ANIMAL POWER UTILIZATION AND MANAGEMENT IN NIGERIA (CASE STUDY OF BAUCHI, GOMBE AND YOBE STATES)

BY

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DEPARTMENT OF AGRICULTURAL ENGINEERING
F.U.T. MINNA.

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SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY.
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JUNE, 2002

CERTIFICATION

I certify that this project was carried out by MIKHAIL B. SALAU in the Department of Agricultural Engineering, Federal University of Technology, Minna.

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DEDICATION

This Project is dedicated to:

MOHAMMED SELIM MIKHAIL

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ABSTRACT

An investigation into the level of work animal utilization was carried out to determine the general scope of work animal utilization level. And to determine cost of animal traction operation (Ridging) in Bauchi, Gombe and Yobe States. The study was carried out by means of structured questionnaires, administered to various animal traction farmers in each state. The finding of the study revealed that Bulls and Donkeys are the most widely used work animals. Bulls are used for Ridging, weeding and transportation, while donkeys are only used for transportation. The total overall cost of operating a hectare of land with animal ridger is Bauchi ₦2,021.56, Gombe ₦ 2,112.03 and Yobe ₦ 1,641.51. Using hand labour it will cost ₦ 3,570.while it cost ₦ 2,625 and ₦ 4,000 for both government and private tractor organization respectively to ridge a hectare of land. Based on the findings of the study, it is recommended that the government should encourage educated youth into the system, introduce wear resistance materials for the farmers ridger and encourage the farmer to use the work-bulls more so as to reduce capital cost.

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CHAPTER 1

1.0 INTRODUCTION

Agricultural mechanization in Nigeria will be a mirage unless the farmers are in control of the tools for their production. The low level of production of the farmers are still largely maintained today because the farmers are in control of the hoes, cutlasses, axes, animals they use on the farm. If we can imagine for a moment what would happen if these tools are not readily available or the cost are too high for farmers to afford, and farmers have to take their turn in loaning these tools from Government or other bodies, the result will be a disaster (Ige, 1996). It is on record that up to 70% of agricultural production in Nigeria today is handled by hand tools and draught animal technology (Onwualu, 1998).

Agricultural mechanization is defined differently by authorities in the field only on the choice of nomenclature but with same context. Agricultural mechanization involves the use of tools, implements and machines to improve the efficiency of human time and labour. The most appropriate machinery and power source for any operation depends on the work to be done and the relative desirability, affordability, availability and technical efficiency of the options (Starkey, 1998). Farm production and rural transport require power to function. There are three main sources of power open to the farmer classified as hand-tool technology (HTT), draught animal technology (DAT) and the use of motors. The choice depends on local circumstances.

The level of sophistication of Nigeria agriculture and food demand requires more than the use of hand-tool technology as sole adopted technology for food production. This is because of some inherent reasons associated with it such as, drudgery, timeliness factor, low output which is not commensurate with the rapid

growth in population. In 1996, CTA and FAO commissioned Dominique Bordet and Rene Rabezandrina to study Mechanization experiences in Africa (Starkey, 1998). These observations were made among others:

(i) Public-sector tractor hire services have failed throughout Africa

(ii) Tractors have seldom proved viable for the small holder sector.

The failure of tractorization is largely due to Nigerian land system, where the farm lands are small and scattered without good access roads, the devaluation of the currencies which has dramatically increased the price of tractors relative to the value of harvested produce is one of the causes of this failure. This devaluation has also affected the price of tractor parts and accessories. The unfortunate fact today is that over 50% of the tractors in the country are unserviceable (Onwualu, 1998).

Animal traction has been a highly successful mechanization innovation in sub Sahara and Savannah zones. It is an appropriate, affordable and sustainable technology in many northern states of the country. One of the most successful farm mechanization introduction is animal traction technology. Draught animal power utilizes locally produced animals, harnesses, implements and feeds, thereby boosting the economy of these local producers. It can be used to reduce drudgery, intensify agricultural production, raise water, mill, level land and construct road. The animals are good source of protein, cow dung among other things can be burnt as fuel and can be used as fertilizer to encourage fish growth. Work animal appreciates instead of depreciating as in tractors.

In this project, emphasis will be laid on animal traction technology, the study was carried out in three states of north eastern parts of Nigeria. The states are Bauchi, Gombe and Yobe which are known for their extensive use of animal traction.

1.1 **OBJECTIVES:** The objectives of this project include:

(i) The study and evaluation of extent of use, of animal traction technology.

(ii) Analysis of cost of animal traction operations.

(iii) Analysis of cost of ridging operation.

(iv) Presentation of comprehensive data on rate of animal power used in agriculture, its cost and problems encountered.

1.2 **JUSTIFICATION:** The present level of information available on animal traction techniques and equipment are found in various publications produced by International Institutions and donor agencies. Data on the extent of use of animal traction are lacking, few that are available need up-dating and wider circulation. There has not been much extensive work on the operator so as to gain an understanding of the farmer in terms of his or her skills, constraints, preferences and aspirations.

Costing of animal traction operation have not been standardized in places where this technology is practised, therefore an in-depth knowledge from the survey carried out are essential for developmental initiatives.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 SOURCES OF POWER IN AGRICULTURAL OPERATIONS

Agricultural mechanization is one of the most essential input technologies for increased agricultural production and productivities. This quest for food security for all through the adoption of concerted policies and actions at global, regional and national levels, points to the need for Nigeria in particular, to evolve a viable agricultural production options that will ensure a continuous sufficient production of food and raw material for agro industries and for export.

In facilitating and actualizing these objectives, three main sources of power are employed in Agricultural mechanization. These are Hand Tool Technology (HTT), Draught Animal Technology (DAT) and Engine Power Technology (EPT). The selection of any of these Technologies has to be related to the local circumstances. In certain cases, the raw materials could determine the technology to be used.

2.1.1 Hand Tool Technology: HTT makes use of tools and implements that rely on human muscle as the prime mover. Such tools include machetes, cutlasses, hoes, diggers, axes, spade, shovel, sickles, rakes, mattocks, shear e.t.c. (Odigboh, 1994). Available information indicates that human power system accounts for 90% power input producing 90% of the total agricultural products and taking 60% of the effective labour force in the country (Musa, 1996).

Human labour is characterized by limited power output, but compensated by versatility, dexterity and judgement. Thus, human has superior capability for operations requiring skills such as transplanting seedling, weeding and selective

harvesting of fruits, vegetables and some fiber crops. The limitation of human power negates the sole use of this technology in food production.

The sustainable rate at which the body can use up energy while working is about 300w for a reasonably fit person in temperate conditions. In hotter climates, heat stress may reduce this value, perhaps to about 250w. The maximum, sustainable power output which a person produces is approximately 75w (Carruthers and Rodriguez, 1992). Many agricultural activities demand higher rates of energy consumption, rest period is then necessary. See Table 1 for human power requirement for some agricultural activities.

Table 1. **Human Power Requirement For Various Farming Activities**

S/No	Activities	Gross Power Consumed (Watts)
1.	Clearing bush and scrub	400 – 600
2.	Felling tress	600
3.	Hoeing	300 – 500
4.	Ridging, Deep Ridging	400 – 1000
5.	Planting	200 – 300
6.	Ploughing with draught animal	350 – 350
7.	Driving tractor	
7.1	Single axle tractor	350 – 350
7.2	Conventional Four wheel tractor	150-300
8.	Driving a Car on the farm	150

Source: Carruthers and Rodriguez, 1992

2.1.2 **DRAUGHT ANIMAL TECHNOLOGY:** Animal traction technology was introduced in Nigeria in the early part of 20th Century. Many authors (Musa, Ladeinde

1996, Phillip et al. 1986), agreed that animal farming was introduced in Daura around 1922 by the British through the mixed farming system (MFS). The objective of the MFS was to have the Nigerian crop grower and animal husbandman to grow both crop and livestock and use the large animals, the bulls as draught animal to cultivate more land. The British aimed at achieving food security for the local farmers and their families and at the same time produce cash crop for the British market.

