (p= 0.001), while the effect of daily work hours and type of animal feed was not significant. Farmers' status and financial capacity, as expressed by their production, purpose significantly affected field capacity and efficiency (p = 0.033 and p = 0.021, respectively) with 64% of those producing cash crops working at 0.02 – 0.08 ha/h. The majority of the latter group (78%) recorded field efficiencies between 70 and 90%.

4. Farming systems approach to improving draft animal power in sub-Saharan Africa by Forbes Muvirimi 1 and Jim Ellis-Jones 2

In Zimbabwe the use of draft animals is widespread and long-established outside tsetse-infected areas. Most farmers prefer to use oxen for ploughing, especially on heavier soils, as they are faster and stronger than donkeys. However, lighter operations, especially weeding and transport, are increasingly being carried out by donkeys. The 1991/92 drought reduced the cattle herd from 4 million to less than 3 million animals and the donkey herd from 400,000 to less than 300,000. Peak demand for animal power is for ploughing at the end of the dry season when animals are in worst condition and feed resources at their lowest. As a result, availability of draft power is a limiting factor in many areas. Productivity could be improved either through increasing the supply of draft animals or reducing the demand for draft animals by increasing their effectiveness. Increased use of donkeys and increasing the carrying capacity of communal land could increase the supply of draft animals. Conservation tillage systems and improved implements could reduce the demand for draft animals. Farming systems in Zimbabwe are complex and vary geographically. If research is to be relevant to farmers it is essential that existing farming systems, rather than current extension recommendations, form the basis for research programme.

1.3 Problem Statement

Despite the long history of animal traction technology in Kordofan states, yet the technology still lags way below its expected outcome and farmer's capacity needs further building and strengthening (Makki and Musa, 2011).

Few data is available regarding research trials and training packages on the different aspects related to the draught power, work rates and efficiency. Research results showed many gaps in farmers' knowledge, attitudes and practices regarding feeding, health care, training and harnessing of work animals between different localities. All

these together will affect the performance of animals and farmers will blame the animals and technology instead of blaming themselves. These even ignored the farmer, animal side in terms of management and usage patterns in relation to work rates using different types of implements. By conducting this research, hopefully planners, trainers, and decision makers will clearly be able to identify the gaps in animal traction technology in the area. This will help in a profitable and successful adoption of animal traction for improvement of farmers' livelihood.

1.4 Objectives

Main Objective:

To identify the effect of animal traction adoption by the farmers

Specific Objectives

1- Estimate the extent of farmer knowledge about animal traction (Animal traction management Practices).
2- Assess to what extent the technical innovations introduced are acceptable by traditional farmers in the area.
3- To identify animal management practices provided for the draught animal.
4- To analyses animal traction adoption among farmers.
5- To find out farmers opinions on the importance/usefulness of animal traction
6- To find out the effectiveness of the extension methods used in promoting animal traction
7- Analyze the different work rates and efficiencies of animal traction in Kordofan (field capacity and efficiency).

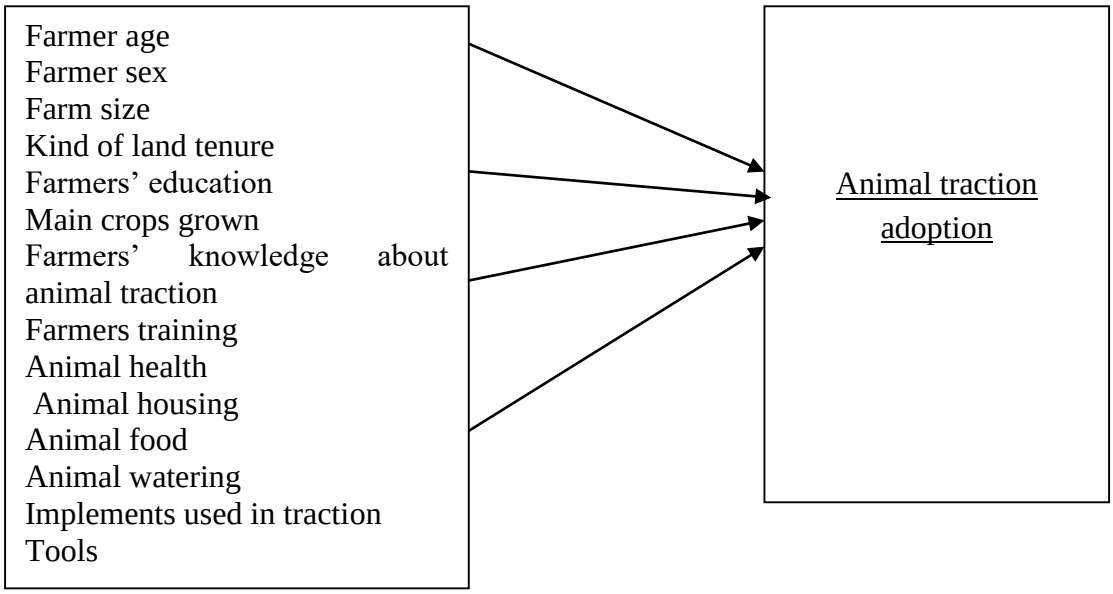
1.5 Main Research Questions

To what extent do farmers in Kordofan state adopt animal traction?

Key question can be stated as follows:

1. Does the farmer own all information related to animal traction?
2. Does the lack of experience prevent the farmers to adopt new technology?
3. Do the farmers receive any technical support about how to use animal traction technology?
4. How did the farmers receive this technology?
5. Do the farmers know about animal management?
6. What is constraints limited adoption of (AT) technology?
7. Have the extension methods used so far affected the adoption of animal traction.

Independent Variables Dependent Variable



Prepared by researcher, 2015

1.6 Research hypotheses

Null hypothesis

Farmers in Kordofan state adopt animal traction

Alternative hypothesis

Farmers in Kordofan state adopt animal traction

1.7 Organization of the study

The study was divided into five chapters, the content of which are indicated below:

Chapter One: includes introduction, previous studies, problem statement, objectives, Research questions, Research hypotheses and organization of study.

Chapter two: provide in depth literature review.

Chapter three: explains and justifies choices of methodology, description of the study area, location population etc.

Chapter four: presents Result and discussion.

Chapter five: includes conclusion, recommendations of the study, appendices and references.

CHAPTER TWO
LITERATURE REVIEW

Chapter Two
Literature Review

2.0 Preface

Chapter two deals with literature on effect of the farmers Operational Skills in the Animal Traction Adoption. Areas reviewed are meaning of AT, contribution of AT to agricultural development, adoption of technology, DA selection, training of draught animal, AT extension, AT as the technology innovation, skill levels in society currently relying on animal power, Other are DT management, working strategy animal harness. The rest are field capacity and field efficiency, factors effecting field capacity. These areas are reviewed because they influence adoption. Before farmers adopt technology must know its characteristics. (Panin and Ellis, 1992) said farmers are likely to adopt a technology if they perceive the technology to be profitable. In the same vein the choice of extension teaching methods and the ability to communicate effectively taking into consideration the socio-economic and socio-culture of farmers play a significant role when introducing a technology for adoption (Leagons, 1960; Maunder 1972).

2.1 History of Animal traction

Animal traction was first started in Asia thousands of years ago. It was introduced into sub- Saharan Africa through European settler farmers, early Development Programmes and Migration of workers within the region during the colonial period (Starkey, 1990).

Animal traction is the use of draught animals for tillage, seeding and other activities (Barret, Lassiter, Wilcock, Baker and Crawford, 1982). Munzinger (1982) also described animal traction as the employment of animals for draught activities.

2.2 Adoption of Technology

Adoption is the decision to apply an innovation and continue to use it. Early studies in adoption found that in the process of adoption an individual goes through five stages. These are; awareness, interest, evaluation, trial and adoption (Maunder, 1972). Later studies re stated that these stages correspond to knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995). He argued that the latter stages are less inspired by normative decision-making theory, and sup Animal traction technology adoption has two main meanings:

1. Transfer of ideas, techniques or implements from an area, where they have worked effectively, to another.
2. The dissemination of knowledge or skills - transferring or communicating ideas and techniques to the intended clientele.

2.3 Factors influencing adoption animal traction technology

Although animal traction is very useful especially for the rural farmers, there are positive and negative factors influencing the adoption of the animal traction technology (Lawrence *etal,*. 1990). However these factors can present as follows:-

2.3.1 Shortening fallow period

It appears that animal traction is more likely to be attractive clearing land is one of the most labour intensives activities.

Animal traction generally assists in this task. In addition, higher slanders of land clearing are required if animals are to perform any subsequent work. In the farms, animal traction saves labour, particularly in land preparation.

Usually the areas where animal traction has been adopted are those in which population density and pressure on land increasing, reducing the length of the fallow period.

2.3.2 Expanding the area cultivated

The adoption of animal traction initially related in many countries to increased production of cash and food crops for sale. It gave farmers the opportunity to expand the area they cultivated. If additional land is not available in system, animal traction will not have livelihood being adopted.

2.3.3 Availability of suitable animals

Animal traction is adopted faster in areas where animal tractionand grazing lands are easily available. Agro pastoral people and others who either have direct experience of livestock or can easily acquire such experience are more likely to adopt than farmers where no or very few livestock are present, as in large areas of state – infested sub humid and humid zones.

In the same areas the cost of animals is beyond the means of poor families, government can offer credit schemes to help spread the technology. In addition, ownership may be individual or collective.

2.3.4 Feed supplies

The quality as well as quantity of animal feed needs careful consideration when introducing animal traction.

The availability of pasture depends on climate, soil, water, farming system and other factors.

2.3.5 Semi-arid areas

Despite the availability of animals and grazing areas, animal traction may not be as attractive for semi – arid areas as one might think. Such areas have a shorter period for land preparation, due to the rainfall pattern and to the potentially large yield losses incurred by delayed planting.

Animal traction is most likely to be adopted in semi- arid areas experiencing-migration (as in Kenya) and favourable prices for certain crops (as in West Africa).

2.3.6 Soil type, crop type and associated risks

Where the soil becomes too compact during the dry season farmers must wait until the onset of the mains before starting to prepare land.

However, if planting is delayed the growing season in effect becomes even shorter and yield losses result. Ploughing in this situation is only advantageous when it effect on yield exceeds the losses associated with delays in sowing. This ploughing is worse on soil with low moisture holding capacity and in the areas of low rainfall. In other instance, farmers may choose to use the plough in selected areas only. For example, on heavier soils in depressions. Thus the adoption of animal traction depends on the soil type, crop grown, climatic conditions and related risks.

2.3.7 Suitable equipment

Equipment has given more problems than any other factor influencing the adoption of animal traction. Implements have been introduced that are complicated and too expensive. They are also economically in appropriate, imported and so not available locally, too heavy for animals and whose profitability cannot be demonstrated to farmers. These problems can lead low rates of adoption many countries.

2.3.8 Sociological factors

Social relationship may influence the adoption of the animal traction.

Social relation may determine whether cost sharing for initial purchase of animals and tools is feasible. Also, gender issues may influence animal adoption. In many countries there is traditional division of labour by sex. For example, in Tanzania women do not have control over the management of oxen, which is left to the men, who own them.

2.4Animal traction selection

Farmers must be able to select the animals most appropriate for their needs. The animals they choose must be culturally acceptable, trainable, maintainable, and profitable with the overall farm plan. It is also important that the animal be available locally, since these animals are already adapted to local feeds and climate and are likely to be resistant to diseases in the region. Of course, farmers should choose healthy animals from strong stock. In some areas, farmers must consider social or religious traditions which restrict the ownership or use of animals (Watson, 1982).

2.4.1 Determining Power Requirements

Before attempting to determine the kind and number of animals required for any particular farm, animal owners should be familiar with the concepts of pulling (draft) capacity and power. They should also consider the work characteristics of draft animals.

2.5 Selection of individual draught animal

Once farmers decide what kind of draft animal will be used, they must be able to choose individual animals which are sound and trainable work expectancy and resale value. Selecting a good draft animal is a matter of evaluating both physical and behavioural attributes. Age, sex, conformation (shape), and temperament are helpful criteria for judging a draft animal's value. The farmer's total animal needs must be noted when judging an individual animal. If it is to be used as pair, it should be roughly the same age and size as its work mate, and should be the same sex (Watson, 1982).

2.6 Training of draught animal

Some animal traction extension programs sell trained animals of custom or contract training, where the farmer pays a professional to do the training. However, these

options are often not available, and many, if not most, farmers are evolved in the training of their animals.

Those who instruct these farmers in animal traction should keep in mind that many of them are already familiar with basic care and handling of animals thought the animals may not be used for traction purposes. In fact, farmers may be more knowledgeable about particularities of local breed or individual animal than the instructor; in many cases the teaching can go both ways. Also, instructors who become involved in animal training should always remember that their goal is to include farmers in every operation and make them do the training.

Farmers quickly become confident trainers when they are shown tools and techniques that give them sure controls over the animals (Watson, 1982).

2.6.1 Before training begins

Before formal training sessions begin, an animal should have time to adjust to its new owner and surroundings. Separated from its familiar environment and handled by someone whose touch, voice, and movements may be new, it may refuse to eat or drink, appear abnormally quiet or nervous, or try to run away.

New owners can help their animals adjust by:

* Handling them in a calm, confident way. People, who use hesitant motions, speak in excited voices or misuse ropes and whips can cause animals to react defensively. Cattle kick, butt, toss their heads, or simply refuse to move. Horses, donkeys, and mules may kick, bite, rear, or try to squeeze a person against a fence or wall; avoiding frightening the animal with procedures that cause it pain or discomfort. Inexperienced owners are sometimes anxious to make their animals more docile or trainable through castration, use of drugs, or restraints such as nose rings or hobbles. While such measures may be needed or advisable under some circumstances, it is generally poor practice to use them before an animal has had time to adjust and reveal its natural disposition (Watson, 1981).

2.7 Animal Traction Extension

Many countries have agricultural extension services of some kind in which locally - based extension workers or agents visit farmers and advise them on new plants species, pests and diseases of crops, and the use of fertilizers and pesticides. Extension agents understand the need for farmers to produce more for the national economy and are expected to help farmers increase their production to meet both the family’s needs and those of the national government.

Social or cultural practices and traditions may dictate the types and number of crops grown, the cropping method, and even when crops are planted or harvested. Farmers using traditional tools and techniques for many years know how much work is required for a certain harvest.

Extension agents provide the support necessary to encourage the farmer and reduce risks of failure from improper use of new systems.

Extension program can provide education and equipment, and health care for the animals. The success of an animal traction program may depend upon the availability of these services to farmers (Watson, 1982).

2.8 Animal traction extension (extension education)

Extension education is a way of supplying new ideas, information, and technology to people who are far from schools or who have no time to attend classes. The teacher, or extension agent, is a trained specialist who lives in a small town or village and circulates to outlying communities where people have shown interest in improving traditional skills or developing new ones.

