American Journal of Applied Sciences

Original Research Paper

Agricultural Mechanization in Niger: What Role do Animals Play?

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Article history
Received: 25-10-2021
Revised: 21-12-2021
Accepted: 06-01-2022

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Abstract: The intensification of agriculture through the use of animal energy has been used since colonial times. This study aims to analyze the level of mechanization in Niger while relying on the role played by animals used for farming in the regions of Maradi and Zinder (Niger Republic). Data collection was carried out between June and August 2020, using a questionnaire addressed to agriculture and related regional technical services and farmers. The questionnaire helped to collect information on the evolution of mechanization, the different coupling tools, the areas worked with animal traction, the proportions of farmers using animal energy, and the species of animals used for farming. The analysis of data collected showed that the farm park equipment has been strengthened by the purchase of agricultural equipment, especially for harness cultivation and intermediate motorization. The cart, the hoe, the plow, and the seeder are the most harnessed tools to the draft animal. The percentage of use of these tools by producers is 87.5, 42.5, 41.67, and 11.67% respectively. The area that worked using animal energy is about 16 times higher than that worked with human energy. It appears that about 90% of farmers use animal energy in carrying out their cropping calendar. Cattle are the most used (98.15%) for animal energy users followed by donkeys (1.85%) and camels (0.93%). Young animals (2-3 years old) are the most used (56.04%) in farming and traction with a pair of oxen is the most developed and represents 55.02% of the coupling. The maintenance of the coupling tools and their repairs are generally carried out locally by the users and other service providers. This confirms that the draft animal largely contributes to the development of agricultural mechanization in Niger.

Keywords: Draft Animal, Farming, Agricultural Mechanization, Cultivated Area, Niger

Introduction

Niger's economy is essentially based on agriculture and animal husbandry, which employ more than 90% of the population (Warouma *et al*., 2013). Population growth, increasing urbanization, and stronger economic aspirations make the need to increase agricultural production essential to ensure food security and self-sufficiency (Starkey, 1999). The weight of the agricultural sector in the economies of both North and South has been steadily decreasing for two centuries, both in terms of domestic product and the share of the employed population. Yet production has increased, due to the joint increase in cultivated areas and yields. This has been possible due to technical innovations, including mechanization (Sarr *et al.*, 2021). Access to appropriate energy sources makes it easier to carry out energy-intensive operations (such as tillage), improves the performance of technically demanding operations (such as sowing and weeding), allows for increased areas cultivated, and value human labor freed for less arduous or more productive tasks (Stephane, 2013). The mechanization of sowing and weeding is a very attractive option for producers in sub-Saharan Africa because it allows more regular and precise placement of seeds, increases yields, and reduces labor requirements (Aune *et al.*, 2019). It can also allow the producer to carry out tillage operations more quickly, and increase the cultivated areas but also respect the intervention dates (Tapsoba *et al*., 2013). The effects of agricultural mechanization are more visible in the

