

# DRAUGHT OXEN POWER UTILIZATION FOR TILLAGE OPERATIONS IN SMALLHOLDER FARMING SYSTEMS IN YOLA - NIGERIA

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## ABSTRACT

*A study on the draught animal power utilization characteristics in tillage operation was undertaken to assess the broad overview of animal traction, the quality of the implements made available to farmers and the viability of the technology in a smallholder farming system in Yola region for three years (2011-2013). . An analysis of actual and potential use of the technology is carried out through surveyed questionnaire designed to collect different categories of information ranged from the type and number of draught animals, the type and number of implements, the acquisition mode, and the repair and maintenance problems. These data were analyzed using simple statistics. The results revealed that oxen used by the farmers were either locally withdrawn from the farmer's own herd or purchased in the village from other farmers either on loan, hired or gifts. Sixty one percent of farmers (61 %) owned only one pair of draught oxen, five percent (5 %) had two pairs of oxen while three percent of farmers (3 %) had 5 draught animals, only the male oxen were selected for their tillage operation. The study showed that the draught oxen are used for ridging only and transportation. Weeding is manually done. Out of the total number of fifty (50) implements available to 40 farmers, 72% are Mouldboard Ridgers, while 28% Ox-carts. 61.3 % of the ridgers were imported, while 38.7 % were locally manufactured by blacksmiths. The ox-cart is 100% locally manufactured by blacksmiths. The farm size ploughed in the area of study varies between 1-7 hectares and the number of farm workers present at the farm level varies between 2-8 workers. The study provides a simplified process necessary for farmers and researchers to monitor draught oxen and implement availability for field operations and management.*

**Keywords:** Draught, Oxen power, utilization, smallholder, tillage operation, Savannah Climate

## 1 INTRODUCTION

**P**espite the great progress of mechanization in agriculture, the challenges facing the agricultural policy makers in the developing countries is increase in agricultural production more than the subsistence production through increase in yield and labour saving. Nowadays in any agricultural crop production system, improvements in farm power availability and partly through development and improvement of soil specific and farmer-friendly technologies for predominantly global agro-eco-regions, humans, draught animals and engines provide the motive power in various proportions for crop production, harvesting, transport and processing [1; 2]. Many studies have shown that human labour and draught animals will still continue to supply nearly all the power for agricultural production for the farmers at the small holder level in Sub-Saharan African with human and animal power accounting 75-85% of the harvested area [2; 3; 4]. In terms of total cultivated land,

it was estimated that human muscle power contributes 80% while animal draught power and mechanical power contribute 15% and 5% respectively in the Sub-Saharan Africa, compared to Asia where over 60% of land cultivated is done using tractor. More than half of the world's population depends on animal power and in some areas it provides up to 90% of power required for crop production [5]. Approximately 10 % of African farmers use draught animal, but this can vary from 1 – 8 % between regions [6]. This is particularly true in semi-arid areas where timeliness in cropping operations is fundamental for successful cropping because of the short growing season. In these situations, draught animal power becomes critical to supplement human energy so that field operations can be done at the right time to reduce the risk of crop failure and to secure a stable yield [7].

Farmers have a relatively wide variety of animal species to choose from for energy supply ranging from mule to horse. Cattle, horses, mules and donkeys are the most commonly used draught animals but camels, dogs, and elephants have been used for traction in some parts of the world. They are used extensively for tillage, sowing, inter-row weeding and transportation [8; 9; 10]. The most commonly used draught animal in Latin America, Africa and Asia is the cattle, but oxen are more preferred because of its availability in numbers and accessibility to farmers, their adaptability to the environment, temperament and muscle ability [8]. In West Africa oxen mostly castrated bulls remain the dominant draught animals for traction. In some areas in Nigeria especially Northern Nigeria, uncastrated males (bulls) are used for traction work [11; 12]. Horses have a very limited geographical range in Africa because they are often expensive, as a result of their high prestige value, unsuitability for transport and their relatively low reproductive efficiency and survival rate [13]. Donkeys are well-suited for pack transport and for pulling carts in relatively flat areas, but they do not have great tractive power, so their use for pulling ploughs is very limited. Camels are used mainly as pack animals in the countries bordering the Sahara desert. Small numbers are used for land cultivation in semi-arid areas in Mali, Burkina Faso, Niger and Nigeria [14]. These general constraints explain most of the variability in the geographical distribution of draught animals in developing countries. [9] reported that only three operations were performed by draught animals in Adamawa State and these are ridging, weeding and transportation. [15] stated that the technology of animal traction is unstable for animal traction users who generally possessed one pair of oxen. The optimal number of oxen at the farm level is three (3) to secure a fast agricultural production.