The extension agent's class room may be a cornfield, forge, family kitchen, shop or marketplace, or dispensary; the student is usually a successful, long practicing professional farmer; the method of teaching is informal discussion, demonstration, and application. While it is ultimately the village extension agent who becomes the farmer's key resource on animal traction, it is often a special instructor who has the job of popularizing the method in a given region. The instructor may be an outside technical assistant such as a Volunteer, missionary or private consultant, or a trained agent of the country's agricultural service.

2.9 Animal traction as a technological innovation

Farmer adoption of a technological innovation will depend on the degree to which the innovation reduces the unit cost of inputs used in the production process (Binswanger, 1986). Since unit costs depend on input levels per unit of output as well as on input prices, economic as well as agro climatic and soil factors are important in assessing the potential for farmers' adoption of any technology innovation in farming system.

If we define animal traction as the use of livestock (cattle, horses, donkeys and camels) as a source of power for transportation, field cultivation and processing, its effect on any farming system in terms of input saving per unit output would be to save labour as crop area per unit of labour increases. Yield – increasing effect of

mechanization is negligible (Pingali, Bgot and Binswanger, 1987), and therefore area required per unit of output is usually unaffected. This means that the savings achieved in labour input per unit of output must be more than offset by the extra livestock and equipment cost. Thus, the higher the wage rates in an area (cost of labour), the greater the potential benefits from animal traction.

2.10 Skill levels in societies currently relying on animal power

In some areas of the world, draft animals are part of the traditional way of cultivating the land. For instance, in Ethiopia, Egypt India, Nepal, Southeast Asia, North Africa, and in most of Latin America, people are accustomed to training and managing their draft animals. Implements are readily available locally, usually made from local materials, with a local system to repair and replace them.

In other area of the world, draft animal power is a more recent technology in cultivation and crop production. For instance, until recently in West Africa and much of sub- Saharan Africa, animal diseases prevented the keeping of animals in many areas, and the traditional methods of cultivating the land used manual labour only. It is only within the last country that many people have made use of draft animals on their farms in these areas, following availability of drugs. Because of the relative newness of the technology, the support infrastructure might not be available locally. As a result, the animals and implements available are expensive and they involve considerable investment by the farmers before they can see the benefits and the drawbacks for themselves. Often, implements are imported or manufactured by companies selling a range of agricultural equipment.

Alack of skill can often be seen where working animals are used in transport enterprises in urban areas. (Pearson, *et al*., 1999).

2.11 Draught Animals Management (Husbandry)

The management of draught animals should include efficient management of the power itself, both when it is required in seasonal tasks and over the rest of the year so that the resource is not wasted (Pearson, 1998).

The draught power output of any animal is largely a function of its live weight, provided it is in good health (Pearson and Smith, 1994), so it is in the owner's interest to ensure that it does not get too thin during the dry season.

Proper management with daily inspection, good handling and careful husbandry of the animals reduces health problems. Simple attention to animal condition, feeding

and provision of adequate water is basic to maintain animals in a healthy state so that they can work well (Jonson, 2003).

The supply of satisfactory level of draught animal's power at the right time for crop production requires sound management of draught animals throughout the year. Relevant features of animal traction management include adequate feeding, health care and appropriate use of animals to ensure their sustained use on farm. Adequate feeding to meet the nutrient requirements of draught animals is major constraint facing farmers using animal power in Sami-arid area. Reasonable levels of animal productivity can be expected from natural pastures during the rainy season (Fall *et al*., 1997).

Number of days worked depends on cropping patterns, animal availability and land ownership. Management of working animals does not just depend on the requirements for work, but also on the other outputs that are expected in addition to work. Compared to other productive outputs from cattle, a 450kg ox doing days' work of 5-6 hr requires an energy intake equivalent to that needed to produce about 0.75kg live weight gain or about 5-6 L of milk. The work output of animal traction is influenced by several factors such as the type of implement used, the working depth and the operator as well as the environment and soil conditions (Pearson *et al*., 1999). Management is easier for these draught animals since the farmers only need not consider the work load and live weight of their animals. The same animals are often kept by one farmer for many years (Pearson, 1998).

Animal husbandry is the science of taking care of domestic animals that are used primarily as food or product sources. In many places throughout the world, people are essentially specialists in animal husbandry by means of being farmers, ranchers, sheepherders, or anyone who takes care of a variety of animals, especially in large groups, is practicing husbandry (Ellis, 1985). Animal traction husbandry should be as stress free as possible. If draught animals are handled frequently, stress caused by contact with human beings will be negligible. Animals should be groomed (washed brushed) and inspected and trimmed as necessary. (Dijkman *et al.*, 2007).

Attention must be given specially to those areas of care of the feet of working animals. Another important area in a working donkey or mule is skin, which is in contact with the saddle or harness because their ability to work is dependent on fittings where sweat may accumulate (Amaswamy, 1994).

Pearson (1986) makes the important point that little benefit will be gained from better feeding, training and improved harnessing and implement design, if health is neglected. Care is required to prevent stress and subsequent loss of health to ensure

the animal can carry out timely work. The animals rely mostly on grazing of natural pastures that are communally owned. These pastures are generally poor in quality and due to lack of control they are overgrazed. During the dry season the pastures do not produce enough fodder to maintain the animals.

The identification of feeding and management strategies for draught animals in farming system requires information on the availability and the nutritive value of existing feed by draught animals and information on the nutrient requirement of draught animals for work. Also it is important to ensure that young animals are given ample feed and opportunity to grow to their maximum possible size before starting the work.

The successful use of animals for draught purposes depends on how they are tamed, trained and harnessed. The animals have to be kept in the training to maintain their strength and skills (Hopfen, 1969).

Much animal traction husbandry and management is the same as for the other animals, but there are special features which include the following:

- Animal traction has been able to work when they might be least able to do so (i.e. at the end of dry season).
- Husbandry practices (e.g. vaccinations, mating of draught cows) will have to be timed in conjunction with work requirements.
- Work can cause stress and predispose animals to further health problems.
- Veterinary care will be required at specific time.
- Foot care is required.
- Draught animals are therefore more vulnerable to illness.
- Draught animals need to be easily handled and used to human beings.
- Draught cow nutrition is more complex than for oxen.
- Draught animals may suffer heat stress.
- Dome specific health hazards of work.
- The animal traction husbandry requires a greater labour input (for feeding, cut and carry).

Practical advice about supplementary feeding is required particularly, if the working day is long or the animal is kept in at the night. The animals have to be trained before they can be used for work. Training is mainly to teach the animals to respond to and obey human language (verbal commands) and how to pull the various implements

2.12 Feeding

Feeding standard for draught animals has been published (Lawrence and Pearson, 1999) and it is now possible to predict energy requirement for working. However Pearson *et al*., (1999) cautioned that some information was still need to validate this feeding standard.

The nutrient requirement of draught animals have been also described by Mather's (1982), Lawrence (1985), Pearson (1986) and Teleni and Hagen (1989). The main energy metabolites which supply working muscles are acetate, free fatty acids and glucose. Acetate is the main energy substrate for resting muscles, but when animals work, free fatty acids become important and glucose utilization is increased (Bird *et al.*, 1981; Pethick, 1984).

Energy requirement depend on maintenance energy required which is related to body weight (MAFF, 1975) and also to the rate of growth, type of work, other productive out puts and environmental condition. Mineral supplements can help to improve productivity in all classes of livestock. In addition most mature dry and green forage are found deficient in phosphorus and sodium (Bediye and Sileshi, 1989).

Residues from areal crops from major component of the forage available for draught animals after the harvest on many farms. However, quality can vary depending on the component of the plant consumed and the length of time that crop residue remains in the field after harvesting. Groundnuts and cowpea residues provide additional forage to reduce the short fall in feed supply between successive rainy seasons, and/or to provide supplementary feeding during work to minimize weight loss (Pearson, 1998).

Feed intake can be influenced positively or negatively by work through direct or indirect mechanism. Direct effects of work on feed intake occur through physiological changes resulting from exercise. Physiological changes in working animals include increased metabolism during work. The resulting heat stress could depress feed intake in working animals (Collier and Beed, 1985). One indirect effect of work on intake stems from the reduced time animals have access to feed. Limit time available to eat and ruminate is a major constraint to increased feed intake in working ruminants (Pearson and Lawrence, 1992).

The owner of draught animals must be made aware of the benefits to them and their animals of improved nutrition and the importance of supplementary feeding, especially during dry period. Possible examples are the promotion of the use of road side grass either by animals under supervision or by cutting and storing, allowing working animals' longer feeding periods, and provision of affordable and suitable

supplementary feed Panin and Ellis (1985). If supplementary feed is given to draught animals it is usually only when grazing is poor.

However, some horses, especially in urban areas, are given supplementary feeding as matter of course. Anderson and Dennis (1994) suggested that animals which are used throughout the year require more feed than those used for only short periods of time seasonally. Supplementary feeding after work in ruminants minimizes intraluminal heat production in the working period. It has been suggested that feeding at least 2 hour before work insures a ready supply of energy yielding substrates for working muscle, particularly in horses and donkeys (Pearson, 1998).

The timing of feeding during the day and the number of feeds when animals are working should allow the animal to consume as much food as possible. Most of the food eaten by a working animal is used to provide energy requirements for protein, vitamin and mineral. Energy requirements other than for maintenance are negligible in the animal traction (Lawrence, 1985; Pearson and Lawrence, 1992). One of the most common problems farmers are faced with, when keeping working animals, is the provision of food of sufficient quantity and quality at the time when the animals are required to do most work. The feed given to working animals depends mainly on season and location (Pearson, 1998). In order to perform well, draught animals need to receive feed of suitable quantity and quality. Pearson (2012) suggested the following remarks on animal traction feeding:

- Time of feeding can be important to minimize heat load during the working period.
- Feed after watering, not before. If it is dehydrated the work animal will not eat well or may stop eating all together.
- Feed working animals individually not in group to reduce bullying and make sure each horse and donkey gets its own ration.
- Feed a mixture of two to three types of concentrate food rather than one type only in the ration.
- Feed handful of salt a day to working animal, mixed into its feed.
- Mix one cup of vegetable oil (250 ml) for a donkey and two cups (500ml) for a horse per day into the feed immediately before feeding.
- If the animal is working, feed concentrates in the day roughage at night and in the early morning when the animals have more time to eat.
- Avoid working the horses or donkeys on a full stomach, allow at least one hour for digestion after feeding. This is a good way to help meet some of the extra energy required by working animals.

- If the feed is dusty or dry add water just before feeding. This is important if the feed is given in nose bag or sack because it will prevent animal from breathing thin in the food or dust.

Time of feeding also affects feed intake. Bakrie and Teleni (1991) reported reduced feed intake by animals fed roughage before work as compared with animals fed after work. Positive effect of work on feed digestibility may stem from the enhancement of microbial fermentation through greater mixing of rumen contents due to exercise (Matthewman and Dijkman, 1993) and higher but moderate body temperature resulting from wok. Detrimental effects of work on food digestibility may result from the shift of blood flow from the gut to muscles and peripheral tissues and reduction in meal frequencies (Matthewman and Dijkman, 1993), and the less thorough mastication of food because of limited time to ruminate (Pearson and Smith, 1994).

2.13 Veterinary care of draught animals

Many countries in Asia and Africa face problem due to epizootic livestock diseases, such as foot and mouth disease and rinderpest. Most countries in these regions have programmers for controlling or eradicating this disease. However, in some countries funds and infrastructures are inadequate. Draught animals may suffer due to lack of adequate field based veterinary services (Amaswamy, 1994).

Veterinary services in some countries tend to be oriented towards pest, dairy animals and race horses. Thus, the genuine requirements of draught animals in rural and urban areas are not met.

Since farmers are widely dispersed, mobile veterinary services should be strengthened in rural area (Amaswamy, 1994). Pearson (1986) Made the important point that little benefit will gained from better feeding, training and improved harnessing and implement design if health is neglected. Care is required to prevent stress and subsequent loss of health to ensure the animal can carry out timely work. Animals should be groomed (washed and brushed) and inspected daily for wounds, skin infection, sign of harness rubbing and tick, hoofs should be inspected and trimmed as necessary. Prior to the main cultivation season, attention should be given to health and condition to ensure that animals will be able to complete the work necessary. Since stress can arise because of poor nutrition, attention at this time to building up body condition is important.

Good vaccination and drugs are necessary for protection against trypanosomiasis. It should be borne in mind that vaccination should be given at time that work stress

does not interfere with immune response. At the time of buying it is necessary to check the animal with assistance of veterinary service as of follows (FAO, 1972):

- By means of clinical examination, that the animal is not ill.
- If it comes from another region, that it is not liable to transmit diseases.
- Take steps to ensure that it is as far as possible protected against diseases.

Cattle can be sprayed strategically against ticks using hand sprays or washing. Routine drenching against round worms and flukes is recommended, particularly where animals are working in water area. Ectoparasites such as lice can be treated with insecticides. Brushes should be treated to stop the spread of manage. Ring worm, which is more common in younger animals, can be treated with tincture of iodine daily on the lesions. Wounds and scratches can predispose to other infections such as streptothricosis and should be washed and disinfected (Pearson, 1986). Healing ointment will help protect the wound and keep flies off. Proper nose rings should be used rather than rope to reduce irritation and laceration of the nasal septum. Horn injures from light ropes and neck and shoulder injuries from harnesses can easily be avoided by careful attention to harnessing methods. Rope harnesses should be disinfected regularly, attention should be given to the possible dangers and causes of lameness in the locality where animals work or graze (Pearson, 1986).

2.14 Housing

Housing is the place where the draught animals are kept when not out grazing or being worked. It should be a place where the animals can relax, rest and feed for the next working day. Because of their value, animal traction offer one of the best ways of introducing improved animal husbandry method to local farmers (ASP, 2004).

Housing Facilities where animals are kept should be appropriately staffed, designed, constructed, equipped and maintained to achieve a high standard of animal care and should fulfil scientific requirements. In general, housing and management practices should be designed to provide a high standard of animal care, and should follow acceptable standards of animal welfare for the particular species concerned. In determining the standard of animal care, the criterion should be animal well-being rather than the mere ability to survive under adverse conditions such as environmental extremes or high population densities. Emergency care procedures shall be available at all times (ASP, 2004).

A simple shelter or lean to would provide the necessary protection from rain. Shelter should have sloping floor to allow run-off to keep them dry and clean, and dung should be removed daily to reduce the problem of flies. Good hygiene is essential

and more harm than good can be caused by allowing houses or shelters to become dirty. Houses should be periodically disinfected and clean bedding provided. Trough for food and water should be provided (Lawrence et al., 1990). In many traditional farming system, cattle are kept overnight in open enclosures.