expansion of areas, the reduction of costs, and the increase in labor productivity. However, the effects on yields are not negligible. The delay in cropping operations causes yield losses that can be avoided by mechanization. These results show that there is a yield gain, even small, with the use of mechanization (Sarr *et al*., 2021). According to Lhoste *et al.* (2010), animal traction has often been presented as a driving force behind Agriculture-Livestock integration. It should contribute to the "modernization" of agriculture by increasing areas and yields and reducing the arduousness of the work (Roesch, 2004). Across the globe, animal traction is still widely used, it is estimated that nearly 33% of the world's farmers are animal traction users. However, there are large disparities in distribution between the different regions of the world (Beurrier, 2021). In West Africa, the labor force is overwhelmingly dependent on physical strength with the use of hand tools such as a hoe to carry out various farming operations. These tools have implicit limits in terms of energy and potential efficiency. These methods considerably limit the area that can be farmed per family. They delay agricultural operations and limit the efficiency of essential activities such as cultivation and weeding and consequently, cause lower yields (Yuan Zhou, 2016). If the introduction and distribution of animal traction in the French-speaking countries of West Africa date from the beginning of the twentieth century, it particularly took off in the 1970 s marked by a very significant drought. These extremely difficult conditions demonstrated the urgent need to improve agricultural production systems. In Niger, the first introduction of agricultural machinery on a large scale dates back to the 1960 s. The second, late development axis corresponds to the development and cultivation of the lowlands in the southern region and along the Niger River (Le thiec, 1996). Since independence, Nigerien agricultural policy has been oriented towards subsidies. But, despite this subsidy granted by the State, the cost of agricultural equipment remains relatively high for a peasant who is not always guaranteed to produce the minimum necessary for his family's subsistence (Sargent *et al.*, 1981). Animal-drawn mechanization is the logical transition between manual and motorized cultivation (Bichat, 1981). In this context, animal traction seems to be a technique of the future adapted to family farming in Africa. Its multifunctionality places it at the heart of producers' strategies (Havard *et al*., 2007). The general objective assigned to this study is to locate the level of agricultural mechanization in Niger while relying heavily on the role played by animals on farms in the regions of Maradi and Zinder.

Materials

The material used in the work is summarized as follows:

- Draft animals from agricultural holdings
- Coupling equipment for farms
- A GPS for the determination of the geographical coordinates and the surface areas of the fields
- A digital device for taking images

Methods

Information relating to agricultural mechanization in Niger was collected from the related technical services. For the field study, the regions known for their agricultural activities, namely those of Maradi and Zinder, were selected.

Choice of Villages

Three villages per region were chosen based on their accessibility, the development of animal traction as well as their diversity. These are the villages of Dan Takobo, Dan Gado, Douma 1 in the region of Maradi and Adare, Bourdodo Haoussa, Jeka da Manda for the region of Zinder. Based on the list of farm households, random sampling was done for each village.

Choice of Sample

Twenty farmers were sampled in each village. During the sampling, the geographical location of the fields was considered. After an exhaustive census of agricultural households, an area frame was drawn up by dividing the agricultural households of each target village into four groups according to the geographical position (s) (East-West-South-North) of the field or the greater number of their fields compared to the village. This approach was adopted to identify the agricultural practices linked to the type of soil. From each group, systematic random sampling was applied to determine five agricultural households from twenty agricultural households desired per village.

Data Collection

Information is collected using a questionnaire drawn up taking into account themes relating to agricultural mechanization in general and animals in particular. This information concerned the evolution of mechanization, coupling tools, breakdowns and maintenance of these tools, spare parts, areas worked by animal traction, the proportions of farmers using animal energy, and species of animals used on farms. This survey was conducted from June 15 to August 24, 2019. At the household level, the questionnaire was administered to the farm manager or a member of the household (individual survey) at least eighteen years old.

Data Processing and Analysis

The survey sheets were first analyzed and then the data was processed with EXCEL and SPSS 16.0. The statistical analysis by the descriptive method made it possible to appreciate the central tendencies and the dispersion of the data through the means and the standard deviations for the main quantitative variables. For the qualitative variables, the calculation of frequencies was prioritized.

Results

Evolution of Agricultural Mechanization in Niger

Due to the creation of agricultural credits and the subsidy that has been in place since independence to date, the distribution of agricultural equipment has undergone relatively significant development. The import and subsidy of agricultural equipment initially concerned animal-drawn tools. To facilitate this subsidy and stimulate local production, several agricultural equipment manufacturing workshops were set up from 1970 to 1976 across the country. Private metal carpentry workshops have also contributed to improving the fleet of agricultural equipment.

The massive diffusion of animal traction was also possible by the establishment of financial institutions dedicated to agriculture, which no longer exist today. Among these institutions are the National Credit and Cooperation Union (UNCC) and the Rural Credit and Cooperation Company (SRCC).