The animal drawn mouldboard plough is widely used for primary tillage in the developing countries of Africa [16]. Farmers in arid areas used cultivation tines for tillage. In certain areas, notably Nigeria, the ridger is often the only animal traction implement being used for primary cultivation, weeding and earthen up [13; 17]. [9] reported that apart from the ridgers, no other animal-drawn implement is used for crop production in Adamawa State of Nigeria. Animal-drawn harrows are mainly used to crush clods and to level a seed bed after ploughing. They are widely used in India, but are rarely seen in Africa. Also, Animal-drawn seeders have seldom had the same degree of success as plough and cultivators in West Africa with the exception of Senegal and Mali. This is because seeding can often be quickly and effectively done by hand while mechanical sowing devices are expensive and often require ideal working conditions. Animal-drawn harvesters are not common, but groundnut lifters have had some success. They are generally simple and relatively easy to use [13]. However, their effectiveness is largely determined by soil conditions and the extent to which plants impede progress.

Yola area of Adamawa State, located in the north eastern part of Nigeria, is dominated by peasant farmers predominantly small scale farmers and employs hand-tool technology to cultivate their lands for crop production. The farmers are faced with lack of capital, small farm holdings that make usage of tractor power uneconomical [18]. The State is predominant with vast number of animals. This study was undertaken to assess the broad overview of animal traction in the study area (Yola region), the quality of the implements made available to farmers and the viability of the technology. An analysis of actual and potential use of the technology is carried out.

## **2 MATERIALS AND METHODS**

### **2.1 Research Sites**

The main field studies was conducted in real farmer environments within Yola ( $9^{\circ} 14'N$  and  $12^{\circ} 32'E$ ) of Adamawa State - Nigeria in 2011-2013. The area is at an elevation of 200m above sea level and falls within the Eastern Sudan Savanna ecological zone of Nigeria. The area is an agrarian tropical environment marked by dry season (November-April) and wet season (May-October) with mean annual rainfall usually ranges from 700mm to 1,050mm [19; 20]. The soils type in the area is predominantly of sandy loam textures [21; 22].

### **2.2 Data Collection**

The study covered two agric-ecological zones of Yola region where animal traction technology is dominant. In each of the agro-zone 20 farmers who use animal power for tillage operations were selected at random for interview. A methodology of data collection on animal traction was proposed through surveys questionnaire designed to collect different categories of information: The data collected ranged from the type and number of implements, the acquisition mode, the system management, the repair and maintenance problems, the type and number of draught animals. These data were analyzed using simple statistics to better understand the agricultural cropping system alternatives available to farmers in relation to the opportunities offered by the type of agro-ecosystem zones.

## **3 RESULT AND DISCUSSION**

### **3.1 Draught Animal Management**

The study showed that oxen were the only animal commonly used for draught power for tillage operations in the study area. All the oxen belong to the *Bos indicus* breed commonly called Zebu. In the selection process, only the male oxen were selected because social and cultural standards of living prohibit the use of female animals for any physical activity. A total of 83 oxen were counted in the study for the 40 households. They represent more than 80% of the draught animals used in crop production. Oxen used by the farmers were either locally withdrawn from the farmer's own herd or purchased in the village from other farmers or obtained through loan, hired or gifts. A close look at the data from Figure 1 shows that 16% of the farmers owned only one draught animal each. They needed to borrow another animal to constitute a pair in order to carry out their field activities, while 61 % of the farmers owned only one pair of oxen (two oxen) for farm operation. This represents also a risky situation as reported by [12]. The study also revealed that 16 % of the farmers interviewed owned three oxen, 5 % of the farmers owned four oxen (4 draught animals), while 3 % of the farmers had five draught animals to make up two pairs and one ready for replacement. Previous study conducted in the area have shown that in most cases, farmers still rely heavily on traditional hand

tools to complete the unfinished work of the draught animals such as weeding, harvesting and transportation [22]