Draught animal technology involves the use of implement machine and equipment, which are powered by work animal such as Donkeys, Horses, Camels, Oxen and Buffaloes (Odigboh, 1994). In Nigerian, animal power system is restricted to the use of oxen or work bull and accounts for 8% of power input in agricultural production (Musa, 1996). Animal traction is particularly well suited for the Guinea, Sudan and Sahel Savanah zones of Nigeria. This area covers about 26 of the 37 states (including FCT). These areas are trypanasomiasis free, has relatively loose soils, there is existing tradition of man-animal interaction (Ladeinde, 1996).

Animal power is of enormous importance throughout Asia and in South America, its use in Africa, particularly South of Sahara is increasing. In Nigeria, the interest and zeal put into promoting the MFS yielded positive results, the number of farmers practising MFS increased from only 3 in 1927 to 15,000 successful mixed farmers by 1955. Today there are 500,000 to over 1 million mix farmer proper and work bull owners in the Northern Nigeria (Musa, 1996).

The major constraints with DAT are:

(i) Under utilization

(ii) Many farmers have restricted access to animal power, this restriction arise because farmers may not own cattle, because mixed farming is not traditional in many areas.

(iii) Government agencies often lack interest and commitment to encourage the use of animal power.

(iv) Animal power operation in Nigeria is synonymous to one implement, the emcotridger for ridging and ridge remoulding operation.

These limitations are by no means dwarfed by its advantages which have been enumerated by different authors (Musa, 1996, Ladeinde, 1996, Gero, 1999 and Suleiman, 2000).

(i) Work animal can be used to reduce drudgery and intensify agricultural production.

(ii) Draft animal can also be used for other activities like water raising, milling, logging, land leveling and road construction.

(iii) It is affordable technology compared to tractor.

(iv) Animal and equipment can be supplied locally and often less expensive.

(v) It does not require much training.

(vi) Appreciation to value of the work bulls instead of depreciation as we have in tractors and agricultural equipment.

(vii) Effective crop-livestock integration that facilitate energy recycling process where by crop residue are fed to work animal and animal waste products are used to fertilize the crop.

(viii) One ton of cow dung contains about 8kg of Nitrogen, 4kg of phosphorous and 16kg potash, which can be used in fish pond as fertilizer to enhance fish growth.

(ix) Animal dung can be burnt as fuel. This is regrettable because it denies the soil of natural fertilizer but it also reduces pressure on limited timber resources.

(x) Draught animal power utilizes locally produced animals, harnesses, implements and feeds. In contrast, 90% of tractor and their implements are produced in industrialized countries and these together with fuel is a drain on our foreign exchange.

It has been demonstrated that Draft Animal Technology system can increase net income by 255% when improved equipment are made available as indicated in Table 2 below.

Table 2. **Economic Returns with Draft Animal (Oxen)**

S/N	Level of Use	Area under cropping (Ha)	No. of Active workers Needed	Area per Active Worker (Ha)	Net Income per Hectare (%/Ha)
1	Light animal traction (horses and Donkeys traction) with light implement	5.2	3.4	1.55	100
2	Animal traction semi-intensive (Oxen with recommended equipment)	8.4	5.1	1.65	182
3	Animal traction Intensive (Oxen with high capacity Equipment	12.0	6.3	1.90	255

Source: N.P.E. Curf Systems Development in Agricultural Mechanization in Developing Countries, Wageningen Netherlands, 1982. As cited by (Musa, 1996).

2.1.3. **ENGINE POWER TECHNOLOGY:** E.P.T. includes the use of a range of tractor sizes as mobile power for field operations. Engine or machine using petrol or diesel fuel or electricity to power such machines as threshers, mills, irrigation pumps, grinders, aircraft for spraying and self propelled machines for production, harvesting

and handling of a wide variety of crops (Odigboh, 1994). Engine power technology is the highest level of mechanization commonly used in agriculture. Although according to (Onwualu, 1998), 70% of agricultural production in Nigeria is handled by hand tool and draught animal technology. However, for the Nigeria agriculture to catch up with the developed countries, the use of motorised machine is inevitable.

Mechanical power system can expend more energy than manual and animal power system. Timeliness and precision in production operations are always obtained. Yields have correspondingly been higher than those obtained from manual and animal power system, large expanse of land can be put under cultivation, reduced losses and improved quality of food product as well as improving the dignity of the farm worker.

In general application, the tractor power system in Nigeria has been found to give very poor yield performance purely due to non-adaptability (Musa, 1996). Maintenance of tractors and its implements has proven to be a difficult task to achieve. This has resulted in breaking down of tractors and implements before their useful life is attained. Over 50% of tractors in the country are broken down due to various reasons including; lack of spare parts, poor operation and maintenance and unhealthy national macro-economy trend which has affected adversely traction and equipment prices. Table 3 shows state of 4 wheel tractors in Nigeria.

TABLE 3: **State of 4 wheel tractors in different States in Nigeria**

S/N	STATE	OPERATION	PERCENTAGE OF CONDITION	
			SERVICEABLE	UNSERVICEABLE
1	ANAMBRA	62	31	7
2	BAUCHI	46	32	22
3	BENDEL	43	57	0
4	BORNO	43	31	26
5	CROSS RIVER	44	35	21
6	GONGOLA	63	32	5
7	IMO	26	28	46
8	KADUNA	80	1	19
9	LAGOS	98	0	2
10	NIGER	52	47	1
11	OGUN	51	34	15
12	OYO	75	19	6
13	RIVERS	89	25	6
14	SOKOTO	64	16	20
AVERAGE		**58**	**28**	**14**

Source: Anazodo et al., 1987.

Information on the number of tractors and agricultural machinery used in the tropics is lacking, and if, according to (Udo, 1999), the level of engine power technology used in Nigeria agriculture is relatively low, then that of the tropical West African countries collectively is better imagined. This premise is based on the fact that Nigeria is widely considered the leader in terms of most developed within the

region.

2.2 APPLICATION OF ANIMAL POWER IN FARM OPERATIONS

The domestication of animal for draught purposes is estimated to have started over 5,000 years B.C. Loosening the top soil for seed placement was probably the first draught operation. Transport developed into second major task for draught animal after the invention of the wheel (FAO, 1982). Very clearly, there is great potential for use of animal traction and equipment to reduce the drudgery of the hand labour in moving soil. Animal drawn scoops, levelers, bund formers, terracing, milling and vast range of tillage equipment are currently being used most effectively.

Animal power is used in different countries to perform different operations, depending on the availability of the animal that is suitable for a particular operation. China which has a long history of animal power usage on the farm has 93.892 billion large animals consisting of 52.528 billion cattle (equivalent to 56% of the total large animal population). The remainder being composed of horses, donkeys, mules and camels. About 53% of the large animal population are used for draught purposes. China also has about 17 million buffaloes of the swamp type. All these animals are used for tillage purposes and the horses for pulling carts (Feng Yang-Lian, 1982).

In India, draft animals are the main source of power both on the farm and for road transport. At present, over 80 million draft animals and 0.7 million tractors are used to cultivate approximately 143 million hectares. These draft animals can contribute more power capacity for India's work effort (30,000 Mega Watts) than the installed capacity of power sources using fossil fuel and hydro-power in that country (FAO, 1982) and Bensal et al., 1986). Farmers primarily use oxen with a variety of traditional equipment for land preparation, sowing and inter-row cultivation. Oxen are commonly used for land-development activities such as field leveling, constructing

anti-erosion bund and field drain.