In the last two decades, there has been a significant increase in terms of purchases and sales at a fair price of agricultural equipment due to the various Economic and Social Development Programs and Plans (PDEs) of 2012-2015 and 2017-2021. This equipment mainly concerned those of harnessed cultivation and intermediate motorization. The existing workshops for the manufacture of agricultural equipment were also rehabilitated.

As an example, between 2000 and 2006, 257 motor cultivators, 656 medium power tractors, 939 motor pumps, 4700 animal-drawn hoes, 280 mills, and 160 hullers were imported by the Central Supply Authority (CA) (Sido, 2010).

Despite this subsidy, motorization remains very low and several villages have so far not adopted horse-drawn cultivation for insufficient and/or lack of awareness and sometimes lack of means.

Composition of the Fleet and Type of Coupling

The materials used are the cart, the plow, the hoe, and the seed drill. They are used according to the importance given by the operators and according to the local cropping system. Thus, the cart used by 87.5% of farmers is the most used hitching equipment on the farms surveyed; followed by the harness hoe (42.5%); while the plow and the seed drill are used by 41.67 and 11.67% of farmers respectively.

All these materials are differently distributed according to the zone (Fig. 1). In addition, in terms of preference, the cart represents 48.50% of agricultural equipment in households and remains the most widely used tool on all farms. Regarding the plow, it represents 21.80% of the agricultural equipment present in households and is most used by farmers in the targeted villages of the region of Zinder (82%) than those of the region of Maradi (18%). The hoe, contributing at 23.10% to the agricultural parking of respondents, it's more used in the households surveyed in the region of Maradi (82.35%) than in those in the region of Zinder (17.65%) while its use in Adare village is similar to that of Douma 1 village. In Dan Takobo village, the harnessed hoe is determining equipment for agricultural production. It is mainly used by farmers and occupies all of the households surveyed (100%).

Regarding the seed drill, despite its limited use (only 6.60% of the park), it is mainly used in the region of Maradi.

Traction with a pair of oxen is the most developed and represents 55.02% of the coupling. It is mainly used for plowing (92%), weeding (64%), and sowing (60%). The monomial coupling is highly developed in local transport (67%) with the use of mono-bovine carts. The single-cow cart is the most widely used hitching tool (Fig. 2).

Breakdowns and Maintenance of Coupling Equipment

Breakdowns are much more observed in working parts in direct contact with the ground and transmission systems due to wear (Table 1). It is more common in tires, colters, bearings, and gears (seed drill). In addition, it is also necessary to note other failures no less important which affect the carts (the frames, the pipe, and the planks), the plows, and the hoes (wear of casters, torsion of the prop, etc.,).

The maintenance of the coupling tools and their repairs are done by the farmers themselves (25%), the blacksmiths (20%), the welders (13%), the vulcanizers, and other repairers of bicycles, motorcycles, and mill grains (42%) (Fig. 3).

Availability of Spare Parts

Among the respondents using their coupling equipment, 52.35% manage to locally resolve certain simple breakdowns (puncture, change of nut, etc.,); while for complicated breakdowns (change of gears, welds, change of bearings, etc.,), farmers (12.80%) refer to the nearest town centers and/or weekly local markets. In addition, it should be noted that a fringe of farmers (34.85%) get their supplies in two ways (locally and in town centers) depending on the availability of the required materials. It can be seen that spare parts are more available in the villages of Maradi compared to those of the region of Zinder which gets its supplies most often from external markets (Table 2).

Species, Breeds, and Categories of Draft Animals

The species of animals used for traction are mainly cattle, asses, and camels. Cattle are employed by 98.15% of animal traction users; followed by donkeys (1.85%) and camels (0.93%) used in conjunction with cattle. The choice of species is based on multiple reasons. These differ from one species to another. Indeed, the preferences of the bovine species over other species are largely due to habit (50.55% of farmers) and the cropping system used. Draft cattle constitute savings capital (16.48%), animals

that are easy to secure against theft (14.29%), and breed (9.89%). They are also considered multifunctional by 3.30% of farmers (Fig. 4).