Although cattle are hardy working animals they respond well to good treatment. Therefore, owners of working cattle can benefit from constructing a simple shed for their draught animals. This can be used to house the animals at night and to provide shelter against the sun, rain and wind when they are not out working or grazing. It should be located on a well-drained site near to any stored feed supplies and close enough to the family dwelling to allow easy access and supervision. The design of the shed should be as simple as possible of local materials, such as maize Stover, sticks, mud bricks, wood etc can be used to keep costs at minimum. In warm and dry environment, thatched roof supported by four poles may be adequate. Where temperatures are cooler it may be necessary to construct half or three quarter side walls to provide greater comfort for the animals. In the colder high land areas or in places where security is a problem, a shed which completely enclose the animals and has door, which can be locked, many be required (Jonson, 2003).

The size of shed depends on the number of animals kept. If the sides of the shed are partially or fully closed, leave enough space for adult person to stand alongside the animal when it is tied in the stall. In general, a shed which is 2-3 m square and 2 to 2.5 m high is adequate to house two adult oxen and allow a person easy access. The yoking bare can be used to tie animals for feeding and watering, during harnessing and when carrying out routine health care, such as removing ticks. If several stalls are constructed in a row they can be separated by horizontal bar attached between posts at the same height as the yoking bar (Jonson, 2003).

Regardless of the design or size of the shed, it is important that it has good ventilation. The roof should extend about 0.5m past the apse to increase the shed area and reduce the problem of rain blowing inside. A roof made of corrugated iron sheets is likely to be expensive (although quicker and easier to erect and longer lasting than thatching). A metal roof absorbs and transmits more heat during the day, thus increasing the temperature inside the shed. This is not generally desirable, except in cooler environments.

A thatch roof provides temperature stability that is better for the animals. Check and remove any exposed sharp edges like splintered or broken rails or nails inside the shed or paddock which could injure the animals. Plant trees in the paddock for additional shade under which animals can rest. A simple crush is essential for

holding the animals during spraying or treatment by veterinary personnel. It is essential that the paddock is well drained. Mud and manure should not be allowed to accumulate in the shed (Jonson, 2003).

2.15 Animals Watering

It is a good practice to ensure that working animals are provided with clean water once a day to compensate for the loss in water through sweating and salivation and complement the increase in dry matter intake associated with energy requirement for work. In the dry season the provision of 30-40 litres day per animal is considered reasonable (Bangura, 2012)

Working animals have an increased requirement for water. The amount needed will depend on the duration of work, and the climatic conditions prevailing. Provision of water can be a problem in Semi-arid areas where the water supply may be some distance from the farm. Water deprivation can reduce food intake, and therefore, exacerbate the low nutrient supply from poor quality forage (Pearson, 1998).

A ruminant can often manage on watering twice a day, but again should be offered water more frequently if it is working. It will not drink immediately after work if it is hot and tense. Let it stand in the shade and cool down first.

Water consumption during working periods includes water intake during days animals were not working. This may have masked any short term effect work would have on water consumption, Water requirements depend largely on the environment, the amount of work or physical activity, nature of the feed and physiological state. Water requirements could range from 20 to 60L/day. Animals under heat stress increase their daily water intake as much as 6 times the level they would consume under optimal temperatures ((Fall *et al.*, 1997).

2.16 Work strategy

The draught of an implement may increase with the speed at which it is pulled, although at normal animal walking speeds, this source of variation will be slight. The implement speed will itself depend on many factors relating to the type and condition of the animals. In practice the draught force that animals exert to draw an implement constantly changes due to numerous interacting variations attributable to the animals, the operator, the soil and the orientation of the implements.

The rate of work (power output) depends on the quantity of work (draught force x distance) and the time in which this is achieved, which is determined by the average speed at which the animals move.

The distance and speed moved depends greatly on the characteristics of the animals used, the species (different species have different walking rates, horses are faster than cattle and donkeys), their weight, size, strength, condition and their standard of training. The power output of an animal may be influenced by its past history (nutrition, disease, body condition, training, recent work experience) and its immediate environment (temperature, relative humidity, sunshine, and ground surface), (Bakrie *et al.*, 1987; Pietersen and Foulkes, 1988; Pearson, 1989).

The way draught animals are used, the time, level and duration of work greatly determine their health and productivity. The duration of work done by the animals generally depends on; food input or the body condition score (nutritional status), physiological status particularly in females (non-pregnant cow can work for longer time without being stressed). Average working duration for oxen in ploughing that is on a good nutrition and body condition is about 5-6 hours per day (Fall *et al*., 1997). If necessary, animals should not be worked every day, but the more work that an animal performs, the more efficient it is. Starkey (1981) found that well fed oxen could work 4-5 hours per day for 5 days a week. Little is known about weather heat affects work output, but the preferred time to work is in the cooler parts of the day (7-11am; 5-7 pm). If condition is being lost, the work load must be reduced or significant supplementary feeds must be given.

In temperate regions animals can work from 6-8 hours per day, presumably as a result of cooler condition and better food input. It might be possible to extend the working period in the tropics if animals are fed higher quality diets and when greater advantage is taken of the cool part of the day, thereby reducing the problems encountered as result of heat stress.

The number of hours that draught animals can work per day depends mainly on animal species, climate, and time of day, health and nutrient status and varies from around 3 - 6 hours per day (NRCWS, 2012). In many countries draught animals are mainly used for land preparation with little advantage taken of their high work rates for weeding. Hired animal traction power services are often paid for through reciprocal labour or other local service. As animals must be looked after seven days a week, farmers may work shifts. This could often include starting early, and on some evenings and weekends. Working with animals can involve hard physical work, and farmers could spend time working outdoors in all weathers (NRCWS, 2012).

The time of the day determines the work capability of draught animals. If the day is too hot it causes heat stress that will result in less performance. In hot climates, heat

loss by convection becomes less effective than in a cool climate and hence the animal has to rely mainly on evaporative losses through sweating and/or panting and/or drooling. Failure to dissipate the heat associated with work limits the amount of work done in a hot climate. The heat accumulated leads to increase body temperature (Fall *et al*., 1997).

The amount of extra energy expended on working day, above the required for maintenance, depends on work done. Several factors determine this, all of which interact. Firstly, the draught force generated, which is dependent on the size, health temperament and ability of animals, the implement used, and in some cases the operator. Secondly, the surface over which animal is working, which will determine the extra energy the animal has to use for moving, and thirdly, the distance covered when working which the will be determined by the operator, the task been undertaken, the length of the working day, the weather and health and temperament of the animal (Pearson,1998).

2.17 Animal Harness

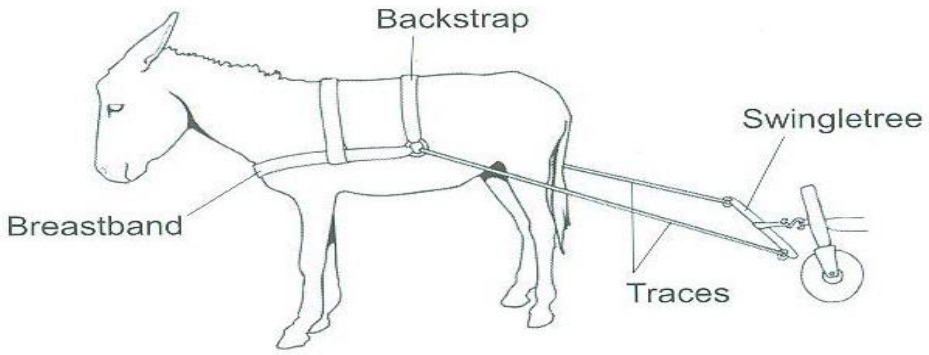
A harness is a system or a device that fitted on the body of the working animal. Donkeys and horses are harnessed with breast bands and collars. Harness has several functions (Pearson *et al*., 2003):

1. Control the working animal.
2. Transfer power from the animal to the attached implement
3. Hold in place any load carried
4. Act as breaking system when pulling a cart.

The breast band and collar harness are the two main types of harnesses used for donkeys, mules and horses when pulling implement or carts (Pearson *et al*., 2003).

2.17.1 The breast-band harness

The breast-band band is a simple design and can be made from cheap and locally available materials (Fig 2.1) it can be adopted for various work activities such as pulling cart or cultivation implement. The breast band harness can be made from; Canvas belting materials, thick cotton webbing and leather.



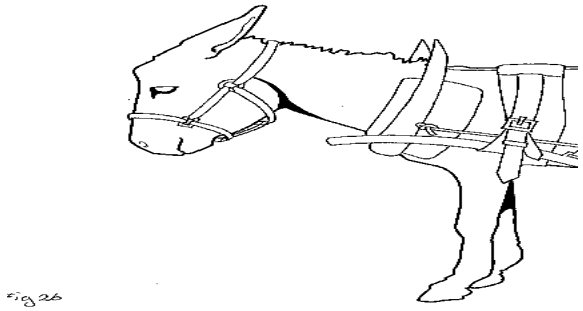
Source (Pearson *et al.,* 2003)

Fig 2.1 breast-band harness

The joint may be stitched using a strong threat or thin, supple wire or bolts. Breast bands should be padded and when fitting the harness to the animals, make sure that bolt ends are always kept away from the animal's body and any stitching is on the outside of the breast band, not in contact with the animal. The padding must be used between the harness and animal. Always remember to make sure that a harness is fitted properly on the animal, not too loose or too tight.

2.17.2 Collar harness

Collar harness may be classified as either full-collar or split-collar. The full collar harness is commonly used with horses and tends to expensive. The split collar harness with two vertical homes jointed at the top and bottom is more versatile and is widely used for donkeys and mules. The collar harness can be made from wood, leather and metal (Figure 2.2).



Source (Pearson *et al.,* 2003)

Figure 2.2 Collar harness

The collar harness has the disadvantage of being more complex in design than the breast bands. The collar harness is good for work at high draught forces; it spreads the force of pulling over wide surface of contact with the animal than a breast band harness. It can be fitted exactly in front of the chest area and adjusted for comfort. The collar harness should not be too big or too small for the animal, but should sit comfortably in front of the shoulder. Padding must be used between the harness and the animal.

Correctly fitted and well maintained harnessing of suitable size should be used and harnessing should be designed to enable the animals to perform to their fullest capacity and should not cause discomfort or injuries (M. James and R.C. Krecek, 1999). There are many terms that relate to harnessing of draught animals and affect their efficiency. These are:

2.17.3 Hitching

Hitching is the way in which the animal or animals are connected to the implement or cart that they are pulling and to other animals in the team. Hitching is important, if the animals are too close to the implements they can get injured, if too far away they can be difficult to control and the efficiency of working may be reduced.

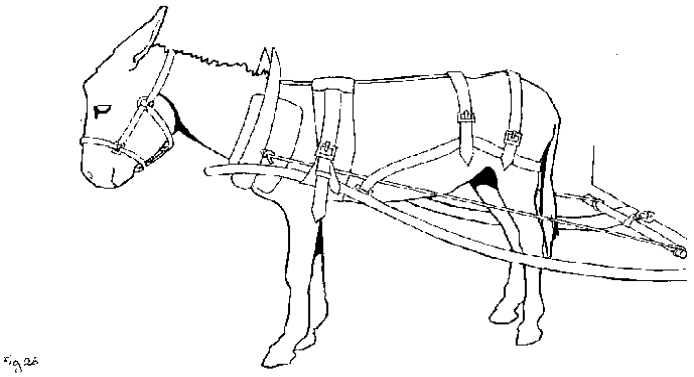
2.17.4 Halter and bridles

Halter and bridles, these are used to control the donkey mule or horse. Controlling an animal's head is the best way to control it. The parts of the halter or bridle in contact with animal should feel smooth of touch, especially at joints and fastening. The joint should be on the outside away from the animal. If a bit is used it should only be snaffle bit. The correct fit is also important so the animal can work comfortably and without injury.

2.17.5 Singletree

A singletree is a wooden or metal bar used to balance the pull of a draught horse or other draught animal when pulling a vehicle.

The traces (the straps by which the animal pulls) attach to its ends, and the vehicle is pulled from its middle. The centre of the singletree may be bolted directly to the body of the vehicle, this bolt pulling the vehicle along (Figure 2.3).



Source (Pearson *et al.*, 2003)

Figure 2.3 Position Single trees

The action of a singletree is to balance the pull from alternate shoulders as the animal walks. It is used especially when the animal is in a breast collar harness, because this can easily rub the shoulders if the pull is uneven. It is needed less for an animal in a horse collar, as the pull does not pass over the shoulders in the same way (FAO, 1999 and FAO, 2000). It is called a singletree because as the horse or donkey walks or trots it swings from side to side with the action of the horse's shoulders.

2.17.6 Halter, bit

A halter is used to lead and tie up an animal. It is used on many different types of livestock. Halters are most closely associated with equids such as horses, donkeys, and mules. However, they are also used on farm animals such as cattle and goats and other working animals such as camels, and yaks.

Halters are often plain in design, used as working equipment on a daily basis. In addition to the halter, a lead line, lead shank or lead rope is required to actually lead or tie the animal. It is most often attached to the halter at a point under the jaw, or less often, at the cheek, usually with a snap, but occasionally spliced directly on to the halter.

In animal hitching always use singletrees (one animal) or singletree, trees and evener (tow animals) between the animals and implement when pulling. Match animals for size in pairs, if different sizes then adjust the evener. Never hitch the traces directly to the implement (Pearson *et al*., 2003).

After use, the harness, regardless of the material, should be cleaned to remove sweat, dust and dirt. This should be done with stiff brush followed by cloth and water.

Soaking a harness in water can make it stiff and rough so it should be done with stiff brush followed by cloth and water. Warm water gets rid of sweat and dirt more easily than cold water. The bit should be washed to keep it clean. Although it is suggested that homemade bits can be satisfactory; care must be taken to avoid using thin wire or metal with sharp edges. If leather harness is used, which is relatively expensive, care should be taken to ensure that it lasts longer.

The use of animal fat to soften the harness is one of the traditional methods used by horse, mule, and donkey owners. Clean cooking oil can be used if animal fat is not available.

Harness should be cleaned and checked for worn out parts regularly, preferably each day following use. When not on the animal, harness should be stored on a hook (away from rodents or dogs), in dry, clean, safe place (Pearson *etal.*, 2003)

2.18 Field operation and implement

Animal traction can be used to accomplish a varity of operations which loosen and improve the soil where crops are grown are called tillage implements, other field operations include skidding (clearing fields of logs and brush), planting, and harvesting (Watson, 1982).