Animal traction technology expanded in the USA and Europe in 18th and 19th Centuries. The famous 'Rothamsted' experiments promoted the practice of deep ploughing and soil inversion to improve drainage and weed control. The use of the heavy plough requiring draft of 200kg and more created a preference for heavy animal and resulted in a shift from bull to horses. The high draught output of these animals allow the mechanization of harvesting animal drawn mowers and reapers to be developed. A new range of agricultural implements were introduced. This include a variety of tillage equipment, planters, potato diggers, corn shedders e.t.c . This development were more or less confined to Europe, North America and Australia and it came to a gradual halt by 1930. When engine power technology became available to advanced countries (FAO 1982).

2.3 ANIMAL TRACTION IN AFRICA

The great diversity of Africa geographically, ecologically, socially, economically and politically makes meaningful generalization very difficult. Even within countries, there can be a great range of conditions, making global statements concerning animal traction in just one country fraught with problems. However, it is helpful to briefly contemplate the history of draft animal power application in Africa.

The development of draft animal power in Africa has been considered in general reviews (FAO, 1982, Starkey, 1986 and Musa, 1996). In Ethiopia, the Nile Valley and North Africa, draft animals have been widely used for centuries and in many ways. In these countries, the plows or Ards are made locally by the village artisans and can be maintained in the village. The use of animals for cultivation and pack transport is very common in Ethiopia with its 6 million draft animals, and in Northern Africa. In several other parts of Africa, including Mali and Somalia, different

cultures have traditionally used animals for carrying people or goods.

However, in most sub-Sahara African countries, the use of draft animal power for crop cultivation became popular less than a century now. In South Africa, the use of plow diffused rapidly and plowing with animals became a standard practice for many of the small holder farmers. In these countries, Madagascar in particular, oxen are used for irrigation scheme and puddling of rice in the swamps.

For the francophone West African countries including Burkina Faso, Cameroun, Guinea, Cote d'voire, Mali and Senegal, private companies provided all the training, extension, credit and equipment necessary to allow very rapid rates of adoption of draft animals for cotton and groundnut production. In Senegal alone, 150,000 seeders and 70,000 groundnut lifters are in use. In Morocco, over One million animals are employed including oxen, donkeys, mules, horses and camels. In Egypt, about one million cattle and water Buffaloes are used for cultivation on the farm, water pumping and threshing.

2.3.1 **ANIMAL TRACTION IN WEST AFRICA** There are three broad zones in which draught animals are used. In the North of Sahel where rain is less than 600mm per year and arable farming is limited, most of animals used are donkeys, horses and camels mainly for transportation. Further South are countries like Senegal, Chad, Northern Nigeria and Northern Cameroun where Zebu breed of cattle are used for crop cultivation. Further South of this zone, are countries like the Gambia, Southern Senegal, Southern Mali, South Western Burkinafaso and Northern of Guinea, Sierra Leone, Cote d'voire,Ghana, Togo, Southern Nigeria and Benin where work animals are used, they are generally small because of trypanasomiasis (Starkey, 1986).

2.3.2 ANIMAL POWER USE IN NIGERIA

The role of animal traction technology in performing different types of operation on the farm and rural development has often been poorly emphasized in Nigeria despite its potential impact on the evolution of agricultural systems. The introduction of animal traction technology in Nigeria was restricted to the northern part because of its tse-tse free zone and the farmers already have tradition of keeping livestock.

It was estimated that, by 1980 only 100,000 farmers were using this technology out of the total of 7.15 million farmers in the Northern states i.e. less than 1.5% of farmers and they were cultivating less than 6% per annum (Jama're, 2000). In Nigeria, animal traction is used in accomplishing variety of farm operations mainly in up land and in particular ridging and transportation of farm produce, Goods and people (Gero,1999 Jama're 2000).

2.4 **APPLICATION OF ANIMAL POWER USE:** Tillage has been the oldest and the principal farming operation using work animals, animal traction can be adapted to accomplish a variety of operation in crop production. The various implements are adopted from tractor implement but considerably reduced in size and weight so that they can be pulled with draught animal. Work animal can be employed in the following as have been cited by various authors (FAO, 1982, Bangura, 1986, Starkey, 1988, Gero, 1999, Suleiman, 2000).

2.4.1 **LAND CLEARING:** There are some potential for using animal power in conjunction with ropes and pulleys to assist in the falling and logging of trees during land clearance. Animal can be used for raking up of residues, this will reduce compaction that will result if tractors or bulldozers are used in land clearing.

2.4.2 **PRIMARY CULTIVATION:** In Nigeria and most of African countries, ridging and ploughing are the only operations performed by draft animals, although ploughing may be followed by harrowing or leveling in order to obtain a good seedbed.

2.4.3 **RIDGING:** Crops like corn, millet and some tuber crops like sweet potatoes, yam and cassava are grown on a ridge or heap. The use of work oxen for such operation can substantially reduce the labour requirement and time spent compared with traditional method where hoes are used.

2.4.4 **SEEDING:** Seeding with draft animal is only common in some parts of Africa, like Senegal and the Gambia where seeding with animal drawn seeder are used for cotton and groundnut planting. In Nigeria, the available planter are the single grain row type satisfactory for groundnut, millet, maize sorghum and the double row type being developed at IAR Zaria.

2.4.5 **WEEDING:** Weeding with draft animal has a high potential for saving labour, the cultivator can be used as general purpose weeding device. Its considerable weight allows for more leveling of old ridges or mound. Flexible spike tooth harrow and rotary hoes are also employed in weeding operations.

2.4.6 **TRANSPLANTING:** The use of animal drawn transplanter was well developed in Europe and America before the introduction of engine technology. However, animal drawn transplanter is till very little developed here.

2.4.7 **HARVESTING:** DAT has little to offer in harvesting equipment in Nigeria, although carefully adjusted weeding sweep can be effective harvesting device for groundnut.

2.4.8 **ANIMAL POWER GEARS:** Animal draft force can be converted to mechanical energy to operate water pump for irrigation, rice hullers, maize grinder, cassava graters et.c. through gear systems. The animals are attached to a

horizontal pole and as they walk in a circle, the gear system is operated. This technique is undergoing on-station trials at Rolako, Sierra Leone, if it works, the processing of agricultural produce at village level will be facilitated.

2.4.9 **MULTI-PURPORSE TOOL CARRIER:** Animal tools carrier development in Africa started in Senegal around 1954, the first tool carrier was designed by a French agriculturist, Jean Nolle. It comprises of a metal chassis and drawbar supported on the two wheels by pneumatic tyres. It can carry a mould board plough, up to three seeders, flexible tines, groundnut lifter, harrow and ridger, a plat form could be fitted to make the tool carrier a cart.

2.4.10 **TRANSPORTATION:** The use of draft animal to pull cart leads to a convenient form of rural transportation and keeps the animal utilized throughout the year. The cart with a wooden or metal body with pneumatic wheels has been the conventional transport equipment for use with draught animals. This trend should have major social and economic benefits for the farmers, it will also stimulate local economics.

2.5 **CONSTRAINTS OF ANIMAL POWER USERS:** In Nigeria and other parts of African countries, the draft animal technology is working in technical isolation. There are many agronomic and economic problems for which the farmers can not offer any viable solutions. Some of these constraints have been discussed by (Reddy, 1986, Jama're 2000, Suleiman, 2000).

2.5.1 **LIVESTOCK DISEASE**: A significant of sub-Sahara Africa is tse-tse infected, this makes keeping of livestock in this area difficult.

2.5.2 **LACK OF TRADITION OF KEEPING LIVESTOCK**: Introducing draught animal technology to people who have no livestock husbandry tradition is always a very difficult task.

2.5.3 **INADEQUATE POWER FROM THE DRAUGHT ANIMALS**: The maximum draught force which a pair of bull can produce is a function of its body weight, anatomy of animal (i.e. distance between front and rear feet) and soil type. However, the most important factor is the body weight. It is estimated that a pair of bull can develop a draught force equivalent to 5-12% of its total body weight. Farmers seem to want tillage system with low power requirements, partly because their cattle are in poor condition and their donkeys are weak.