The study shows that several breeds of animals are used for harnessing. The choice of the breed depends in part on the availability of the latter in the area and the expectations of the farmers. The Azawak (Commonly called Dalledji) and Azawak-Bororo (Bakatike or Batchoussaye or Bohaye or Batchintchine depending on the localities) breeds are respectively the cattle breeds most used in animal traction for field work; followed by the Bororo and Goudali races.

All of these cattle breeds differ from one area to another (Fig. 5). Thus, the Azawak breed is much more represented (80% of traction cattle from the farms observed) in the three villages of the region of Maradi even if there are only three heads in the farms of Adare and Bourdodo Haoussa villages, that is 6.38% of the draft cattle from the farms surveyed in the region of Zinder.

In the region of Zinder, the Azawak-Bororo mestizos are the most used (59.57%) followed by Bororo races (31.91%) exclusively reserved for the farms of Adare and Bourdodo Haoussa villages.

The Goudali breed, originating from Nigeria, is the least exploited (2.17% of the draft animals of the farms studied) in the technical agricultural routes of the study area. It is found in Douma I and Bourdodo Haoussa villages and represents respectively 9.09 and 6.67% of village draft animals.

Three categories of animals are used for animal traction on the farms. Young animals (2-3 years) are the most used (56.04%). Some farmers (32.97%) prefer medium animals (4-6 years old) able to withstand heavy teams; They have an average career span compared to that of young people who last a long time (except in cases of major force) on farms before reaching the reform period. However, adult animals are the least used (10.99%) to purchase even though they are important sources of energy. Their use in agricultural work remains risky because of their sizes and their well-developed horns, they are most often difficult to master, especially in an environment that seems foreign to them.

The young animals represent the bulk of the draft animals of the respondents of Dan Takobo, Jeka da Manda and Bourdodo Haoussa villages. However, middle-aged animals are listed in the farms of Douma 1 and Dan Gado villages, while the adult animals, less used, are found in the farms of Adare and Dan Gado villages (Table 3).

Involvement of Animals in the Farms

In the six villages, 90% of the farms use animal traction in the execution of their cropping schedule. We notice the wide distribution of animal traction in the farms of Dan Takobo and Adare villages, while in Dan Gado, Douma 1, Bourdodo Haoussa, and Jeka da Manda villages, animal traction is not generalized.

Harvested Areas

The agricultural areas used vary from one farm to another. Thus, the average farmed area using animal energy is much greater than those that do not use this energy (Table 4). The total farmed area with animal traction is estimated at 694.25 ha, while the one in manual work is only 43.75 ha.

Transport

The cart is one of the most used tools (48.47%) of farming equipment in the agricultural work of the farms surveyed. It facilitates the transport of manure to the field, thus making it possible to fertilize the soil. Besides, it contributes to the transport of agricultural equipment and harvested products and is used in the transportation of labor.