2.18.1 Field Capacity and Field Efficiency

1. Field capacity: is the rate at which an animal can cover a field while performing its intended task. This is one of the considerations determining the cost per unit area for the operation. It is expressed as the area covered per unit time from the time work starts until it finishes. This includes stoppages for rest, adjustment to the implement and turns in the field. It is commonly used with assessing tillage and planting implements. The effective field capacity is defined as actual average rate of work, usually expressed in area per unit time.

2. Field efficiency: is expressed as the percentage the machine actually achieves under real condition compared to the theoretical maximum it could achieve. It accounts for failure to utilize the full operational width of the machine (over lapping) and other time delays. These might include turning, idle travel across head land or to carts, filling seed and pesticide hoppers, emptying grain tanks, cleaning a plugged machine, necking machine's performance and making adjustments, waiting for carts, animal and operator rest stops.

Field efficiency is generally a multifunctional parameter; as it can be affected by the forward speed, field size and shape and operator's skill along with the experience

and working period of the draught animals. Young animal may stop more often and waste time compared to older experienced animals. There is a good correlation between field capacity and forward speed.

2.19 Factors effecting afield Capacity

2.19.1 Implement type and condition

Different implement types produce different field capacities as a result of differences in operating widths. For the same type of implements large/wider implements cover more area compared with smaller\narrow ones. This reduces the effective width operation. For the same working animals and conditions work rates vary according to the implement type and operation.

2.19.2 Soil moisture content and Condition

For the same implement, field capacity and efficiency potentially increase from heavy soils to lighter ones. While for the same soil, field capacity will depend on soil condition weed cover, and tillage operation scheduling.

Animals tend to work slowly in muddy soils and operators will find great difficulty in controlling both the implement and their working animal.

2.19.3 Operator's Experience

At the beginning, unskilled and \or untrained operator's record comparatively lower work rate and efficiencies.

2.19.4 Animal Power

Large animal work steadily for longer periods provided that other factors are eliminated. When the animal size is sufficient to generate enough force to match the draught force of the implement, it achieves higher work rates. But when the animal size is too small for the work condition or the implement, it struggles hard to work tires faster and tend to work slowly and stops frequently while working giving lower work rate and efficiency.

2.19.5 Animal training

Steady work of draught animals improves with training. Untrained or not well trained animals produce less work at lower efficiency.

2.19.6 Harness Condition

Harness condition and suitability to the animals and implement is one of the most important factors affecting work rates and efficiency. When using donkeys and horses it is important to consider the material used for producing the singletree and harness as it should be strong enough and comfortable for the animals. Yokes should be padded specially at the start of the working season if animals have not been working regularly in the dry season as their skin will be soft and liable to rub.

2.19.7 Field operating Method

This determines the times 'lost' in turning at the end of the field. Operating should carefully select method depending on field conditions and shape (Makki and Pearson, 2011).

The role of animal traction technology (DAT) in agriculture and transport is well understood and documented in different parts of the world. The improved use of the technology is seen as the most appropriate and relevant form of strategy for small holder agriculture due to economical, technical and agro-ecological problems associated with mechanized agriculture. The technology has been qualified as an ecologically sustainable means of increasing agricultural production, reducing human drudgery and improving the quality of the rural life (Chanie et al., 2012).

The realization of the technology benefits in some parts of Asia and Latin America lead the technology to be widely advocated in the Savannah areas of Africa.

Nevertheless, the technology did not perform to its potential capacity due to many reasons; amongst which poor extension remains the most important. This is typical to the situation in Sudan where the technology was introduced few decades ago to many parts of the traditional rain-fed farming system in an attempt to assist rural farmers achieving food security and reducing the drudgery of work. The objective was to reduce the drudgery of work and assist the farmers to expand horizontally in a traditional subsistence oriented farming system. Oladeji et al. (2012) recommended that a well-designed extension based animal traction program should be put in place to arouse the interest of farmers in the technology to combat shortage of labour in the agricultural sector. They continued suggesting design of animal traction oriented program and use of appropriate extension organ to disseminate well packaged animal traction related information to propagate the use of the technology in Northern Nigeria. Pearson et al. (1999) pointed that small scale farmers are not receiving the information they need, much of which is available; to improve the farming practice. Further, Chanie et al. (2012) emphasized that the absence of work

to improve traits for work performance indicates least emphasis is given to promote animal traction power. Pearson (1998) added "research and extension activities have to be undertaken in an environment in which population is increasing, grazing land is diminishing and labour expectations are changing". In rural Sudan poor field performance a major concern
for the success of animal traction technology programs. Few are reported on the effect of extension on DAT in the country.

2.20 Contribution of AT to Agricultural Development

This section has the following sub-headings under it. These include AT and crop yields, AT and fanning systems, AT and farmer preferences, AT and different ages and gender of farmers, AT and ownership of draft animals and lastly, AT and animal population.

2.20.1 Animal Traction and Crop Production and Yields

Animal traction may assist farmers to increase the total production of their crops. One of the clearest ways to achieve this is through increase in area cultivated (Starkey, 1988). According to him, there is very often a conflation between farm size and ownership of draft animals although this does not necessarily mean that the animals are the cause of the large area of cultivation. It may be that farmers who have big farms are the ones wealthy enough to use draft animals. He observed that records on farmed areas before and after the adoption of draft animals indicated that where land was available, farmers cultivated more land when they had draft animals so that total yield over farm increased. However, in some areas there were drops in yield per unit area as farmers tended to farm more extensively rather than intensively. Also, the use of AT can result in better timing due to faster and better land preparation, seeding and weeding which may give rise to higher yields and less crop failures (Seifert,1992).

2.20.2 Animal Traction and Farming Systems

Animal traction is associated with the tendency to move from bush fallow cultivation involving mixed cropping in partially cleared areas still containing stumps, to permanent systems, in which single crops are grown in cleared fields. Animal traction may lead to extensive fanning with large areas being less intensively managed. One of the more notable ways AT affects farming system is through the integration of crop and livestock enterprises (Starkey, 1988). Also, AT may lead to

changes in the crop mix, and therefore may have differential effects on crop production. Starkey noted that AT has often been promoted in West Africa for mono cropping in areas where inter-cropping was traditional. It was earlier thought that AT led to increased production of cash crops to the detriment of food crops
However, according to him, surveys have not found marked differences in crop mix associated with AT.

2.20.3 Animal Traction and Farmer Preferences for Animals

In common with most aspects of life, AT both benefits and suffers from long standing preferences and the vagaries of more rapidly changing "fashions". Animals often have prestige status unrelated to their working abilities, so that one sickly horse may have higher social status than a pair of strong oxen. In some countries and communities the colors of animals and implements may be very important influencing decisions relating to adoption even though it is unlikely that these factors would influence performance. Such preferences that appear illogical may have a technical justification that is not immediately apparent to an outsider. Nevertheless, farmer prejudice can be as important as farmer judgment, when it comes to selecting animals, implements, harnesses or management regimes. In such circumstances any reduction in possible technical efficiency may have to be set against the pleasure associated with the choice, since "fashion' may sometimes be viewed as a social benefit of animal traction (Starkey, 1988).

2.20.4 Animal traction and Different Ages and Gender of Farmers

The social costs and benefits of AT vary considerably between people of different ages and gender in farm households. Men and children usually train the animals, work with them and herd them. These people have the initial problems associated with first use of animals and area expansion, but may later benefit from easier and more fulfilling work. In some communities, men consider it appropriate to cultivate land for the crops usually grown by women, in others, they do not. Women and children often have the tasks of weeding and harvesting and their work may be increased if cultivated areas are expanded. Children often tend draft animals and because of these their educational prospects can suffer, either due to limited school attendance or due to fatigue when school is combined with looking after animals. In some small survey in Sierra Leone, it was found that children of daft animal owners were less likely to attend primary school. On the other hand, the general correlation

between draft animals and wealth might make it easier for animal owners to afford secondary school fees (Allagnat and Koroma, 1984; Gboku, 1988)

2.20.5 Animal Traction and Ownership of Draft Animals

In some parts of West Africa, AT has been introduced through communal ownership, often encouraged by governments and Aid agencies. While there have been examples of successful village associations for AT, many have experienced major social and organizational problems associated with conflicting interests for access during the animal working hours and responsibility for maintaining the animals at other times (Starkey, 1988). With individual ownership, it is clear who is responsible for both costs and the benefits of animal management. One of the costs is grazing supervision, and if this is not carried out with dedication, the animals may suffer from insufficient food, accident or theft. Alternatively growing crops can be eaten, causing much social conflict and expense (Starkey, 1988) Corbel (1988) said in one survey in Sierra Leone a quarter of farmers reported that they had to pay out significant sums in compensation as a result of the alleged misbehavior of their work oxen.

2.20.6 Animal Traction and Quality of life of Farmers

Animal Traction may well have a direct impact on the quality of life of farmers by reducing drudgery of personal transport. It also provides opportunities for social and economic benefits such as:

* Enhanced possibilities for collecting and distributing harvest, water, building materials timber, farm implements and other goods
* Increased marketing opportunities for farm produce and Greater ease of utilizing crop residues, compost and manure (Starkey, 1988)

2.20.7 Animal Traction and Animal Population

Starkey (1988) observed that castrated bulls remain the dominant draft animals in West Africa. However, in some areas such as Northern Nigeria, uncast rated males are used for work. In Sine Saloum in Senegal, cows are increasingly being worked. Reh and Horst (1982) reported that N'dama cows used for draft purposes actually had higher reproductive characteristics than similar cows kept in traditional herds. This was attributed to the fact that the better husbandry associated with draft animal, more than compensated for the stresses imposed by the work. In countries where work oxen come from small local herds, the "best selected for work and so are

castrated and are therefore unable to breed. Thus the breeding bulls may be genetically inferior in terms of body size and males that seem large a Conformation (Starkey, 1988)

2.21 Relative Advantage of the Technology

This is the degree to which a technology is perceived to be better than the ideas it supersedes in terms of economic, profitability, social prestige, physical convenience, low initial cost, lower perceived risk, decreasing discomfort, psychological satisfaction or saving time Association for International Agricultural and Extension Education [AIAEE], 1998). Panin and Ellis (1992) said farmers are likely to adopt a technology if they perceive the technology to be profitable, by either reducing costs or increasing income without necessitating major changes in their farming systems.

2.22 Constraints to the Adoption of AT Technology

There are difficulties that make the spread and adoption of AT problematic. These is:

* Lack of appropriate implements (Bobobee, 2003)

* Lack of appropriate implements could be an important constraint to the use of AT and farmers have sometimes found it difficult or impossible to obtain suitable equipment Harnessing. Several people had suggested that harnessing was a major constraint. Starkey named these people as Mucuta (1985), Smith (1988) and Vietmeyer (1982). They strongly advocated the use of head/horn yokes, withers/shoulder yokes, collars, breast bands, single yokes or double yokes Human labor. Human labor can be a critical constraint in a family and AT may ease or exacerbate this. Farm households that do not have sufficient labor to manage draft animals throughout the year may be unable to adopt AT. Stumping fields to allow the use of animal drawn ploughs it requires much labor, and in some areas, this may be a critical constraint to adoption (Seifert, 1992)

* Lack of capital and/or credit. The adoption of AT can be highly dependent on the availability of these resources. The market cost of oxen, cultivation implements and carts in West Africa is high, relative to average farm incomes (Starkey, 1988). Seifert (1992) noted that it would be impossible for poor peasants to introduce AT due to lack of funds, or it would be inappropriate due to small acreage or family size.

* Limited availability of animals. This can be a serious constraint to the employment of draft animal power in some areas. In the humid and sub-humid zones of West and

Central Africa there are very few cattle. Elsewhere, civil unrest or wars can restrict animal Availability (Starkey, 1988).

* Social traditions: Starkey (1988) observed that in areas where AT is still a highly innovative technology, it is common to hear someone argue that the technology is appropriate to one tribal group, but not to another. Theft of animals or fear of this can affect AT users. In Gambia, a reason given for using donkeys rather than oxen was the reduced risk of theft with donkeys. In some countries, draft animals give prestige to their owners but they may also cause jealousy and friction within communities (corbel, 1988).

* National policies: National development policies can act as a major constraint to the adoption of AT. Interventions at national level can greatly influence decisions at farm-level. If AT is discouraged by governments as the case for Ghana in the (late 1950's and early 1960's Munzinger, 1982), the necessary implements may become unavailable to the farmers. There will not be allocation of resources for the provision of national services such as credit extension research and training.

CHAPTER THREE
METHODOLOGY

Chapter Three
Methodology

3.1 Study Area:

This study was conducted in En-nuhoud locality west Kordofan, and Dibibat locality South kordofan State to explore the adoption of Draught Animals by farmers, the region has been identified in 2015, Both state are located in the semi-arid savanna zone in West Sudan.

Farmers in this area depend on rain-fed agriculture, the main source of the water is underground wells, and most of the population depends on agriculture beside other activities like animal breeding and poultry product. Different types of crops are grown in the area like (Millet, Groundnuts, Karkady, Sorghum, Sesame and water melon and etc).

Donkeys, camels, Oxen and horses are used for agricultural work and beside other purposes. The dominant system of agriculture in this area is traditional rain-fed farming system.

3.2 Study duration:

Study was carried out during the period from 2015 to 2018.

3.3 Population

The sample was selected from two localities around (i) En-nuhoud locality of West Kordofan state, and (ii) Al-Dibibat locality of south Kordofan:

The population of En-nuhoud locality is 227109 person according to the 2010 census.

The population of Al- Debibat locality is 52.000 person.

Farmers population of the study area = 43.000 farmers.

A sample of 200 farmers was selected from different localities around West and south Kordofan the selection was mainly focus on the localities that benefited directly from the animal traction project in the area. As it is difficult if not impossible to obtain a sampling frame, localities was selected using the simple random sampling technique; while individuals from each of localities was selected using the systematic random sampling technique on geographical basis.

The sample size in this study was determined according to the following equation:

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

Where:

N= Community size.

Z= Class standard it is corresponding to the level of significance (0.95) and is equal to (1.96).

P= Ratio provides a neutral property and equal to (0.50).

Q= the error rate is equal to (0.05)

Sample size were being 200

3.4 Data Collection and Analysis

- **Primary data:** Data was collected using questionnaires. The questionnaire was divided in different sections to cover:
(1) Personal Data, (2) services and extension (3) management practices as defined in the conceptual framework (4) implements/ tools and Harnessing issues(5) Benefit and Constraints (6) Animal traction adoption(7) field capacity parameters The questionnaire data was analyzed using the Statistical Package for Social Science (SPSS) to produce frequency and percentage tables. Chi-square test was used to measure the association between farmer's skills and animal traction adoption.