2.5.4 **POOR NUTRITION**: Feed ration of work animal has to be balanced for good growth and maximum output in draft requirement. Feeding supplements of cereals is necessary and about 9 to 10kg is required for a 360kg cattle, straw/crop residue of about 4.5kg is needed in addition to a 7hr. grazing for forage intake. This is hardly met by our local farmers, especially in the dry season when feeds are scarce.

2.5.5 **LACK OF IMPLEMENTS**: Although there have been a lot of research and developmental work done on DAT implements, but many of the innovations are still to move from prototype stage. Animal processing equipment are rare in most agricultural establishments and farms. The use of animal drawn implement has increased production, but this has led to the creation of new bottlenecks. The larger amount of crop harvested can not all be processed at the farm level.

The efficiency of implement used for secondary and primary cultivation is reduced when used on land that are stumpy for crop can not be sown in straight line which in turn makes inter-row weeding and subsequent operations difficult. As it can be evidenced, it is mouldboard plough and ridger that are widely adopted in area where DAT is used.

2.5.6 **FLOODING:** Many farm areas experience seasonal flooding. This imposes limitation on the successful use of DAT during the wet season. Movement of draught

animal in such aquatic environment becomes impossible.

2.5.7 **COMPETING DEMAND FOR LIVESTOCK PRODUCTS:** Demand for meat and milk supply are quite high and hardly ever satisfied in Nigeria. It is difficult for farmers to use their livestock for farming as it will appear profitable to produce milk and meat rather than engage in arable crop production.

2.5.8 **ECONOMIC REASONS:** DAT use is constrained because of high initial investment cost and cash-flow problems in the short run. Realization of full benefit to new adopters is often deferred for many years. This is associated with the long learning period (i.e. the period new adopters use in learning how to handle the animals and the training of the animals).

2.6 **ECONOMIC USE OF DAT:** Investment in agricultural mechanization is like any other economic investment, for the acquisition of capital assets and for the purpose of generating wealth (Gittinger, 1982). Farms are business, they have inputs that cost money and output that gives income. Cost analysis in animal farming operation will involve farmers in considerable investment in their time and resources. Therefore, a careful analysis is needed to guide the farmer from liquidation.

Work on the profitability of an investment in animal traction has been carried out by some authors (FAO,1982, Ndiame, 1986, Abimbola, 1991, FAO, 1994). It has to be appreciated that work animal and its equipment cannot be literally maintained in perpetuity, equipment physically deteriorates due to wear and tear, animal on the other hand will grow weak and weak until it cannot perform effectively again. However, there should be adequate budgetary allocation for replacement

In deriving the cost of animal power operation, most of the authors (FAO, 1982, Ndiame, 1986, FAO, 1994) works are not based on Nigeria local obtainable conditions. The indigenous author (Abimbola, 1991) has derived his formular on

calculating animal operation cost on computer system, which further alienate the majority of the users who are illiterates.

However, there is consensus by the authors on the best method to use in calculating cost of animal traction operations. Costing of farm operations are the same all over the world and if these are understood and some basic facts and assumptions agreed upon, then it is simple matter to adjust the costing system to suit a particular need.

Costing can be done on an hourly basis or on a hectare basis. Generally, animal traction cost are classified into two major groups namely: Fixed Cost and Variable Cost.. Variable cost includes: Supervision of animal, labour cost (mate), Feed Supplementation and Management Cost . Fixed cost consists of: Depreciation, Risk/Insurance Cost, Interest, Veterinary and Health Care Cost, Feeding Cost, Labour. It is suffice to say here that work animal grows during their working lives and are generally sold at profit. This appreciation in value is very important and is an added attraction to the use of draught animal.

CHAPTER 3

3.0 METHODOLOGY

Three states were selected in the North Eastern part of Nigeria for the survey, mainly North of 11^0 latitude which include Bauch, Gombe and Yobe states. Fig. 1. These states were chosen based on the fact that they are among the states that have the largest concentration of work animals. Other states include: Kano, Katsina, Kebbi, Sokoto and Zamfara State (Musa, 1996).

Structured questionnaire were developed and distributed within five (5) Local Government Areas in Bauch State, three (3) Local Government Areas in Yobe and Gombe States. Five (5) Local Government Areas were chosen from Bauchi State because of its size, population and number of Local Governments compared to the other two states chosen for the survey. Bauchi State has 20 Local Government Areas while Yobe and Gombe have 12 and 11 Local Government Areas respectively.

The five Local Government Areas chosen from Bauchi State include Darazo with farm house hold number of 15,102, Giade with farm house hold number of 10,882, Katagun with farm house hold number of 23,821, Misau with farm house hold number of 24,188 and Shira Local Government with farm house hold of 19,699 as at village listing serving of 1997 by Bauchi State Agricultural Development Programme (BSADP, 2002). The three Local Government Areas chosen from Yobe State include: Damaturu with farm house hold number of 12,415, Fune with farm house hold number of 37,431 and Potiskum with farm house hold number of 35,431 as at 2000. Village listing Serving by Yobe State Agricultural Development Programme (YOSADP 2002). The three Local Government Areas chosen from Gombe State are

Dukku with farm house hold numbers of 25,559, Gombe with farm house hold number of 13,030 and Kwami with farm house hold of 20,477 as at 2000 Village Listing Serving, by Gombe State Agricultural Development Programme (GSADP, 2000).

The questionnaire were divided into seven (7) sections, the first section contains the background information on the farmer, the second section contains types of animal used for DAT, followed by operations and the type of animal used, the fourth section is on the input into the animal traction farming, the fifth is on the local charges for animal operations, the sixth consists of the salvage values of the work animals and its equipment, while the seventh section contains the problems encountered by the work animal users.

The survey was conducted in two ways. The first is by question administration, where prepared questions were distributed and filled by the farmers. The second is by oral interview, where physical visitation were made to the farmers and farmers interviewed. The questionnaires were targeted at the real work animal users. These farmers were selected randomly and interviewed by the author and other agricultural Engineers who helped in the survey. Almost accurate data were obtained due to the physical visitation made. Twenty questionnaires were distributed and filled in each local government area covered by the survey, thereby making a total of 220 filled questionnaires. All the questionnaires were returned.

Attempts were made to calculate the cost of using hand labour and the government charges for the use of Tractors to ridge a hectare of land to compare with the one calculated from the use of animal traction.

The data available from the filled questionnaires gives insight into the extent of animal used, types of animal used and the local ways of charging for animal traction operation within the area covered by the survey as compared to using hand labour, Government and Private Tractor Hiring Unit.

Table 4: **NUMBER OF QUESTIONNAIRES DISTRIBUTED & RETURNED**

State	No. of Questionnaires Distributed	No. Returned	% Returned
Bauchi	100	100	100
Gombe	60	60	100
Yobe	60	60	100
TOTAL	**220**	**220**	**100**