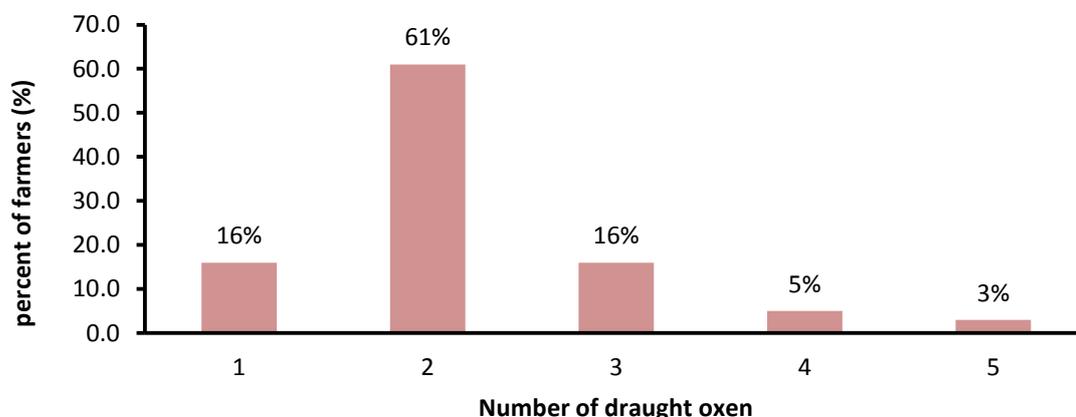


Figure 1: Draught animal distribution

The study also revealed that training of draught animals for teamwork as well as training of farmers to better use and adjust farm implements was found to be a serious concern to farmers. There was no formal training sessions mentioned by the farmers. The farmers are left to themselves to learn and train animals at a much younger age. Most of the draught animals in the study area were trained between the ages of 2 to 3 years. On some rare occasions, older animals of 5 to 6 years were trained. A minimum of 3 years’ experience is generally accepted in the area as needed for a pair of oxen to respond correctly to commands. The average working experience of each draught animal was found to be 4 years. The longest working career was 9 years.

Farmers are faced with challenges concerning draught animal power usage. It was revealed that it took 4 to 5 years of experience for farmers to master the technology. The mastering is necessary before steady yield improvements become apparent. This include implement hitching and adjustments, adjustment of line of draught, keeping ploughshare sharp and moldboard in good scouring conditions, ox-team driving, resources allocation and choice of appropriate cropping techniques.

### 3.2 Land Availability

The study showed that majority of the farmers that is (65%) operated 2 – 3 ha of land, while 27.5% owned between 4 – 5 ha, with about 2.5% of the farmers above 6 ha of land (Figure 2).

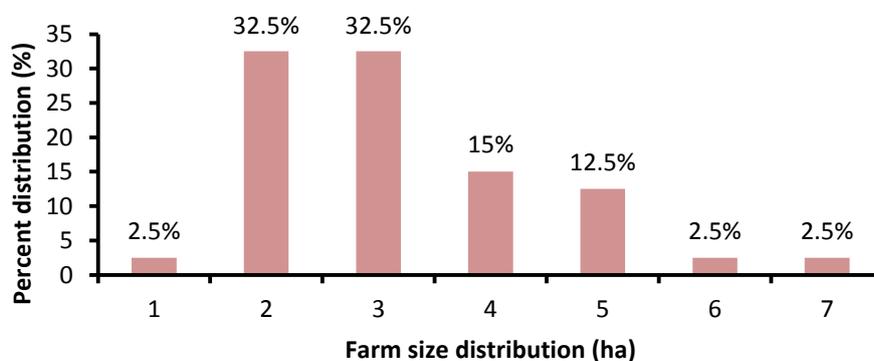


Figure 2. Farm size distribution

### 3.3 Farm labour

Figure 3 shows the number of farm workers present at the farm level.

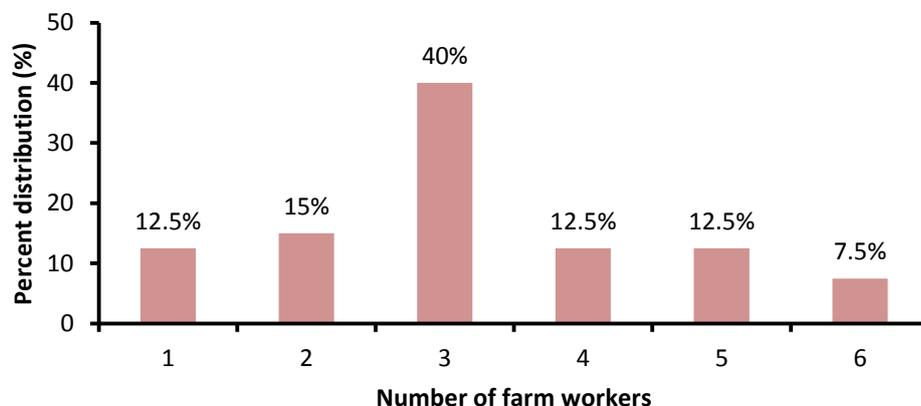


Figure 3. Farm labour distribution

The availability of the farm workers throughout the growing season is crucial to meet the production objectives. The results showed that lack of enough farm labour in a household affect the increased in production of crop. There is therefore need for more mechanization process to meet with the demand. The temporary absence of active family members was pointed out to be a constraint at weeding time.