- **Secondary data**

Data was collected from publication (book, magazines, and papers) and website**.**

- **Field Capacity**

The field capacity was determined using two stop watches and a tape meter. As the operator start working the two watches was set on and when he reached the end of the plot and start turning one of the two watches was set off to measure the networking time, while the other one was still on to measure the total working time. The watch that was set off reset on again as the operator finish turning and start operating. This procedure was repeated until the operation finishes. From this test

the total and net time of operation was recorded. The area worked was measured using a tape meter (m^2) and the number of passes taken to cover the plot was also being recorded. Implement rating and working widths were also recorded. Then the field capacity in (ha/h) was taken as the product of dividing the area worked (ha) by the total time (h) as fallows

$$\text{Field Capacity (F.C)} = \frac{\text{Area (ha)}}{\text{Total Time (h)}}$$

And the field efficiency:

$$\text{Field efficiency} = \frac{\text{Net productive time}}{\text{Total time of operation}}$$

CHAPTER FOUR
RESULT AND DISCUSSION

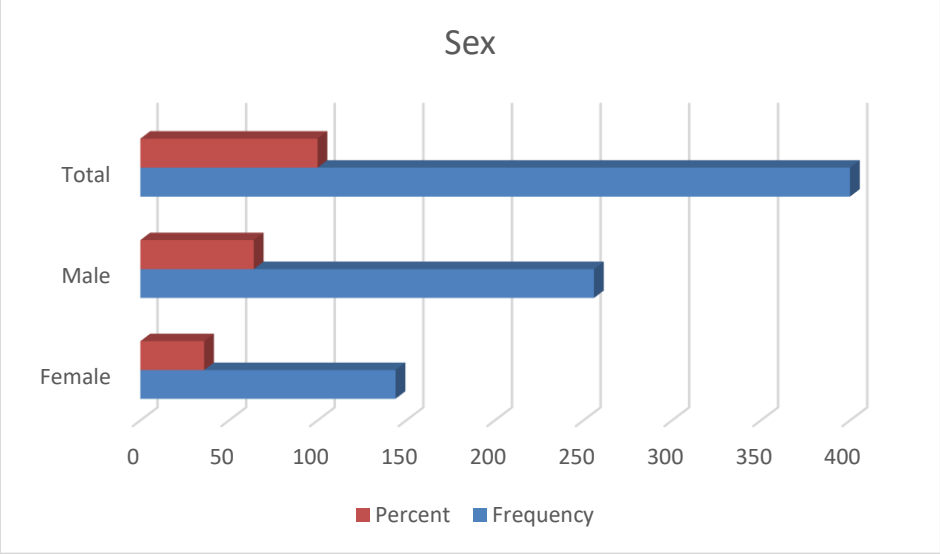
Chapter Four
Result and Discussion

Table 4.1 Frequency Distribution of respondents according to age

Age	Frequency	Percent
15 to 25 year	40	20.0
26 to 35 year	80	40.0
36 to 45 year	60	30.0
46 to 55 year	20	10.0
Total	200	100.0

Source: Field Survey 2015

Table (4.1) shows that less than half of the farmers, (20%) farmers the age ranged between 15 to 25 year, the farmers ranged between 26 to 35 year present (40%), While (30%) of the farmers the age ranged between 36 to 45 year, (10%) of respondent age ranged between 46 to 55 years. Age plays an important role in animal traction adoption that indicate the majority of respondents used animal traction were in productive age.



Source: Field Survey 2015

Figure 4.1 Distribution of farmers by Sex

Figure (4.1) illustrates that most of respondent are male (64%), while females represented by (36%), this confirmed females participated in using animal traction by low percent.

Table 4.2 Frequency Distribution of respondents according to education level

Education level	Frequency	Percent
Illiterate	18	9.0
Khalowa	4	2.0
Year of education before university	149	75.0
University	29	14.0
Total	200	100.0

Source: Field Survey 2015

The distribution of respondents by educational level is presented in Table (4.2) Most of respondents (75%) years and education before university, this category lead to majority of people in two area depend on agriculture, (14%) university, (9%) illiterate, while only (2%) khalow. Education plays an important role in the adoption process. An educated and literate person is likely to adopt an innovation faster than an illiterate person if literacy is required. He has access to a lot of information about the technology through reading Urasa, (1994) said most smallholder farmers have had only very limited education and so any new technology to be introduced should be simple enough to be understood by the farmers. This means that all farmers educated is adopt to new technology and effectively in the rate of animal traction adoption.

Table 4.3 Frequency Distribution of respondents according to marital status

Marital status	Frequency	Percent
Married	113	57.0
Unmarried	87	43.0
Total	200	100.0

Source: Field Survey 2015

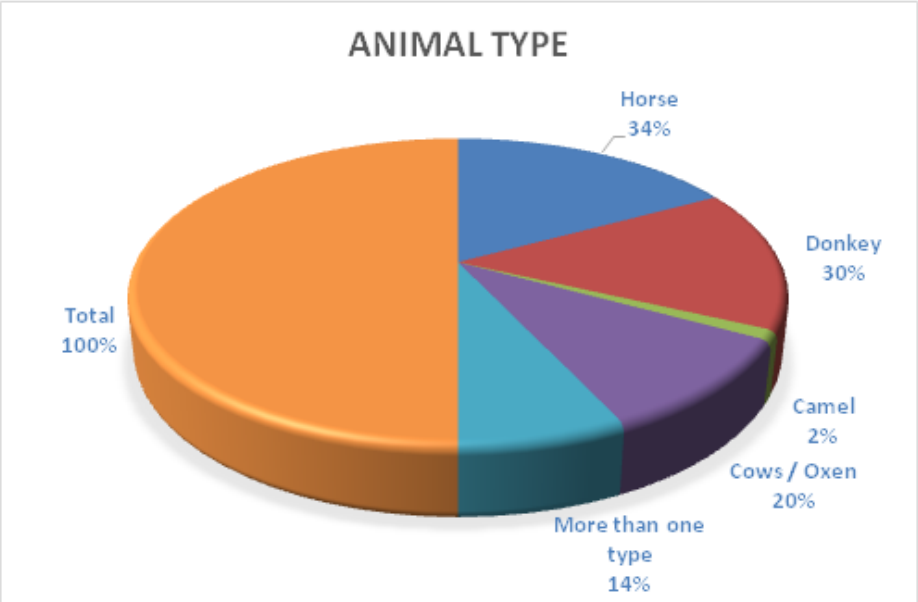
Table (4.3) mentioned farmers' marital status. More than half of the farmers (57%) are married, while (43%) are unmarried. Most of animal traction farmers are married to increase house hold income**.**

Table 4.4 Frequency Distribution of respondents according to land ownership

Land ownership	Frequency	Percent
Owned	140	70.0
hired	8	4.0
Partnerships	8	4.0
laborers	38	19.0
Rented	6	3.0
Total	200	100.0

Source: Field Survey 2015

Most of the farmers (70%) owned their farms, (4%) hired, at the same respondent (4%) partnerships, (19%) laborers, while only (3%) are rented (Table 4.4).This is very important when animal traction is concerned as it is well understood that farmers who own their farms tend to invest more in their animals. In the case of owning land the farmers are expected to own the animal traction also. But in the case of hiring and sharing the land, the farmer would hire the services of the animal traction rather than owning it. Otherwise farmers will face the problem of taking care of it during of season or fallow periods.



Source: Field Survey 2015

Figure 4.2 Distribution of farmers by animal type

Three animals are generally used to pull ploughs and planters, Horses dominated in Kordofan area (34%), while (30 %) owned Donkeys and few farmers (20%) owned cows/oxe, (14%) of the farmers owned more than one animal, while only (2%) owned camel (Figure 4.2). All these animals also used for drawn water, bring agriculture production and transport. This result is comparable to that reported by Musa (2009) who surveyed the technology in En-nuhoud area. It is however, different than that witnessed in the neighboring South Kordofan and Darfur (Munzool, 2011).

Table 4.5 Frequency Distribution of respondents according to soil type

Soil type	Frequency	Percent
Clay	38	19.0
Sand	140	70.0
Gardod	22	11.0
Total	200	100.0

Source: Field Survey 2015

Table (4.5) mentioned soil type in different locality. (19%) of respondents has clay soil, while (70%) in sand soil, and (11%) in gradod soil. this lead to suitability of animal traction in clay and sand soil.

Table 4.6 Frequency Distribution of respondents according to crops type

Crops type	Frequency	Percent
Groundnuts	135	68.0
All crops	24	12.0
Groundnuts and Dura	37	18.0
Sesame and Dura	4	2.0
Total	200	100.0

Source: Field Survey 2015

Result in table (4.6) mentioned crop grown. Crop grown played important role on animal traction adoption. All of the farmers used animal traction cultivated groundnuts (68%), in the study area where groundnuts are the main cash crop, (12%) cultivated all crops, and (18%) cultivate Groundnuts and Dura, while only (2%) cultivated sesame and Dura.

Table 4.7 Frequency Distribution of respondents according to Farm size (*mukhamus*)

Farm size	Frequency	Percent
10 to 20Mukhamus	110	55.0
21 to 30 Mukhamus	56	28.0
31 to 40 Mukhamus	32	16.0
More than 41 Mukhamus	6	3.0
Total	200	100.0

Source: Field Survey 2015

The distribution of respondents by size of farm is presented in (Table 4.7).Farm size shows the maximum percentages (55%) it ranged between (10 - 20) *Mukhamas*, (28%) of respondents it ranged between (21 – 30) *Mukhamas*, (16%) it ranged between (31 – 40) *Mukhamas*, while only (3%) their farm size was more than 41 *Mukhamas.* Farm size gives a general view on farmers' financial capacity and the potential state of animal's employment in agriculture along with the care and level

of husbandry practices they can receive. There is a potential that some animals might be overworked especially in the large farms if the owners did not pay attention to this, in addition lack of farmers skills.

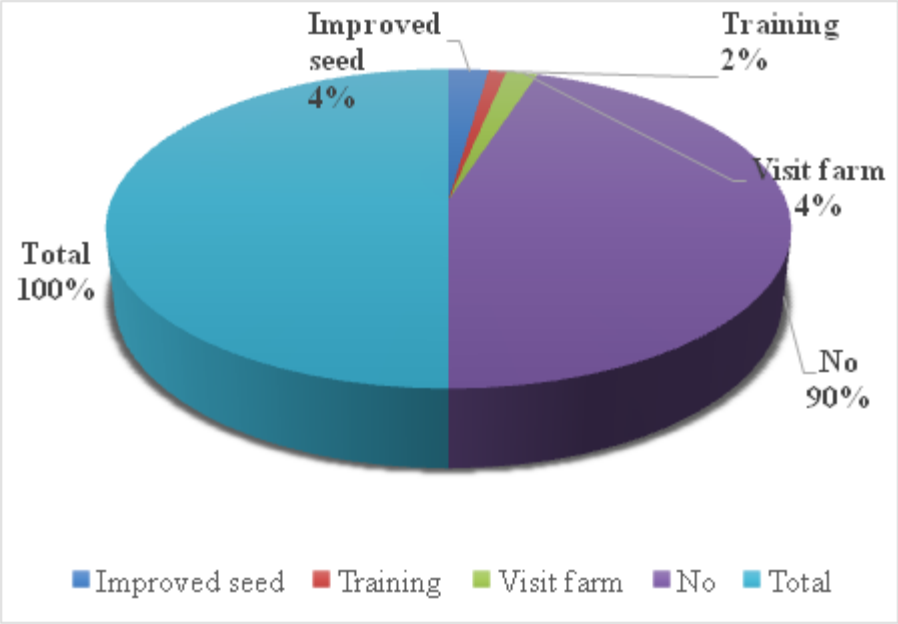
Gboku (1988). He noted that animal traction might assist farmers to increase the total production of their crops. One of the clearest ways in which this is achieved is through increase in area cultivated. He said there is very often a conflation between farm size and the ownership of draft animals, although this does not necessarily mean that the animals are the cause of the large area of cultivation; it may be that the farmers that have big farms are the ones wealthy enough to use draught animals, so that draught animals may be the result of large farms. Recorded farm areas before and after the adoption of draught animals tend to indicate that where land is available, farmers will cultivate more land when they have draught animals, so that total yield per farm increases (Barrett et al, 1982; Panin, 1986)

Table 4.8 Frequency Distribution of respondents according to Extension service

Extension service	Frequency	Percent
Receive	47	23.0
Not receive	153	77.0
Total	200	100.0

Source: Field Survey 2015

Most of respondents (77%) don't received extension services, while (23%) of respondents receive extension services (Table 4.8). The extension services in target area concentered on one type of extension (distribute improve seed) and ignore another side of extension. This implies that more attention should be paid to provide more extension services in order to make best use in this technology.



Source: Field Survey 2015

Figure 4.3 Distribution of farmers by extension type

The farmers received extension services by different type. (4%) of respondents improved seeds, (2%) received training, while (4%) visit farm. The extension services in target area concentered on one type of extension (distribute improve seed) and ignore another side of extension. (Figure 4.3).

Table 4.9 Frequency Distribution of respondents according to Participation with development organization

Participant DO	Frequency	Percent
Participate	35	17.0
Not participate	165	83.0
Total	200	100.0

Source: Field Survey 2015

Most of the respondents (83%) do not participate with development organization, while (17%) of respondents participate with development organization. This lead to absenteeism of development program in target area. (Table 4.9).

Table 4.10 Frequency Distribution of respondents according to type of organization n = 35

Type of organization	Frequency	Percent
Agricultural extension and care	6	17.0
Agricultural extension	29	83.0
Total	35	100.0

Source: Field Survey 2015

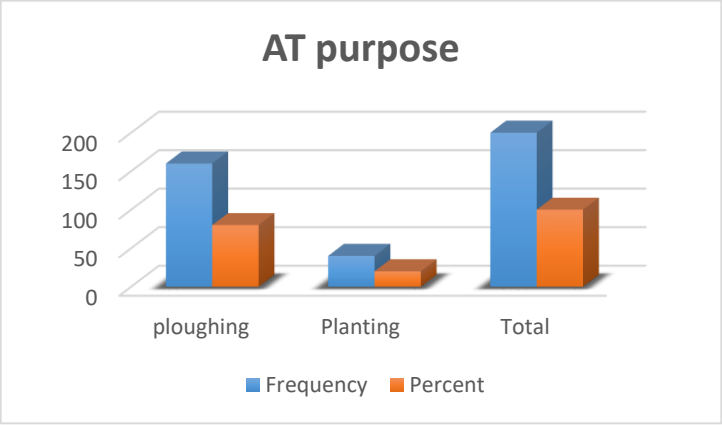
Table (4.10) illustrates the type of organization. Most of respondents (83%) participated on agriculture extension, while (17%) participated on agricultural extension and care organization, this confirms the agriculture extension is dominant on agricultural program.