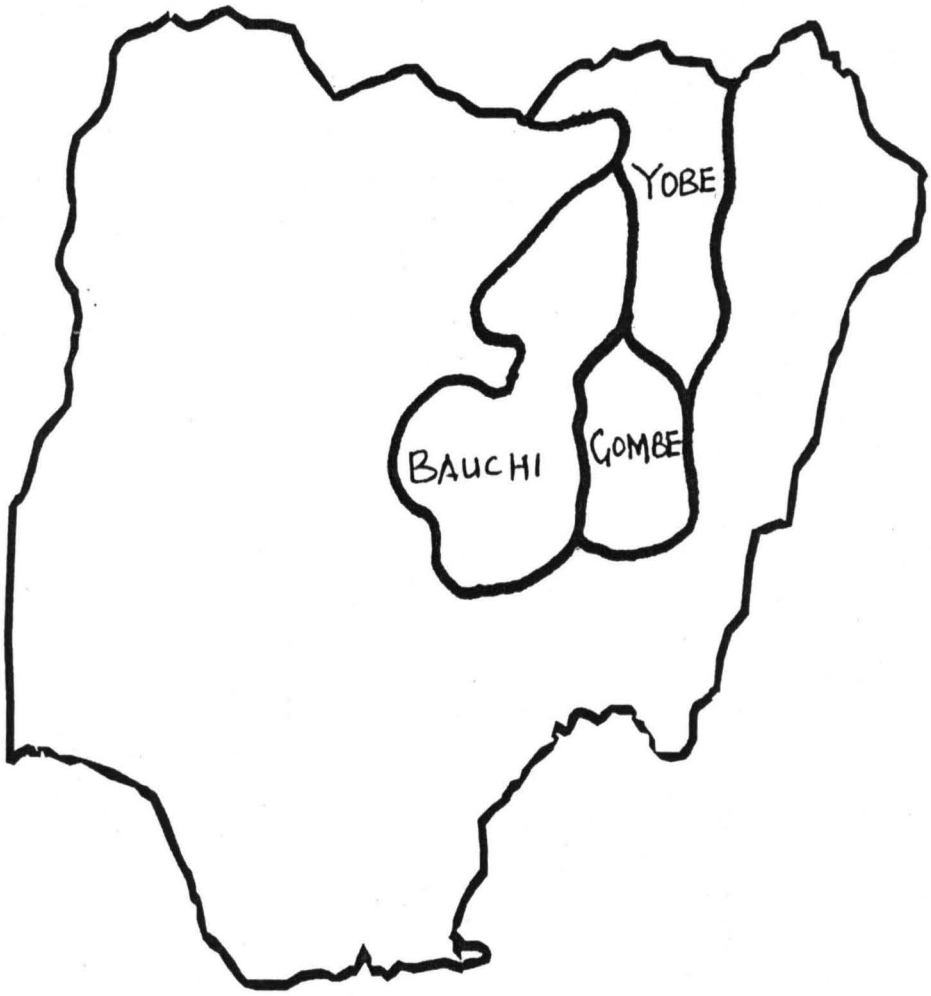

Fig. 1 Map of Nigeria Showing the States Covered by the Survey

CHAPTER 4

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

The results are put in form of table for easy analysis.

Table 5 shows the distribution of age of farmers, educational background and experience with animal traction technology. (See Appendix A).

The breakdown of age group distribution, show that there was no any animal traction farmer whose age was below 20 years in all the 3 states surveyed. Most of the farmers interviewed were between the ages of 41 and 60 years (Bauchi State 54%, Gombe State 63.33% and Yobe State 48.33%). The percentage of farmers above 60 years are: Bauchi 14%, Gombe 15% and Yobe State 18.34%.

The educational level of the farmers interviewed shows that most of the farmers have non formal education (Bauchi 65%, Gombe 63.33% and Yobe 68.33%). The percentage of farmers whose level of education were above secondary school are shown in table 5 to be (Bauchi 5%,Gombe 5% and Yobe 11.67%.

Experience with animal traction shows how long the farmers have been using animal traction technology. Result shows that most of the farmers interviewed have been using animal traction technology between 10 to 20 years (Bauchi 38%, Gombe 38.33%, and Yobe 43.33%) Farmers who have above 20 years of experience are Bauch 40%, Gombe 30% and Yobe 40%.

Utilization of work animal is focussed in Table 6, result from the survey shows that the types of operation performed by work-bull are ridging and weeding, transportation is done by work-bull and sometimes by donkey.

The predominant impliment in the surveyed areas are ridgers, weeders which

is called 'Kalkabeta' by the farmers and carts for transportation of goods and people. The percentage of farmers who own these impliments are shown in Table 6. (See Appendix A). Results show that all the farmers interviewed (100%) owned at least a ridger.

Weeder is not widely used like the ridger, so only few animal traction farmers own one. The percentage of ownership of weeder in each State is shown in table 6, Bauch 34%, Gombe 5% and Yobe State 36.67%. Breakdown of framers who own cart are shown, Bauchi 82%, Gombe 58.33% and Yobe State 75%. Animal traction farmer who owns donkey is shown in Table 6, (Bauch 7%, Gombe 5% and Yobe5%). The use of animal traction for irrigation farming is only practiced in Bauchi State., and only 8% of the farmers practice this farming method.

The average hours of work by a pair of work-bull per day in Table 7 shows that the animal works for 4.37hrs. in Bauchi State, 4.36 hrs. in Gombe State and 4.32 hrs. in Yobe State. (See Appendix B). Ownership of work bulls shows that majority of the work-bulls, are owned privately (Bauchi 98%, Gombe 95% and Yobe 96.67%).

Use of work-bull from Table 7 shows that most of the farmers use their work-bull on their private farm and hire it out, result shows that the percentage of farmers who practiced this method for each State are Bauch 79%, Gombe 78.33% and Yobe 78.33%). It was observed from Table 7 that there was no any animal traction farmer who only hires out his animal and implement.

Table 8: **Average age and Average number of work animal per farmer**

STATE	AVERAGE NUMBER OF WORK ANIMAL PER FARMER IN EACH STATE		AVERAGE AGE OF WORK ANIMAL (YRS)	
	BULL	DONKEY	BULL	**DONKEY**
BAUCHI	**3**	**0.1**	**4.53**	**2.3**
GOMBE	**2**	**0.0833**	**4.18**	**2.5**
YOBE	**3**	**0.1333**	**4.40**	**2.5**

The average number of work animal per farmer is shown in Table 8, the breakdown of the average number of workbull per farmer is Bauchi 3, Gobe 2 and Yobe 3. The average number of donkey per farmer in the surveyed areas are shown (Bauchi 0.1, Gombe 0.0833, Yobe 0.133).

Age distribution for work-bull in Table 8 shows the average age to be, (Bauchi 4.53, Gombe State 4.18 and Yobe State 4.4 years). The average age for donkey per State are: Bauchi 2.3, Gombe 2.5, Yobe 2.5 years.

Table 9 shows the various types of problems encountered by the farmers in the surveyed areas (See Appendix B). The most complained problems is wear of shear point and furrow wheel (Bauchi 26.34%. Gombe 25.08%, Yobe 25.79%). The second most complained problem is animal disease, Bauchi 18.63%, Yobe 17.20%, for Gombe State the second most complained problem is high cost of work animal and implement 13.04%/ The complain on cart is mostly on tyres (Bauchi 19.45%, Gombe 13.15%, and Yobe Stated 16.17%

Table 10 show some input and output in animal traction technology costing, (see Appendix C). Result from the table shows that an average workbull is sold in Bauch State for N30,400, Gombe N23,066.67, Yobe State N24,200. The averager price of a ridger is Bauchi N6000, Gombe N6000, Yobe N5500.

Table 11: Estimate of the Working Life for Work bull and Equipment

ESTIMATES OF THE WORK LIFE FOR WORK BULL AND EQUIPMENT

STATE	AVERAGE USEFULL LIFE OF WORKBULL (YRS)	AVERAGE USEFULL LIFE OF A RIDGER (YRS)	AVERAGE USEFULL LIFE OF HARNESSING EQUIPMENT (YRS)
BAUCHI	4.42	21.0	1.86
GOMBE	5.33	22.2	1.80
YOBE	4.53	23.0	1.93

The breakdown of useful life of some animal traction equipment are shown in table 11, the average useful life of a work bull in the surveyed areas are Bauchi 4.42 years, Gombe 5.33 and Yobe 4.53 years. The average useful life of a ridger is 21, 22.2 and 23 years for Bauchi, Gombe and Yobe States respectively. Useful life of harnessing equipment are Bauchi 1.86, Gombe 1.8, Yobe 1.93 years.

The distribution of number of work-bulls in each local government surveyed are shown in Table 12 (See Appendix D). The estimated number of farm house hold shows the estimated number of farmers in each local government area. The rate of adoption is the percentage of animal traction farmer within the estimated farm household. If the estimated number of farm household is multiplied by average number of work-bull per farmer in the local government and multiplied by the rate of adoption in the local government, the estimated total number of work bull in the local government is obtained.