### 3.4 Farm equipment survey

A total number of fifty (50) implements belonging to 40 farmers located in the study area were surveyed. The study showed that 72% of the farmers interviewed owned Mouldboard ridgers used for tillage operation and 28% owned Ox-cart equipment for transportation (Figure 4). The study showed that apart from mouldboard ridger no other animal drawn implements are in used in agricultural operations except as prototypes in some institutions of high learning. This was considered as the priority by the farmers for the high emphasis given to land preparation to improve the field operation timeliness, the extension of cropped areas, and the reduction of drudgery. This agrees with the studies of [9; 12; 13] which reported that ridger is the commonly used animal drawn implement in Nigeria for tillage operations. There is no post tillage activities carried out by the farmers using animal. This could be due to lack of awareness by most of the farmers and the non-availability of some such as animal drawn planters, weeders, fertilizer distributors and harvesters. The percentage (28%) of farmers that owned ox-drawn carts for transportation is above the figure of 2.3% that was reported by [12] for farmers in Borno State Nigeria.

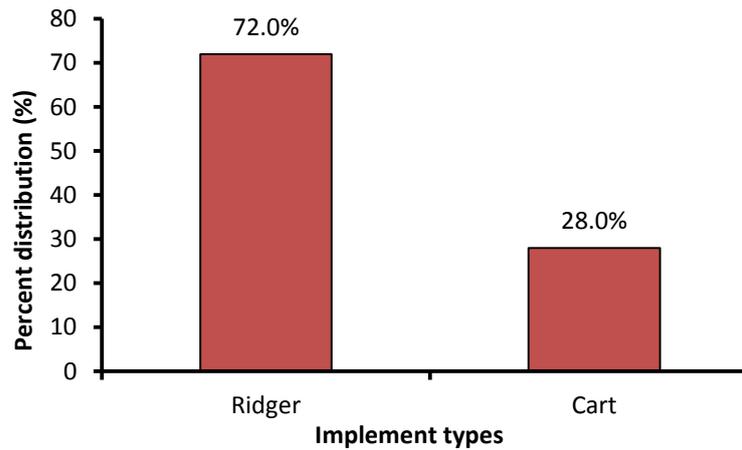


Figure 4. Types of implement used by farmers

This result agreed with study of [7] which said that, the geographical distribution of the types and number of implements that exists at the farm level is also related to the agricultural practices used in relation to the resources available to the farmers (land, number of farm workers).

### 3.5 Repair and maintenance

The quality of repair and maintenance represents a key factor in the adoption of draught animal power technology by farmers. The survey has revealed that the level of expertise of the local blacksmith was directly related to the farm implement working conditions and reliability. Most of the blacksmiths were not equipped enough to solve all the maintenance and breakdown problems encountered by farmers on their pieces of equipment

### 3.6 Implement repair and maintenance reliability

The reliability of each farm implement or equipment (IMPLREL) in percent was evaluated and shown in Table 1. Two types of reliability coefficients are calculated; one on the yearly basis and the other on the implement lifetime basis. On the implement life time basis, two reliability coefficients are calculated, one on the manufacturer’s given life expectancy (IMPLREL<sub>man</sub>) in percent and the second on the real farm life time (IMPLREL<sub>farm</sub>) in percent.

$$IMPLREL_{year} = 1 - \left( \frac{Days_{breakdown}}{NWDAYS} \right) \tag{1}$$

$$IMPLREL_{life} = 1 - \left( \frac{Years_{breakdown}}{IMPLIFE} \right) \tag{2}$$

Where:

IMPLREL<sub>YEAR</sub> = Implement reliability per year

DAYS<sub>BREAKDOWN</sub> = Number of days of breakdown in the year

NWDAYS = Number of working days in the year

IMPLREL<sub>life</sub> = Implement reliability life expectancy

YEARS<sub>breakdown</sub> = Implement years of breakdown

IMPLIFE = Implement farm life time in years

The real implement reliability per year (IMPLREL) in percent is expressed by the combined reliability of the two:

$$IMPLREL = (IMPLREL_{year}) * (IMPLREL_{life}) \quad (3)$$

Among the most used farm equipment, the ox-cart appears to have the lowest overall reliability (IMPLREL) of 46.66 %. The observed breakdowns are frequent and complex (pole welding, pneumatic problems) and required more time to repair in comparison with the ridger (74.79 %). According to the level of utilization, breakdowns on newly purchased farm equipment happens more often after 2 years of use for cropping implements and after 3 to 5 years for ox-cart, evaluated from their first date of service. On the average, the lifetime of ridger is 10.1 years in farmers' condition and the manufacturer given lifetime was not available, however on the average 5 years was considered.