Table 4.11 Frequency Distribution of respondents according to cultivation purpose

Cultivation purpose	Frequency	Percent
Increase income	100	50.0
Self-sufficiency and increase income	100	50.0
Total	200	100.0

Source: Field Survey 2015

Table (4.11) explain (50%) of the farmers cultivated to increase their income, while (50%) cultivated for both self-sufficiency and increase their income. This refers to almost of animal traction farmer cultivate to increase their income.



Source: Field Survey 2015

Figure 4.4 Distribution of farmers by animal traction purpose

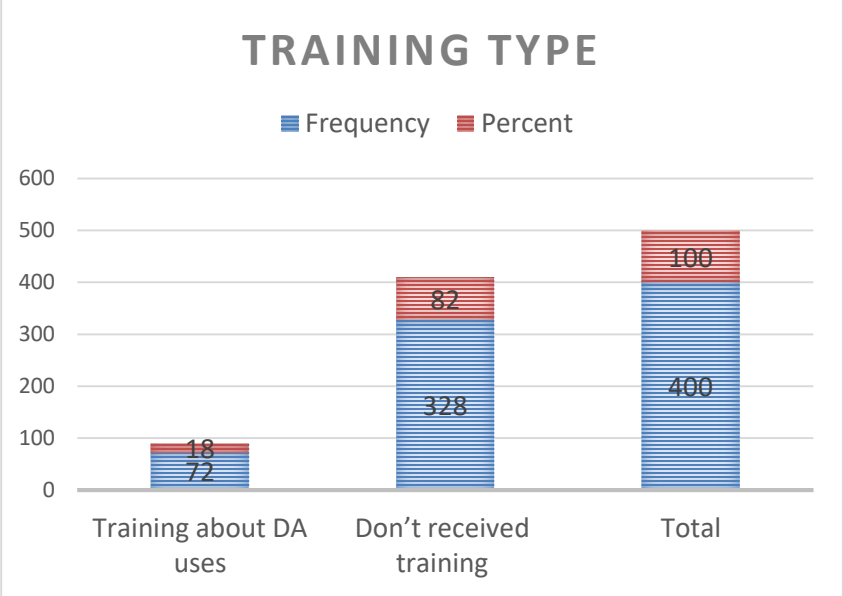
Result in (Figure 4.4) shows purpose of using animal traction. The farmers in two areas used animal traction for two purpose, majority of respondents (80%) used AT for ploughing, while (20%) used AT for planting. The farmers prefer AT in plough because the plough is two dimensions they plough and grow at the same time.

Table 4.12 Frequency Distribution of respondents according to training course

Training course	Frequency	Percent
Trained	28	14.0
Not trained	172	86.0
Total	200	100.0

Source: Field Survey 2015

All the aforementioned results show (86%) are a direct consequence of the lack of training, while as only (14%) of them reserved training about uses of animal traction. This refers to the lack of training package among two target farmers. (Table 4.12).



Source: Field Survey 2015

Figure 4.5 Distribution of farmers by training type

Result in (Figure 4.5) mentioned type of training (18%) of respondents received training package on use of draught animals, while (82%) did not received training about AT .Training service should be based on the available resources and the level of knowledge of farmers.

Table 4.13 Frequency Distribution of respondents according to training institutions/NGOs n = 172

Institution/NGOs	Frequency	Percent
Agriculture extension	50	29.0
Care Organization	40	23.0
IFAD	22	13.0
Peer farmers	60	35.0
Total	172	100.0

Source: Field Survey 2015

Result in table (4.13) shows the parties provide training to the farmers, (29%) of respondents received training from agricultural extension, (23%) from care organization, (13%) received training from IFAD, while (35%) received training from (village neighbor, peer farmers). Training package that provide by GOs and NGOs covered low percent of farmers.

Table 4.14 Frequency Distribution of respondents according to knowledge about DA

Knowledge	Frequency	Percent
Have knowledge	200	100.0
Total	200	100.0

Source: Field Survey 2015

Table (4.14) illustrates the knowledge about AT acquired by the respondent. All of the farmers (100%) have sufficient knowledge about animal traction. Lack of knowledge is major constraint on animal traction adoption.

Table 4.15 Frequency Distribution of respondents according to source of knowledge

Knowledge source	Frequency	Percent
Peer farmers	70	35.0
Agriculture extension	50	25.0
South kordofan Development program	50	25.0
IFAD and Care Organization	30	15.0
Total	200	100.0

Source: Field Survey 2015

The farmers in west and south Kordofan achieved knowledge about Animal traction by different ways. Table (4.15) mentioned (35%) achieved knowledge from peer farmers, (25%) from agriculture extension, at the same respondents (25%) from south Kordofan development program, while (15%) from IFAD and care Organization. All the farmers who used AT have sufficient knowledge about technology.

Table 4.16 Frequency Distribution of respondents according to knowledge period

Knowledge period	Frequency	Percent
One to 10 year	72	36.0
More than 20 year	16	8.0
During this season	102	51.0
Long time	10	5.0
Total	200	100.0

Source: Field Survey 2015

Results in table (4.16) mentioned the period of knowledge. Less than half of respondents (36%) achieved knowledge between one to 10 year, (8%) more than 20 years, (51%) achieve knowledge during this season, while (5%) achieve knowledge for long time. Knowledge period play an important role on animal traction adoption, the result mentioned that the animal traction farmers achieved knowledge for a long time.

Table 4.17 Frequency Distribution of respondents according to veterinary care

Veterinary care	Frequency	Percent
Claimed VS care	176	88.0
Not claimed VS care	24	12.0
Total	200	100.0

Source: Field Survey 2015

All most of the farmers (88%) claimed that they veterinary care to their animals, while the rest responded (12%) negatively to that (Table 4.17).This refers to the accessibility to the veterinary care around the targeted area.

Table 4.18 Frequency Distribution of respondents according to reason& Inaccessibility to the service n = 24

Service inaccessibility	Frequency	Percent
Not available	24	100.0
Total	24	100.0

Source: Field Survey 2015

Inaccessibility to the service in an area with serious problem lack or rare of veterinary care (Table 4.18), Shows all of respondent (100%) the veterinary care is not available. It is very important to have the animals examined by a veterinarian or a veterinary officer to avoid any possible loss of health and infection by diseases for sustainable utilization of the animal. Generally animal owners who have access to veterinary service are in a better economic situation compared with their peers who do not access the service regularly. In this case providing veterinary officers in the villages around the locality helps in solving the transportation issues and puts the service within reach to the farmers.

Table 4.19 Frequency Distribution of respondents according to type of treatments

Treatments	Frequency	Percent
Themselves\hired	47	27.0
Calling veterinarian	99	56.0
Take to the pharmacy	30	17.0
Total	176	100.0

Source: Field Survey 2015

Lack of knowledge on the importance of veterinary care accompanied with difficulty in accessing the service forced, (27%) of the farmers to resort to themself/hired remedies, (56%), calling veterinarian, while (17%) buying the medication from the veterinary pharmacy as shown in Table (4.19). It is obvious that farmers who take

their animals to the veterinary service are the ones who live in the vicinity of the near localities center (EN-Nohoud and Al-debibat).

Table 4.20 Frequency Distribution of respondents according to Animal vaccination

Vaccination	Frequency	Percent
Vaccine	24	12.0
Not vaccine	176	88.0
Total	200	100.0

Source: Field Survey 2015

Most of the farmers (88%) don't vaccinate their animals, while the rest respondent (12%) positively to that. It is very important to vaccinate animals against the domesticated diseases in the area to protect them and maintain them in a good condition to perform work when it is mostly needed (Table 4.20).

Table 4.21 Frequency Distribution of respondents according to time of vaccination n = 24

Time of vaccination	Frequency	Percent
Summer and autumn	10	84.0
All vaccination campaign	4	16.0
Total	24	100.0

Source: Field Survey 2015

Frequent as (84%) of the cases took their animals each summer and autumn to the center, (16%) of respondents take their animal to all vaccination campaign. this refers to the lack of knowledge about veterinary care.
(Table 4.21).

Table 4.22 Frequency Distribution of respondents according to lack of vaccination n = 176

Availability of vaccination	Frequency	Percent
Not available	176	100.0
Total	100	100.0

Source: Field Survey 2015

Difficulty in accessing the service was the major reason for the entire respondent (Table 4.22) hindered percent of respondents the vaccination not available to the farmers. A fact that is very alarming and can jeopardize animal welfare and endanger animals' health leading to a great loss of farmers' investment in their animals. This can potentially constitute serious hazards and limitations to the diffusion and adoption of this technology amongst farmers who are most in need for it to improve their farming practices for increased production and productivity allowing them to achieve food security.

Table 4.23 Frequency Distribution of respondents according to handling when animal disease

Handle when animal disease	Frequency	Percent
By themself/herder	95	48.0
Calling veterinarian	105	52.0
Total	200	100.0

Source: Field Survey 2015

Table (4.23) shows that less than half of the farmers (48%) treatment animal by themself, while (52%) take their animals to the veterinarian. This indicates to the lack of veterinary center.

Table 4.24 Frequency Distribution of respondents according to animal housing

Animal housing	**Frequency**	**Percent**
Locally/stall next house	48	24.0
Locally/at home under the roof	24	12.0
Locally under tree	128	64.0
Total	200	100.0

Source: survey 2015

The majority of the farmers (24%) keeps their animals locally/stand next house, (12%) of respondents locally/ at home under the roof, while (64%) locally under tree (Table 4.24). This refers to the absenteeism of training package in animal management.

Table 4.25 Frequency Distribution of respondents according to basic feed

Basic feed	Frequency	Percent
Green fodder, clover	4	2.0
Concentrate+ Aldrich and dry feed	196	98.0
Total	200	100.0

Source: Field Survey 2015

All most of the farmers (98%) fed their animals dry and concentrated feed, while the rest (2%) fed their animals on fresh 'green' fodder and clover (Table 4.25). The latter practice is probably during the rainy season only as access to fresh fodder is difficult in a semi-arid area where irrigated farming is not practiced. By concentrated feed farmers refer to oil seed cake and grains rather than to concentrated feed supplemented with feed additives. Free grazing is not an option to the farmers as it is possible only during the rainy season when animals are supposed to do most of the work leaving few time for grazing.

Table 4.26 Frequency Distribution of respondents according to time of feed

Time of feed	Frequency	Percent
At work	2	1.0
Morning and evening	154	77.0
All time	44	22.0
Total	200	100.0

Source: Field Survey 2015

Most of the farmers (77%) fed their animals in the morning, evening, (22%) fed their animal all the time, while only one percent fed their animals at work (Table 4.26) Frequency of animal feeding is very important as it reflects the potential opportunity of animals benefiting from that feed. When animals are not heat stressed and have ample time to ruminate they benefit most of the feed. Otherwise they will not have enough time to digest the feed and will benefit less from it if at all. Changing feeding pattern at the beginning of the season benefits animals less. Feed offered at the beginning of the season will not add to animals' capacity to work as the latter depends on the fat reserves the animals accumulate before work; therefore animals should be fed efficiently before they start working to provide them with the reserves

required to work effectively and efficiently (Pearson, 1998). It was noticed that horses and donkeys are fed in the same manner; a practice that Aganga *et al*. (2000) considered mismanagement and stressed on that donkeys should not be fed like horses.

Table 4.27 Frequency Distribution of respondents according to Water during work

Providing water	Frequency	Percent
Provide	10	5.0
Not provide	190	95.0
Total	200	100.0

Source: Field Survey 2015

Animals watering practices are not better than those of feeding. Working animals have an increased requirement for water. The amount needed will depend on the duration of work, and the climatic conditions prevailing. Provision of water can be a problem in Semi-arid areas where the water supply may be some distance from the farm. Water deprivation can reduce food intake, and therefore, exacerbate the low nutrient supply from poor quality forage (Pearson, 1998). Keeping free will water available year round is advisable for all draught animals (Houser, 2008). Only (5%) of the farmers offer water to their animals during the work, while (95%) do not offer water to the animal during work (Table 4.27).

Table 4.28 Frequency Distribution of respondents according to time of water n=190

Water time	Frequency	Percent
Morning and evening	112	59.0
After and before the work	16	8.0
When need	34	18.0
Morning +afternoon and evening	28	15.0
Total	190	100.0

Source: Field Survey 2015

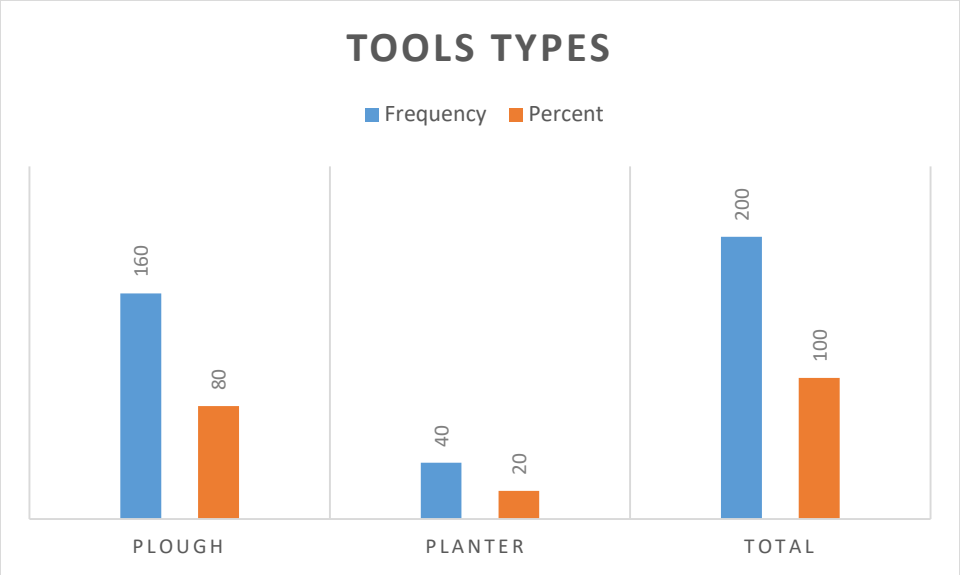
More than half of the farmers (59%) provide water to the animals on the morning and evening, (8%) after and before the work, (18%) did when their animals need, while (15%) on the morning, evening and after noon, (Table 4.28).Offering water to the animals after eating will not benefit them and results in low ability to work Only the latter is the proper practice according to Makki and Pearson (2011) who reported that watering the animal after eating reduces its ability to eat and digest.