Results from table 12 shows that Misau local government area is having the largest concentration of work-bulls in Bauchi State, 61,315. In Gombe State, Kwami local government is leading with an estimated number of work-bulls of 42,403. In Yobe State, Fune local government has about 87,095 work-bulls.

4.1.1 COSTING OF ANIMAL TRACTION OPERATION USING A RIDGER IN BAUCHI STATE

Animal traction cost include two major costs: Fixed Cost and Variable Cost

Fixed Cost Include: Animal cost, implement cost, harnessing equipment cost,

interest cost, health cost, insurance cost and feed supplementation.

Variable Cost include: Hired labour and feed supplementation..

Initial Estimates

Animal purchase price (2 bulls)	=	N 60,800 - Table 10
Animal sales price after working life	=	N130,800 - Table 10
Animal working life	=	4.43 years - Table 11
Cost of a new ridger	=	N6,000 - Table 10
Cost of harnessing equipment	=	N375.60
Cost of labour	=	N150/Operator
Feed supplementation throughout the year (2 bulls)=(N27x365)2	=	N19,710 - Table 10

Total Equipment Cost = 6000 + 375.6 = N6375.60

4.1.2 Animal Equipment Cost calculation

Animal equipment depreciation:

(Average Working Life of a Rider is 21 years from Table 11)

Depreciation = $\frac{6375.6}{21}$ = N303.6/year

Interest Calculation is given as 10% on 50% of equipment Cost (FAO,1994)

Interest = N318.78

Repair and Maintenance = 10% equipment cost (FAO, 1994)

Repair and Maintenance = N637.56

Total equipment cost = N1259.94

4.1.3 Annual Animal Cost Calculation

Animal Capital cost

(Appreciation over 4.42 years) - Table 11

Appreciation Over a year = $\frac{(130{,}800 - 60{,}800)}{4.42}$ = N15,837.10

Interest cost for purchasing animal is given as 10% interest on 50% of animal cost = N6540.

Management and veterinary cost = (224 x 12)2 = N5376 - Table 10

Feed Cost throughout the year = N19,710

Insurance Cost = 5% of initial cost of animal (FAO, 1994)

Insurance = N6540

Total Animal Cost = (654 + 5376 + 19710 + 6540) – 15837.10

= N22,328.9

Total Annual Fixed Cost = 23,588.84

VARIABLE COST

Hire labour per day (2 people) = N150x2 = N300/day

Feed supplementation Cost = (27 + ¼ of 27)2 = N67.5/day

Total variable cost = N367.50

Land preparation using work bulls in Bauchi State starts form May 1st to August 31st , about 123 days (BSADP). See Appendix C Table 13, Average \ working days per pair of work bull is 77 days (from field experience). Pair of work bull works for 4.37 hrs everyday appendix B Table 7. Total hours of work in a year is 77 x 4.37 = 336.5 hrs.

Total fixed cost / hr = $\frac{23{,}588.84}{336.5}$ = N 70.10

Total Variable cost / hr = $\frac{367.5}{4.37}$ = N 84.10

Total Cost / hr = 70.10 + 84.10 = N 154.20

Work bulls works for an average of 4. 37 hrs each day and it takes 3 days to ridge a hectare of land. 4.37 x 3 = 13.11 hrs.

Total Cost / ha = 154.20 x 13.11 = N2021.56 in Bauchi State.

In Gombe State, from calculation it will cost the sum of N 2,112.03 to ridge a hectare of land while in Yobe State it will cost N 1,641.51 only.

According to (Crossley, et al. 1983) an average human beings daily output is between 0.07 – 0.04 ha / day with daily work length of 5 hrs. if a human being's output is 0.07 ha / day, it will take 14.3 men working 5 hrs each day to ridge a hectare of land or take one man. 14.3 days to ridge a hectare of land. If a man is paid N250 / day, it will cost N 3,575 to ridge a hectare of land using hand labour.

A 52kw tractor is hired, 8 hrs in a day in Bauchi, Gombe and Yobe State for N8,000 excluding fuel and feeding of the operator and the mate. If these expenses are added to the charge, the total cost of a tractor will be about N 10,500. The tractors average output is 4 ha (the reason for the low output is because most of the farms are small and not in one place, so the tractor waste a lot of time in traveling form one farm to the other). Therefore, the cost / ha is N2,625. This is the government price.

Private organization charge almost twice as much the government price about N4,000 / ha (from field experience as a tractor and equipment schedule officer for more than 4 years).

4.2 DISCUSSION

The findings of the study revealed the age distribution of the farmers in table 5, it shows that most of the farmers in the 3 states surveyed are aged. Gombe state is the most affected having 63.33% of its farmers between the age of 41 and 60 years and 15% above 60 years of age. This shows that animal traction is not being patronised by the energetic youth on whose shoulder the future of this country lies.

This assertion is in agreement with (Apollos, 2001).

Most of the farmers are not educated (table 5), Yobe State is having the highest percentage of non educated farmers 68.33%. The implication of this is that, it will be very difficult to make changes for improvement in animal traction technology. Most of the literature on animal traction are in foreign languages, only an educated person will be able to have access to them, read and understand. This postulation concur with (Jama'are, 2000) "There is a need to undertake research on why this technology (Animal traction) has not been widely adopted or improved upon in the Savannah belt despite over 70 years of extension effort". However, table 5 shows that the farmers are well experienced with animal traction technology.

Table 6 shows that all the animal traction farmers own at least a ridger. Jama'are, 2000 has also said "In most cases only the ridger has been well adopted". The weeder/cultivator has not been as accepted as the ridger, from table 6 only 5% of the farmers from Gombe State own weeder. This partial adoption is in agreement with (Gero, 1999). "presently the low level of animal-drawn weeder adoption seem to be due to farmers unfamiliarity with the technique."

Many animal traction farmers are not keeping donkeys, probably because it is used for transportation only. Bulls can also be used for transportation, through the attachment of carts as well as for cultivation, many farmers own carts now as can be seen from table 6. Another reason is that donkeys have very low salvage values unlike bulls, which appreciate during its working life.

Animal traction farmers who use their animals for irrigation farming are very small. In Bauchi State only one local government area (Shira) among the surveyed local government practiced this system of farming, it only average 8% of the total farmers in the State (Table 6).

Average hours of work (Table 7) shows that a pair of bull work for about 4.37

hrs in Bauchi State, 4.36 hrs. and 4.32 hrs in Gombe and Yobe States respectively. The bulls are worked only in the early hours of morning. This is quite inadequate as it has been shown by (Suleiman, 2000) that pair of bull can work between 5 – 6 hrs a day if the work is scheduled for morning and evening.

Most of the bulls (table 8) are owned privately (Bauchi 98%, Gombe 95% and Yobe 96.67%). Ownership of cooperative is very small Bauchi 2%, Gombe 5%, Yobe 3.33%). This could be another reason for the lack of development in animal traction technology. To promote this technology, the government must participate fully.

The distribution of age of animal (Table 8) shows the average age of work-bull (Bauchi 4.53, Gombe 4.18, Yobe 4.4 years). This quite agree with (Suleiman, 2000). "Animal may be trained at 2 to 3 years of age and then put to work at the age of 3 or 4 years." An average animal traction farmer in Bauchi has 0.1 donkey (Table 8). This is to say that, out of 100 farmers interviewed 10 have donkeys.

The most complained problem by animal traction farmers (Table 9) is on the wear of shear point and the furrow wheel. From field experience, a farmer changes this part up to 2 times during the farming season. Effect of this is loss of money, and valuable time during this season. The implementation agencies should introduce wear resistant materials to ameliorate these problems The problem related to cart is tyre puncture which can be rectified easily by the local vulcanizer. This could be the reason why most of the farmers own cart (Bauchi 82%, Yobe 75%) Table 6.