The primary failure of ox-cart is the breakage of the tongue which generally occurs at least once in its lifetime. Tongue breakage in combination with the tire problem account for 22.2% to 38.5 % of the breakdowns. The lifetime in farmers' condition is close to 10.07 years in total and manufacturer implement life span is 10 years.

Table 1. Implement repair and maintenance reliability

Implement types	Potential NWDays	Manufacturer implement life	On-farm life	Potential on-farm life	Number of days of breakdown					Reliability	
					Days/yr	% Days/yr	Yrs/life	% manufacturer	% on-farm	Manufacturer	Farm
Ridger	45	5.00		8.00		6.51		32.00	20.00	63.57	74.79
Average			10.10		2.93		1.60				
Minimum			5.00		0.00		1.00				
Maximum			19.00		5.00		2.00				
Ox-cart	365.00	10.00		10.00		21.18		40.80	40.80	46.66	46.66
Average			10.07		77.29		4.08				
Minimum			1.00		1.00		1.00				
Maximum			21.00		130.00		8.00				

NWDays=Number of working days in the year

### 3.7 Farm Equipment Reliability

The reliability of farm equipment is closely linked to the existing maintenance network and to the quality of technical services provided to farmers. Figure 5 shows that farmers rely on three categories of service providers: local blacksmiths, advanced implement dealers located in the big towns and farm equipment local dealers. Currently, the local blacksmiths represent the central piece of the network of the farm equipment servicing by carrying out about 84 % of the repair and maintenance.

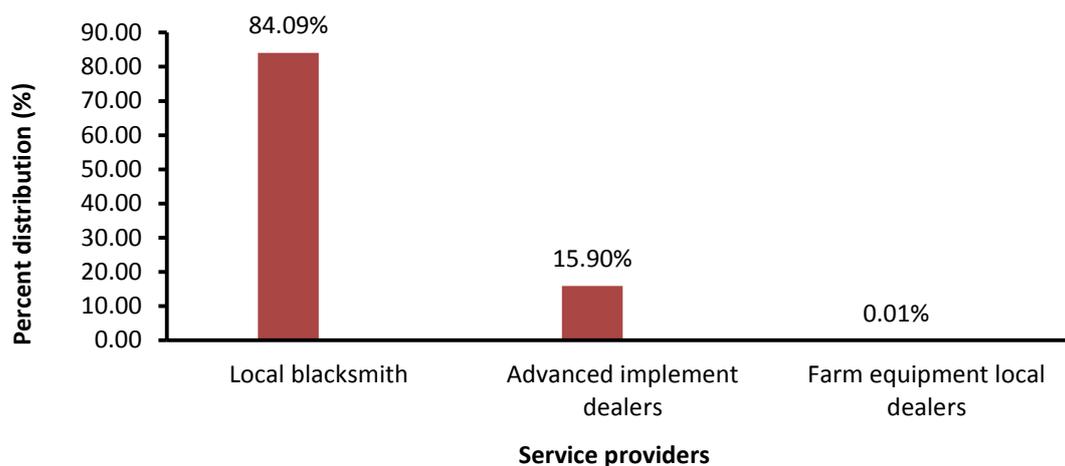


Figure 5. Implement service providers

#### 4 CONCLUSIONS

The broad overview of animal traction in the study area shows that many factors were involved in the implementation of the technology. The quality of the implements made available to farmers is of major importance in relation to its life expectancy. The quality of maintenance and servicing is important to the viability of the technology. An analysis of actual and potential use of the technology carried out showed that ox is the only draught animal used in agricultural operations. The majority of the farmers (70%) relied on only one pair of oxen. Only the ridging implements were available. The farm implements experienced several breakdowns. This was associated with the quality of the materials used to make the working components, the conditions of use and absence of technical support. In these conditions the reliability, evaluated for each piece of farm equipment was generally found to be low. The skill and expertise of local blacksmiths must be improved through training and better tool supply.

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