Table 4.29 Frequency Distribution of respondents according to animal harness

Animal harness	Frequency	Percent
Collar and saddle	84	42.0
Breast straps	86	43.0
Double shoulder yolk	30	15.0
Total	200	100.0

Source: Field Survey 2015

Animal harnessing should receive the same care as health and feeding. Research showed that little benefit will result from good feeding and health care if harnessing was not properly performed (Fall *et al.*, 1997; Joubert, 1999; Pearson *et al.*, 2003). Less than half of the farmers (42%) harnessed their animals using collars and saddle, followed by breast straps (43%), while (15%) used double shoulder yolk, (Table 4.29). In the Sudan collars are common with horses, while breast straps are common with donkeys. Using a saddle with the collar reflects concerns on fixed harnessing from the farmers' side. Even donkeys are harnessed with collars in most of the cases especially in rural Kordofan. For the same type of working animals it is expected that animals harnessed with collars will perform better than those harnessed with breast straps. Farmers do not realize that different types of harness can result in different work output, even for the same animal (Geza, 1999).



Source: Field Survey 2015

Figure 4.6 Distribution of farmers by tools types

Less than half of farmers (80%) used the light single mouldboard plough (locally known as a *Koriat* plough and five tine cultivator locally known as a Nubian hoe) for ploughing, while (20%) of the farmers used planter, (Figure 4.6). This marginal portion raises questions on the source of their information on using the five tine cultivator for ploughing and planter it is clear that the introduction of this implement had not been carefully advocated by the Administration of Agriculture or the cost excluded farmers from its use. Lack of knowledge on the plough and planter appeared clearly in farmers' responses regarding the procedure followed to check the plough and planter before and after work and at the end of the season.

Table 4.30 Frequency Distribution of respondents according to benefits of AT

Benefit	Frequency	Percent
Reduce time and burden	140	70.0
Increase production, reduce time and burden	60	30.0
Total	200	100.0

Source: Field Survey 2015

Most of the farmers (70%) use animals' traction reduces time and burden; while (30%) benefited from draught animals increased production, reduced time and

burden. All the farmers in target area mentioned the benefit of animal traction this refers to the portability of new technology (animal traction). Table 4.3

Table 4.31 Frequency Distribution of respondents according to AT increase production

Increase production	Frequency	Percent
Yes	178	89.0
Some time	22	11.0
Total	200	100.0

Source: Field Survey 2015

For most of the farmers (89%) the uses of animal's traction in kordofan increase production, while for the rest (11%) of respondents the uses of animal traction increase production but at some time. This confirms to the major effect on increase farmers income. (Table 4.31).

Table 4.32 Frequency Distribution of respondents according to constrains of DA

Constrains	Frequency	Percent
Lack of tools	12	6.0
Lack of VS	4	2.0
No problem	180	90.0
Lack of training	4	2.0
Total	200	100.0

Source: Field Survey 2015

Table 4.32 mentioned the problems face farmers in adoption of animal traction, (6%) lack of tools, (2%) lack of animal health, (90%) of the farmers no problem, while only (2%) lack of training. Starkey (1988) also observed that constraints to animal traction may include: Lack of appropriate implements, Limited credit, insufficient animals, Animal health problems, inadequate animal nutrition, Unclear fields, Farmer traditions, Lack of technical knowledge, Poor infrastructure and, Limited

marketing possibilities. Therefore, the identification of a district specific farmer's needs is necessary to be able to propose policies and measures to the situation.

Table 4.33 Frequency Distribution of respondents according to farmers Opinion on DA

Opinion on DA	Frequency	Percent
Useful for soil and available	11	6.0
Useful for soil, convenient for small farmer, increase production, easy to use and available	189	94.0
Total	200	100.0

Source: Field Survey 2015

All most of the farmers (94%) said that the application of animal traction technology is Useful for soil, convenient for small farmer, increase production, easy to use and available, while only (6%) useful for soil and available. This confirms that the program of AT is successful in target area. The adoption of animal traction was initially related in many countries to the increase production of cash and food products for sale (Starkey, 1985), table 4.34.

Table 4.34 Frequency Distribution of respondents according to proposal for Project

Project suggest	Frequency	Percent
Providing DA management (Veterinary care, Feed)	120	60.0
Provide tools of DA (planter, plough)	10	5.0
Training unit	20	10.0
best site unit	38	19.0
Land ownership	12	6.0
Total	200	100.0

Source: Field Survey 2015

Table (4.34) mentioned the proposal for project on the area, more than half of respondents (60%) need to veterinary service and feed, (5%) need to plough and planter, (10%) need to training unit, (19%) best site unit, while (6%) need to land ownership. All most hand tools farmers need to (plough and planter) to adopt animal traction and other farmers need to animal feed and veterinary services this confirms to lack of animal traction tools and management.

Table 4.35 Frequency Distribution of respondents according to best area

Best area	Frequency	Percent
My area	200	100.0
Total	200	100.0

Source: Filed Survey 2015

All the respondents (100%) need the project in their area or locality (table 4.35). This indicates to the unavailability of animal traction services in target area.

Table 4.36 Frequency Distribution of respondents according to reason to select project area

Reason to select area	Frequency	Percent
The area in need for project	200	100.0
Total	200	100.0

Source: Field Survey 2015

From the table (4.36) appeared the reason to select project area. All the respondents 100% believed the area is in need for project more than other areas. The farmer's area is so far from the urban or center, during the rainy season the do not able to reach the center.

Table 4.37 Frequency Distribution of respondents according to Program provide by institutions

Availability of program	Frequency	Percent
Government	36	18.0
Private	16	8.0
Not available	144	72.0
Government and private	4	2.0
Total	200	100.0

Source: Field Survey 2015

Table (4.37) mentioned the program offered by institutions. Most of respondents (70%) not available, (18%) of respondents received program by the government, (8%) by private sector, while only (2%) received program by the private sectors and

government. This refers to the lack of program development among rain fed farmers in target area.

Table 4.38 Frequency Distribution of respondents according to type of services

Service type	Frequency	Percent
Extension and training	32	16.0
No services	136	68.0
Planter and ploughs	32	16.0
Total	200	100.0

Source: Field Survey 2015

Result in table (4.38) illustrates type of services introduced to the farmers, Majority of respondents (68%) there are no services, and (16%) received extension and training services, (16%) received planter and plough. This mentions that the services were provided to small part of the farmers.

Table 4.39 Frequency Distribution of respondents according to received program

Execute program	Frequency	Percent
Seminar and workshop	14	7.0
Team work	38	19.0
No program	148	74.0
Total	200	100.0

Source: Field Survey 2015

The distribution of respondents by the received program is presented in Table (4.39). Most of respondents (74%) did not have any program, (7%) by seminar and workshop, while (19%) by team work**.** This indicates that the hand tools farmers they don't have services rather than the animal traction farmers.

Table 4.40 Frequency Distribution of respondents according to program participation

Program participation	Frequency	Percent
No participation	182	91.0
Limited participation	6	3.0
Active participation	12	6.0
Total	200	100.0

Source: Field Survey 2015

Table (4.40) explain that all most of respondents (91%) had no participation, (3%) limited participation, while (6%) of respondents active participation. Participations is major effect to adopt new technology, all anima traction farmers participated in different program.

Table 4.41 Frequency Distribution of respondents according to type of Support needed to adopt DA

Support type	Frequency	Percent
Financial support	188	47.0
plough, Training, planter, animal	144	36.0
plough and Planter	64	16.0
Seed	4	1.0
Total	400	100.0

Source: Field Survey 2015

Result in table (4.41) illustrates type of support to adopt AT. Less than half of the respondents (47%) need financial support, (36%) need to plough, training, planter and animal, (16%) need to plough and planter, while only one percent needs seed. Availability of tools play major role on animal traction adoption.

Table 4.42 Frequency Distribution of respondents according to working speed (km/h)

Categories	Frequency	Percent
1 and less than 2 km\h	172	86.0
2 and less than 3 km\h	16	8.0
3 – 3.5 km\h	8	4.0
3.6 – 4.5 km\h	4	2.0
Total	200	100.0

Source: Field Survey 2015

A considerable portion of the farmers (86%) recorded very low working speed of 1 and less than 2 km/h (Table 4.41), only (2%) recorded very high working speeds (3.6 – 4.5 km/h). Farmers recording working speeds of 2 and less than 3 km\h were (8%), while (4%) recorded 3 – 3.5 km/h. When animals are poorly harnessed they tend to walk slower. Geza (1999) and Nengomasha (1999) reported comparable forward speed of 3.9 and 3.1 km/h for horses and heavy donkeys, respectively.

Table 4.42 Frequency Distribution of respondents according to ffield capacity (ha/h)

Categories	Frequency	Percent
Less than 0.04 ha\h	30	15.0
0.04 – 0.10 ha\h	58	29.0
0.11 – 0.15 ha\h	44	22.0
0.16 – 0.20 ha\h	28	14.0
0.21 – 0.25 ha\h	10	5.0
0.26 – 0.30 ha\h	18	9.0
0.31 – 0.35 ha\h	8	4.0
More than 0.35 ha\h	4	2.0
Total	200	100.0

Source: Field Survey 2015

The working speed range reflected on the effective field capacity and slightly (15%) recorded field capacities less than 0.04 ha/h. An (29%) recorded 0.04 – 0.10 ha/h. Farmers recording high field capacities more than 35 ha/h were 2% of the sample,(22%) recorded 0.11 – 0.15ha\h, (14%) recorded 0.16 – 0.20 ha\h, (5%) field capacity 0.21 – 0.25 ha\h, (9%) recorded 0.26 – 0.30ha\h, while (4%) recoding 0.26 – 0.30 ha\h (Table 4.42). The low field capacities are probably a direct result of the

poor harnessing, low capacity of the farmers both leading to frequent stoppage of animals. Comparable low field capacities were reported for draught horses with collar harness in Ethiopia by Geza (1999). Nengomasha (1999) reported similar low capacities for heavy male donkeys harnessed to the same type of plough used in the study area.

Table 4.43 Frequency Distribution of respondents according to field Efficiency (%)

Categories	Frequency	percent
40 and less than 50%	12	6.0
50 and less than 60%	8	4.0
60 and less than 70%	40	20.0
70 and less than 80%	38	19.0
80 and less than 90%	58	29.0
90 to 97%	44	22.0
Total	200	100.0

Source: Field Survey 2015

Field efficiency results were rather on the low side (40 – 70%) for 30% of the farmers (Table 4.43). Those who recorded 71 – 80% were 19% of the sample. Farmers recording high efficiencies (80 to 90%) were 29% of the total farmers, while efficiencies (>90%) were 22%. The low ranges of field efficiency can possibly be attributed to the frequent stoppage time while ploughing. Stoppage from its side relates to the poor harnessing of both horses and donkeys. Since field efficiency is taken as a product of net-working time to the total time of operation, any stoppage will result in lower values.

Table 4.44 Frequency Distribution of respondents according to by Operational way

Categories	Frequency	percent
Square	24	6.0
Straight-line	176	44.0
Total	200	50.0

Source: survey 2015

Table (4.44) shows the operational way different from farmers to another, most of the farmers (44%) operational way straight- line, while the rest (6%) square way table 4.49.

Chi-square Test for animal traction adoption in En-nuhoud and Aldebibat in West and South Kordofan States

Table (4.45) Summary (Chi-square Test in the animal traction adoption by gender, education, land ownership, crop, extension, training and production)

Cross tabulation	Level of significant	Relationship
Adoption of animal traction by gender	0.000	Significant
Adoption of animal traction by education level	0.000	Significant
Adoption of animal traction by land ownership	0.000	Significant
Adoption of animal traction by crop grown	0.000	Significant
Adoption of animal traction by extension service	0.000	Significant
Adoption of animal traction by training package	0.000	Significant
Adoption of animal traction by increase production	0.000	Significant

Table (45) shows chi- square test (cross tabulation) between adoption of animal traction technology and (age, gender, education level, land ownership, farm size crop grown and animal ownership) at level of significance 0.05. The results showed high significant association between the variables since (PV < than 0.05) for all variables. Age influenced the adoption of animal traction since (AT) adopters were smaller in their age compared to hand tools farmers.

Gender: the dominant adopters were males. Education level: shows significant relation with adoption process as Urasa, (1994) said most small holder farmers have only very limited education and so any new technology to be introduced should be simple enough to be understood by the farmers. Crop grown**:** there were significant association between crop grown and animal traction adoption (PV < than 0.05), this is due to the importance of animal traction adopting for the farmers who cultivates groundnut, because groundnut considered as main cash crop in the target area. Land ownership: there were significant association between land ownership and animal traction adoption (PV < than 0.05) that means land accessibility identify the increase or decrease rate of animal traction adoption, this is very important factor because the farmers (owners) decided to adopt the technology. Land size: shows significant

relation with adoption of the technology Barrett et al, 1982; Panin, (1986) recorded farm areas before and after the adoption of draught animals tend to indicate that where land is available, farmers will cultivate more land when they have draught animals, so that total yield per farm increases in addition Gboku (1988) said there is very often a conflation between farm size and the ownership of draft animals, although this does not necessarily mean that the animals are the cause of the large area of cultivation; it may be that the farmers that have big farms are the ones wealthy enough to use draught animals, so that draught animals may be the result of large farms. Animal ownership: there was significant association between animal type and animal traction adoption (PV < than 0.05). All farmers believed that horses are faster in the tillage process and easier in training.

Table (4.46) Chi-square test for effect of the farmers Operational Skills in the Animal Traction Adoption by Gender

Gender			Do you use DA in Agriculture		Total
			Yes	No	
Gender	Female	Count	0	145	145
		% within Do you use DA in Agriculture	0.0%	72.5%	36.2%
	Male	Count	200	55	255
		% within Do you use DA in Agriculture	100.0%	27.5%	63.8%
Total		Count	200	200	400
		% within Do you use DA in Agriculture	100.0%	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	227.451[a]	1	.000		
Continuity Correction[b]	224.325	1	.000		
Likelihood Ratio	288.607	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	226.882	1	.000		
N of Valid Cases	400				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 72.50.

b. Computed only for a 2x2 table

Table 4.46 shows that there were significant association between animal traction adoption and gender (PV < than 0.05).

Table (4.47) Chi-square test for effect of the farmers Operational Skills in the Animal Traction Adoption by educational level

Education			Do you use DA in Agriculture	
			Yes	No
Education level	Illiterate	Count	18	62
		% within Do you use DA in Agriculture	9.0%	31.0%
	Khalowa	Count	4	34
		% within Do you use DA in Agriculture	2.0%	17.0%
	Year and education before university	Count	149	70
		% within Do you use DA in Agriculture	74.5%	35.0%
	University	Count	29	34
		% within Do you use DA in Agriculture	14.5%	17.0%
Total		Count	200	200
		% within Do you use DA in Agriculture	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	76.779[a]	3	.000
Likelihood Ratio	82.250	3	.000
Linear-by-Linear Association	33.926	1	.000
N of Valid Cases	400		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 19.00.

Table 4.47 shows that there were high significant association between educational level and animal traction adoption (PV < than 0.05).Educated farmers showed clearly high rate of adoption especially at year and education before university. This means that all farmers educated is adopt to new technology and effectively in the rate of animal traction adoption.