Using some data from table 10 and 11 it will cost N2,021.56 to ridge a hectare of land in Bauchi State, N2,112.03 in Gombe and N1,641.51 in Yobe State. From this analysis, it is cheaper to own work-bulls in Yobe than in Bauchi and Gombe States. The reason for this cheapness in Yobe State could be because of large concentration of work animals in the State. A local government area (Fune) in Yobe State has about 87,095 work-bulls table 12. This reason is in agreement with (FAO, 1994). "In

some areas where there are lot of draught animals, it will be quite cheap to hire a pair to plough the land". Currently, Yobe charge N 1300 / ha, Bauchi N 1688 / ha and Gombe State N 1980 / ha using animal traction, these charges are quite inadequate. This is the reason why most of the work-bull owners are complaining of inadequate returns from their investment in the business.

Using hand labour, it will take 14.3 men each working for 5 hrs to ridge a hectare of land, at N 250 / man it will cost N 3,575. Government tractor hiring unit in the 3 States charge average of N 2,625 / ha while private organization charge about N 4,000 to ridge a hectare of land.

The results of the study show that when viewed in economic terms, the tractor is not readily available for the farmers and during busy period labour is scarce. Particularly, on a lager farms the use of animal power may become relatively attractive. This is in agreement with Crossely et al. 1983.

CHAPTER 5

5.0 CONCLUSION & RECOMMENDATION

5.1 CONCLUSION:

The important fact that have come out of this survey is that, Bulls and Donkeys are the most widely used work animals on the farm in all the states covered by the survey. The commonest farm operations in these states are ridging, weeding and transportation. Bulls are use for ridging, weeding and transportation through attachment of cart, while donkeys are use for transportation only.

From costing of animal traction operation it is concluded that the rate at which the farmers are charging for operations, they will be running at loss. It will be cheaper to operate work animal in Yobe State than in Bauchi and Gombe because of differential capital cost.

The major constraints of the animal traction farmer in all the states is wearing of the shear point and the furrow wheels of their implements. This is closely followed by animal disease and high cost of work bulls and implements.

5.2 RECOMMENDATION:

The general view is that agricultural development agencies have proved more successful at introducing animal traction technology than improving it. Base on the finding of this study, the following recommendations are made:

(1) The government should formulate policies that will encourage educated youth to participate in this technology fully.

(2) Research Institutions should be funded to complete various design of animal traction implements in developmental stages.

(3) Farmers already in the system should be encouraged to enroll in adult education

(4) Most of the relevant literature on animal traction technology should be translated into local languages.

(5) Farmers should be educated on costing of animal traction operation, so that they can make the break even point when charging

(6) Extension officer should be employed to encourage the farmers to adopt implement which promote intensive farming rather than extensive farming e.g. weeder.

(7) Increase in use of the animals and equipment decrease the cost of ownership. Therefore, farmers should use the animals more than what is obtained presently.

(8) Government should become more involved, by giving loans or involve in animal traction hiring unit as in tractor case

(9) The problem of wear of Shear point and furrow wheel should be corrected, (Materials that resist wear more than the present one s by the local black smith should be introduced to the market by the implementation agencies).

(10) Irrigation farming, using animal traction should be encouraged

REFERENCES

Abimbola, T.O. 1991. A Computer – Aided Model for Optional Selection of Farm Power and Machinery Systems in Nigeria. Ph.D Thesis submitted to the Department of Agricultural Engineering, University of Nigeria, Nsukka.

Anazodo, U.G.N., Abimbola, T.O and Dairo, T.A. 1987. Agricultural Machinery Inventory, Type and Condition in Nigeria (1984 – 1985). A National Survey Report, F.D.A. Lagos.

Apollos, S.K., 2001. Farmers Knowledge and Use of Draught Animal Technology in Bauchi State. Proceedings of NIAE, Enugu, 2001. NIAE/2001/PM-4.

Bangura, A.B. 1986. The Utilization and Management of Draft Animals at Farm Level. Proceedings of the Second West African Animal Traction Net workshop. Held September 19-25, 1986, Freetown, Sierra Leone

Bansal, R.K., Klaij, M.C and Serafini, P.G. 1986. Animal Traction in Improved Farming Systems for the Semi-arid Tropics: The ICRSAT Experience in India and West Africa. Pp. 139 – 147. Proceedings of the Second West Africa Animal Traction Net work shop. Held September 19-25, 1986, Freetown, Sierra Leone

Carruthers, I and Rodriguez, M. 1992. Tools for Agriculture: A guide to Appropriate Equipment for Small Holder Farmers. CTA and GRET 4th (Ed.)

Crossley, P., Kilgour, J and Morris, J. 1983. Small Farm Mechanization for Developing Countries. John Wiley & Sons UK.

FAO, 1982. Report of the FAO Expert Consultation on the Appropriate Use of Animal Energy in Agriculture in Africa and Asia. Held 15-19 Nov. 1982, Rome, FAO, Rome Italy

FAO, 1994. Draught Animal Power Manual: A Training manual for Use by

Extension Agent. FAO, Rome.

Feng Yang-lian, 1982. The Use of Draught Cattle in China. Pp 21-27. In Animal Energy in Agriculture in Africa and Asia. Animal Production and Health Paper 42 FAO, Rome, Italy.

Gero, M.M. 1999. A World-wide View of Animal Traction. Highlighting some Key Issues in Some Parts of Africa. Proceedings of NIAE, Bauchi, 1999.

Gittinger, J.P. 1982. Economics Analysis of Agricultural Projects. The John Hipkins University Press, London.

Ige, M.T. 1996. Development of Blacksmithing for Sustainable Agricultural Machinery Manufacture in Nigeria. Proceedings of the National Workshop on Appropriate Agricultural Mechanization for Skill Development in Low-cost Agricultural Mechanization Practices. NCAM. Ilorin

Jama'are, A.U. 2000. Draught Animal Power Use in Agriculture. Paper Presented at the Train-The-Trainer Workshop on Animal Traction. Held at Animal Traction Training Centre, Tambu, Katsina State and Darazo, Bauchi State. FDA. Garki, Abuja.

Ladeinde, M.A. 1996. Animal Traction as an Alternative Source of Power for Agricultural Development. Proceedings of the National Workshop on Appropriate Agricultural Mechanization for Skill Development in Low-Cost Agricultural Mechanization Practices. NCAM. Ilorin.

Musa, H.L.1996. The Role of Appropriate Mechanical Technology in Agricultural Development in Nigeria. Proceedings of the National Workshop on Appropriate Agricultural Mechanization for Skill Development in Low cost Agricultural Mechanization Practice. NCAM. Ilorin

Ndiame, F. 1986. Animal Traction in Lower Casamance: Technical Aspect and Socio-Economic Implication. Pp. 253 –261. Proceedings of Second West African Animal Traction Networkshop. Held Sept. 19-25, 1986. Freetown, Sierra Leone

Odigboh, E.U. 1994. Continue Controversies on Tillage Mechanization in Nigeria. NAMA Newsletter 2. PP 25.

Onwualu, A.P. 1998, Strategies for Rehabilitation and Maintenance of Unserviceable Agricultural Tractors and implements in Nigeria. Proceedings of a National Training of Trainers Course for Agricultural Mechanics, Operators and Outboard Engine. NCAM, Ilorin

Philip, D.O.A., Abalu, G.O.I and Ingawa, S.A.. 1986. Economic Implications of Animal Power in Small Scale level in the Savannah Zone of Northern Nigeria: A Linear Programming Simulation of Farmer Circumstances. Pp. 225-232. Proceedings of Second West African Animal Traction Networkshop. Held Sept. 19-25, 1986. Freetown, Sierra Leone.

Reddy, S.K. 1986. Use of Animal in West African Farming Systems: Farm Level Problems and Implication for Research: Perspective from Mali. Pp. 182-189. Proceedings of Second West African Animal Traction Networkshop. Held Sept. 19-25, 1986. Freetown, Sierra Leone

Starkey. P. 1986. The Introduction, Intensification and Diversification of the use of Animal Power in West African Farming Systems: Implications at Farm Level. Proceedings of Second West African Animal Traction Networkshop. Sept. 19-25, 1986. Freetown, Sierra Leone.

Starkey, P. 1988. Animal – Drawn Wheeled Tool Carriers: Perfected yet Rejected. Vieweg and Sohn, Braunschweig', Germany. Pp.11-140.

Starkey P (ed), 1998. Integrating Mechanization in to Strategies for

sustainable Agriculture. Technical Centre for Agricultural and Rural Co-operation (CTA), Wageninmgen, The Netherlands. Pp. 5 – 24.

Suleiman, M. 2000. Animal Traction: A Viable Mechanization Alternative for small and Medium scale Farmers in Nigeria. Paper Presented at the Train-The-Trainer Workshop on Animal traction. Held at Animal Traction Training Centres, Tambu, Katsina State and Darazo, Bauchi State. FDA, Garki, Abuja.

Udo, D.U. 1999. Agricultural Mechanization Strategies and System for the Tropical Countries of Africa. Seminar Paper Presented to the Department of Agricultural Engineering. University of Nigeria Nsukka. In Partial fulfillment of award of M. Eng. Degree in Agricultural Engineering.

APPENDIX A

Table 5: **Background Information on Animal Traction Farmers**

STATE	AGE OF FARMERS (%)				EDUCATIONAL BACKGROUND OF THE FARMER (%)				EXPERIENCE WITH ANIMAL TRACTION (%)		
	< 20 yrs	20-40 yrs	41-60 yrs	> 60 yrs	Non Formal	Primary School	Secondary School	Above Secondary School	< 10 yrs	10-20 yrs	>20 yrs
BAUCHI	0	32	54	14	65	17	13	5	22	38	40
GOMBE	0	21.67	63.33	15	63741 33	16.67	15	5	31.67	38.33	30
YOBE	0	33.33	48.33	18.34	68.33	15	5	11.67	16.67	43.33	40

Table 6 **Utilization of Work animal in Bauchi Gombe and Yobe State.**

STATE	TYPES OF OPERATION PERFORMED BY WORK ANIMAL IN EACH STATE	TYPES OF IMPLIMENT USED AND % OF FARMER WHO OWN SUCH IMPLIMENT		TYPES OF WORK ANIMAL USED FOR THE OPERATION	% OF ANIMAL TRACTION FARMER WHO OWN DONKEY	% OF FARMER WHO USE ANIMAL TRACTION FOR IRRIGATION FARMING
BAUCHI	RIDGING	RIDGER	100	BULL ONLY	7	8
	WEEDING	WEEDER	34	BULL ONLY		
	TRANSPORTATION	CART	82	BULL & DONKEY		
GOMBE	RIDGING	RIDGER	100	BULL ONLY	5	0
	WEEDING	WEEDER	5	BULL ONLY		
	TRANSPORTATION	CART	58.33	BULL & DONKEY		
YOBE	RIDGING	RIDGER	100	BULL ONLY	5	0
	WEEDING	WEEDER	36.67	BULL ONLY		
	TRANSPORTATION	CART	75	BULL & DONKEY		

APPENDIX B

Table 7: **OWNERSHIP AND USE OF WORK ANIMALS**

STATE	AVERAGE HOURS OF WORK PER PAIR OF BULL IN A DAY (HRS)	OWNERSHIP OF WORK BULL (0/0)			USE OF WORK BULL 0/0		
		PRIVATE	CO-PERATIVE	GOVERNMENT	HIRE ONLY	PRIVATE FARM ONLY	BOTH
BAUCHI	4.37	98	2	0	0	21	79
GOMBE	4.36	95	5	0	0	21.67	78.33
YOBE	4.32	96.67	3.33	0	0	21.67	78.33

Table 9: **PROBLEMS ENCOUNTERED BY ANIMAL TRACTION FARMERS**

S/NO	PROBLEMS	% OF THE MOST COMPLAINED IN EACH STATE		
		BAUCHI	GOMBE	YOBE
1	Animal disease	18.63	9.99	17.20
2	High cost of work animal and implement that restrain replacement	13.65	13.04	9.27
3	Matching of the animal	0.00	4.31	0.00
4	Matching of implement to animal	0.53	0.00	1.67
5	Labour constraints	2.40	9.87	7.11
6	Inadequate animal health service	2.70	6.56	1.82
7	Lack of feed or grazing reserve	12.02	12.51	15.32
8	Training of the animal	4.28	5.49	5.65
9	Wear of shear point and furrow wheel	26.34	25.08	25.79
10	Problems of tyre in cart e.g. puncture	19.45	13.15	16.17
TOTAL		**100**	**100**	**100**

APPENDIX C

TABLE 10

INPUTS AND OUTPUT IN ANIMAL TRACTION COSTING

STATE	AVERAGE PRICE OF A WORKBULL (N)	AVERAGE PRICE OF HARNESSI-NG EQUIPME-NT (N)	AVERAGE PRICE OF FOOD CONSUM-ED BY A WORK-BULL PER DAY (N)	AVERAGE MONTHLY BILL ON HEALTH OF A WORK-BULL (N)	AVERAGE COST OF MAINTAIN-ING A RIDGER PER MONTH (N)	AVERAGE PRICE OF A RIDGER (N)	AVERAGE AVERAGE CHARGES FOR RIDGING A HECTARE OF LAND (N)	AVERAGE LABOUR CHARGES FOR ONE PERSON PER DAY (N)	AVERAGE SALVAGE VALUE OF WORKBULL (N)	USEFUL LIFE OF A WORK BULL (YRS.)
BAUCHI	30,400	375.60	27	224	180	6,000	1688	150	65,400	4.42
GOMBE	23,066.67	232	32	253.33	249.33	6,000	1980	160	54,666.67	5.33
YOBE	24,200	440	28	176.67	140	5,500	1300	150	56,666.67	4.53

TABLE 13: **ESTIMATED PLANTING PERIOD OF SOME CROPS IN BAUCHI STATE**

CROP	PLANTING DATES
Millet	May 1st - June 30
Sorghum	May 1st - July 15
Rice	May 1st - July 31
Cowpea	June 1st – August 31
Maize	June 1st – July 31
Cotton	May 1st - August 15

Information supplied by Bauchi State Agricultural Development Programme (BSADP).

APPENDIX D

TABLE 12

NUMBER OF FARMERS AND NUMBER OF WORK BULL IN EACH LGA SURVEYED

STATE	LGA	ESTIMATED NO. OF FARM HOUSE HOLD IN THE SURVEYED LOCAL GOVERNMENTS			AVERAGE NO. OF WORK BULL PER FARMER	RATE OF ADOPTION	NUMBER OF WORKBULL PER L.G.A.
	LGA	1997	2000	2002			
BAUCHI	DARAZO	25,102	15,606	15,952	2	0.8	25,523
	GIADE	10,882	11,245	11,494	2	0.8	18,390
	KATAGUM	23,821	24,616	25,548	3	0.8	60,386
	MISAU	24,188	24,995	25,548	3	0.8	61,315
	SHIRA	19,699	20,356	20,806	3	0.8	49,934
GOMBE	DUKKU	24,426	25,559	26,331	2	0.67	35,284
	GOMBE	12,453	13,030	13,423	2	0.67	17.987
	KWAMI	19,569	20,477	21,096	3	0.67	42,403
YOBE	DAMATURU	12,009	12,415	12,690	2	0.75	19,035
	FUNE	36,634	37,871	38,709	3	0.75	87,095
	POTISKUM	34,275	35,431	36,215	3	0.75	81,484

Calculated from Data given by BSADP, GSADP & YSADP 2002
House Hold growth per Annum = 1.1% for Bauchi and Yobe State.
Gombe State 1s 1.5% per annum
Rate of Adoption in Bauchi State = 80%
Rate of Adoption in Yobe State = 75%
Rate of Adoption in Gombe State = 67%