Table (4.48) Chi-square test for effect of the farmers Operational Skills in the AT Adoption by land ownership

Land ownership			Do you use DA in Agriculture		Total
			Yes	No	
Land ownership	Owned	Count	140	144	284
		% within Do you use DA in Agriculture	70.0%	72.0%	71.0%
	hired	Count	8	52	60
		% within Do you use DA in Agriculture	4.0%	26.0%	15.0%
	Partnership	Count	8	4	12
		% within Do you use DA in Agriculture	4.0%	2.0%	3.0%
	Employer	Count	40	0	40
		% within Do you use DA in Agriculture	20.0%	0.0%	10.0%
	Rented	Count	4	0	4
		% within Do you use DA in Agriculture	2.0%	0.0%	1.0%
Total		Count	200	200	400
		% within Do you use DA in Agriculture	100.0%	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	77.656[a]	4	.000
Likelihood Ratio	98.469	4	.000
Linear-by-Linear Association	30.700	1	.000
N of Valid Cases	400		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 2.00.

Table 4.48 shows that there were significant association between land ownership and animal traction adoption (PV < than 0.05).This means land accessibility identify the increase or decrease rate of animal traction adoption, this is very important factor because the farmers (owners) decide to adoption the technology.

Table (4.49) Chi-square test for effect of the farmers Operational Skills in the AT Adoption by Crop grown

Crop grown			Do you use DA in Agriculture	
			Yes	No
Crop grown	Groundnuts	Count	200	72
		% within Do you use DA in Agriculture	100.0%	36.0%
	Groundnuts, dura and okra	Count	0	16
		% within Do you use DA in Agriculture	0.0%	8.0%
	All crops	Count	0	30
		% within Do you use DA in Agriculture	0.0%	15.0%
	groundnuts and Drua	Count	0	74
		% within Do you use DA in Agriculture	0.0%	37.0%
	Sesame and Dura	Count	0	8
		% within Do you use DA in Agriculture	0.0%	4.0%
Total		Count	200	200
		% within Do you use DA in Agriculture	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	188.235[a]	4	.000
Likelihood Ratio	240.128	4	.000
Linear-by-Linear Association	165.151	1	.000
N of Valid Cases	400		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 4.00

Result in table 4.49 Shows that there were significant association between crop grown and animal traction adoption (PV< than 0.05).This is due to the importance of animal traction adopting for the farmers who cultivates groundnuts, because groundnuts main cash crop in the target area.

Table (4.50) Chi-square test for effect of the farmers Operational Skills in the AT Adoption by Extension services

Extension services			Do you use DA in Agriculture		Total
			Yes	No	
Extension service	Yes	Count	47	0	47
		% within Do you use DA in Agriculture	23.5%	0.0%	11.8%
	No	Count	153	200	353
		% within Do you use DA in Agriculture	76.5%	100.0%	88.2%
Total		Count	200	200	400
		% within Do you use DA in Agriculture	100.0%	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	53.258[a]	1	.000		
Continuity Correction[b]	51.016	1	.000		
Likelihood Ratio	71.432	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	53.125	1	.000		
N of Valid Cases	400				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.50.
b. Computed only for a 2x2 table

Result in table 4.50 Shows that there were significant association between extension services and animal traction adoption (PV < than 0.05).This is due to the importance of extension for different process like (management of AT and training).

Table (4.51) Chi-square test for effect of the farmers Operational Skills in the AT Adoption by training package

Training package		Receive training package		Total
		Yes	No	
Do you use DA in Agriculture	Yes	27	173	200
	No	43	157	200
Total		70	330	400

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.433a	1	.035		
Continuity Correction	3.896	1	.048		
Likelihood Ratio	4.466	1	.035		
Fisher's Exact Test				.048	.024
Linear-by-Linear Association	4.422	1	.035		
N of Valid Cases	400				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 35.00.
b. Computed only for a 2x2 table

Table 4.51 Shows that there were significant association between training package and animal traction adoption (PV < than 0.05).This is due to the importance of training in all agricultural operation (animal traction and hand tools).

Table (4.52) Chi-square test for effect of the farmers Operational Skills in the AT Adoption by production

Production			DA increase production		Total
			Yes	Some time	
Do you use DA in Agriculture	Yes	Count	178	22	200
		% within DA increase production	47.1%	100.0%	50.0%
	No	Count	200	0	200
		% within DA increase production	52.9%	0.0%	50.0%
Total		Count	378	22	400
		% within DA increase production	100.0%	100.0%	100.0%

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	23.280[a]	1	.000		
Continuity Correction[b]	21.212	1	.000		
Likelihood Ratio	31.780	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	23.222	1	.000		
N of Valid Cases	400				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.00.

b. Computed only for a 2x2 table

Result in table 4.52 shows that there were significant association between increase production and animal traction adoption (PV < than 0.05).This means the use of animal traction in agriculture increase production rather than hand tools.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Chapter Five

Conclusion and Recommendation

5.1 Conclusion and Recommendation

From the results of this study the following conclusions can be made:

1. Horses 34% and donkeys 30% were the dominant draught animals in the study area.
2. Male 64% are dominant on uses of At.
3. 70% of the farmers owned their land
4. All of the farmers 100% owned knowledge about AT.
5. Farmers mostly 98% feed their animals on dry forage and concentrates.
6. 88% of the farmers used plough and 20% used planter.
7. Farmers used animal traction (AT) were in productive age 40%.
8. Education level among farmers was low to medium 75%.
9. Groundnut 68% is main crop grown by (AT) users.
10. 77% of the farmers lack extension services and skills for animal traction uses.
11. Extension in targeted area introduced to the farmers by poor way.
12. All extensions concentrated on distribute improve seed 4% beside farmer visit 2%, training 4% and ignored another side of extension.
13. Most of the farmers 70% owned local knowledge about animal traction from beer farmers.
14. Farmers mostly access veterinary service 88%, due to inaccessibility; therefore they mostly rely on local remedies for animal's treatment 27%
15. The commonly type of harness was the collar and saddle 42%.
16. Farmers lack knowledge on animal housing, feeding, watering and hardness.
17. All of the farmers need different services and skills to adopt animal traction
18. The poor state of animal management resulted in low working speed, filed capacity and efficiency.
19. The result shows high significant association between animal traction adoption specifically age of farmers, education level, gender, land ownership,

land size crop grown, training, extension, animal ownership and adoption of animal traction.

20. The results revealed different reasons that limited and constrained the expansion of the technology where the major reason was lack of animal health and feed training, while all most of the farmer 90% don't face problems.
21. Also lack of knowledge, tools and money were reported as limitations and constrains for adopting the technology.
22. Maximum respondent (29%) recorded high efficiencies (80 to less than 90%), while minimum respondent (4%) recorded (50 and less than 60%).
23. The maximum respondent (29%) recorded field capacities from 0.04 to 0.10 ha/h, the minimum respondent (2%) recording high field capacities more than 35 ha/h.

5.2 Conclusion

Majority of the farmers used plough while the rest planter. Farmers used animal traction (AT) was in productive age, education level among farmers was low to medium. Groundnut is main crop grown by (AT) users in addition horses were the dominant among (AT) users. The result shows high significant association between animal traction adoption specifically age of farmers, education level, gender, land ownership, land size crop grown, training, extension, animal ownership and adoption of animal traction. The results revealed different reasons that limited and constrained the expansion of the technology where the major reason was lack of animal health and feed of animals while training was recorded as the minor reason. All the farmers owned local knowledge about animal traction from beer farmers. Also lack of knowledge, tools and money were reported as limitations and constrains for adopting the technology.

The results showed serious gaps in farmers' knowledge, attitudes and practices regarding all the aspects of draught animal's adoption. This appeared more acute in issues related to animal health care, feeding and watering, harnessing.

The poor state of animal management resulted in low working speed, filed capacity and efficiency. Maximum respondent (29%) recorded high efficiencies (80 to less than 90%), while minimum respondent (4%) recorded (50 and less than 60%).The maximum respondent (29%) recorded field capacities from 0.04 to 0.10 ha/h, the minimum respondent (2%) recording high field capacities more than 35 ha/h.

5.3 Recommendation:

1. We advise the farmer in the study area to learn animal management skills in addition to cultivation techniques.
2. We advise to provide training for extension staff in the use of animal traction, if they are to provide useful advise
3. We advise to address problem of animal nutrition through low-cost inputs to increase the efficiency of animal traction.
4. Appropriate animal health package will be needed to protect them against diseases.
5. Adoption rate of the technology can be improved by providing credit service, capacity building of the staff responsible for extension and training at the formal bodies dealing with the technology transfer and providing high quality of training sessions for optimal application of the technology.
6. Ministry of Agriculture and governmental organizations should facilitated accessibility of credit and tools to farmers in the area of study extension agents should expand their role to raise farmer's knowledge about the technology.
7. Formal and non-formal education should be provided among traditional farmers.
8. Furthers studies should be carried to assess farmers perception towards the innovation (AT) attributes.

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Appendixes (1)

Questionnaire

Adoption of Draught Animals by Farmers in West and South Kordofan State

Adoption (West and South Kordofan)

This questionnaire is concerned with farmer's adoption draught animals in West and South Kordofan State. It is one of the requirements for research for Phd in the Agricultural Extension and Rural Development at Sudan University of Science & Technology. Please, tick in the appropriate box to identify your response. All data shall be deal within confidential manner.

Part One:

Personal Data:

1-Serial
Number……..

2-Where are you live?
Locality……. Administration……..Village…….
3- How old are you?.....
4- Gender? Female ( ) Male ( )
6- What is your level of education? A. Illiterate ( ) B.Khalwa ( ) C. Year and education before university ( ) D. University ( ) E. other mention ( )
7- Marital status? A. Married ( ) B. Divorced ( ) C. widow ( ) D. Deserted ( ) E. other mention ( )
8- Land ownership? A. Owned ( ) B. hired ( ) C. Partnerships ( ) D. Other mention ( )
9- What is type of animal that you use in agriculture?
A. Horses ( ) B. Donkeys ( ) C. Camels ( ) D. Cows ( ) E. Other mention ( )
10- Soil type? a. Clay ( ) b. Sand ( ) c. Gardod ( ) d. other mentions ( )
11- Crop type? A. Groundnuts ( ) B. Sorghum ( ) C. Sesame ( ) D. Karkady ( )
E. Other mentions ( )
12- What is the cultivated area by animal traction/ Makhamus? …….

Part two

Services and extension data

1- Do you receive any extension services? Yes ( ) No ( )

If yes what is type? A. improved seeds ( ) B. Training ( ) C. Visit farms ( ) D. Pesticides ( ) E. Cash ( ) F. Other mention

2- Do you participate or link with any Development organization?

Yes ( ) No ( )

If yeswhat type of organization……

3- Cultivation purpose? A. Increase income ( ) B. Self-sufficient C. Other mention ( )

4- Do you use the animal tractionin agriculture? Yes ( ) No ( )

- If yes for what purposes?.....
- If no why ……..

5- Did you receive any training package about animal traction? Yes ( ) No ( )

-If yes what type of training? …….

- From what party? …….

6- Knowledge about animal traction?

Yes ( ) No ( )

- If yes source of knowledge? .....
- Period of time? ……....

Part Three

Animal Management

Veterinary care and Vaccination

1-Do you provide veterinary care for the animal? Yes ( ) No ( )

- If no why? …….....

-If yes, A. By yourself or hired ( ) B. calling veterinarian ( ) C. take the sick animal to the hospital ( ) D. Other mentions it……

2- Do you vaccinate your animals?

Yes ( ) No ( )

- If yes what are time? A. Summer ( ) B. autumn ( ) C. Winter

- If no why? ……

3- How do you handle your animal diseases?

A. By yourself or herder ( ) B. Calling veterinarian ( ) C. Take the sick animal to the hospital ( ) D. Other mention ( )

Animal Housing

1-What type of housing do you use to keep your draught animals?

A. In a barn (un-shaded) ( ) B. Tied outside the house ( ) C. Stall next house ( ) D. By a tree ( ) E. at home under a thatch roof ( ) F. other mention ( )

Animal Feeding and water:

1-What type of basic feed provided to animals during the year?

A. Green fodder, clover ( ) B. Concentrate Fodder ( ) C. Al darich ( ) D**.** Dray food ( ) E. Other mention ( )

2-When do you provide fodder for the animal? A. In the morning ( ) B. In the evening ( )

C. At work ( ) D. Other mention ( )

3- During work do you provide water for the animal to drink? Yes ( ) No ( )
-What is the time? ……

Part Four

Implementing

1-What type of harness do you use to your animal?

A. Collar and ropes ( ) B. Collar and Saddle ( ) C. Breast straps ( ) D. Other mentions ( )

2-What type of tools do you use? .....

Part Five

Benefit andConstraints

1-What are the benefits of using animal traction? A. Increase production ( ) B. Reduce the time ( ) C. Reduce burden ( ) D. other mention ( )

2-Does the use of draught animal's increases production?

Yes ( ) No ( ) Sometime ( )

3-What are problems and constraints facing use of draught animals? A. lack of tools ( ) B. Lack of veterinary services ( ) C. Neglect of intermediate technology ( ) D. Other mentions ( )

Part Six

Animal traction adoption

1-What is your opinion in animal traction technology? A. Useful for soil ( ) B. Convenient for small farmers ( ) C. Increase production ( ) D. Easy to use ( ) E. available f. other mention ( )

2- What are the type of projects suggest? A. Providing veterinary care ( ) B. Provide a food source ( ) C. training of farmers ( ) D. providing improved seeds ( ) E. other mention ( )

-Best area in locality to establish project? Why…….

3-What are the types programs and project for development of animal traction provided to you by institutions? A. Government institution ( ) B. Private Institution ( ) C. Institution and civil groups ( ) D. Other mentions ( )

4-What type of services is offered by institution? A. cash ( ) B. Extension and training ( )

C. other mention ( )

5-How do the institutions execute their programs with you?

A. Seminar sand workshop ( ) B. teamwork ( ) C. Other mentions ( )

6-What is the extent of your participation in the implementation of programs and projects? A. No participation ( ) B. Limited participation ( ) C. Active participation ( )

Part Seven

Field Capacity and Efficiency

Animal type	Soil type	Type of Tool	Tool width	Length of distance	Width of pieces	Total time	Net time	Operation way	Number of ridges

Appendixes (2)

Figure 1 (AT) by Donkey (Planter)

Figure 2 Planter

Figure 3 (AT) by Cows/ Oxen (Planter)

Figure 4 Nubian Plough

Figure 5 Koriat Plough

Figure 6 (AT) by Horses (ploughing)

Figure 7 (AT) by Donkey (Ploughing)

Appendixes (3)

Fig 1 West Kordofan Map

Fig 2 South Kordofan Map