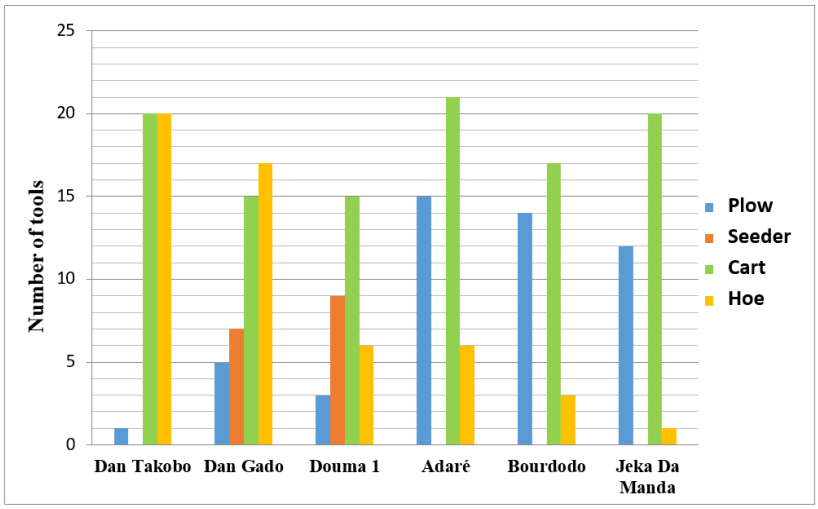

Fig. 1: Distribution of agricultural equipment per village

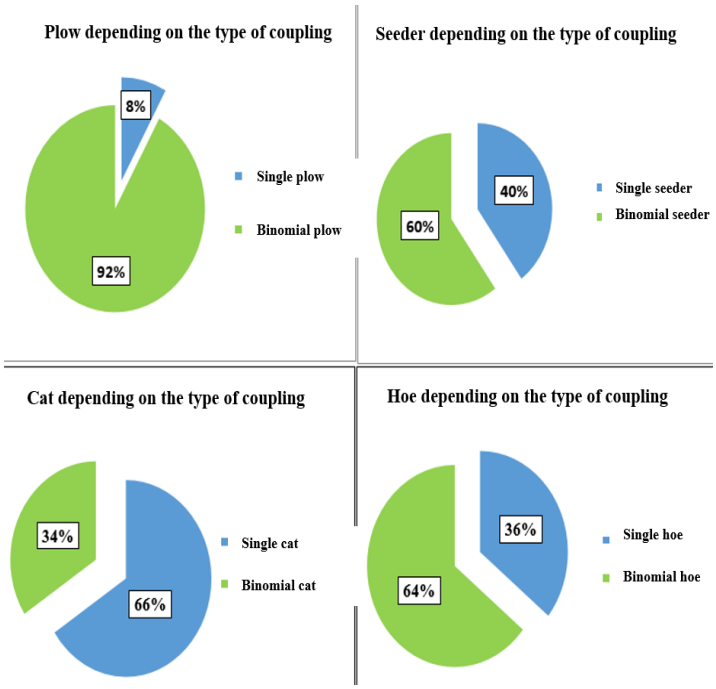

Fig. 2: Type of coupling according to the material

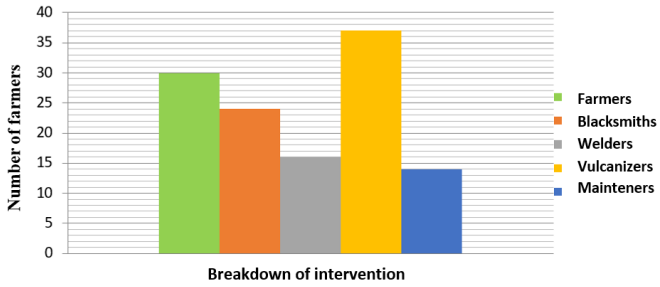

Fig. 3: Types of agricultural equipment maintainers

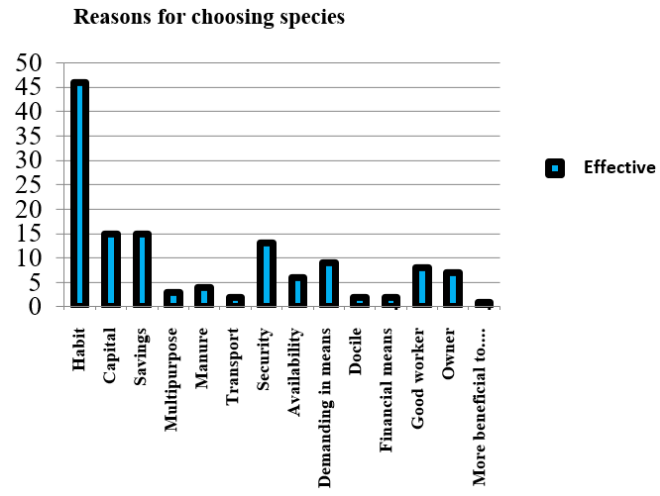

Fig. 4: Reasons for the choice of bovine species

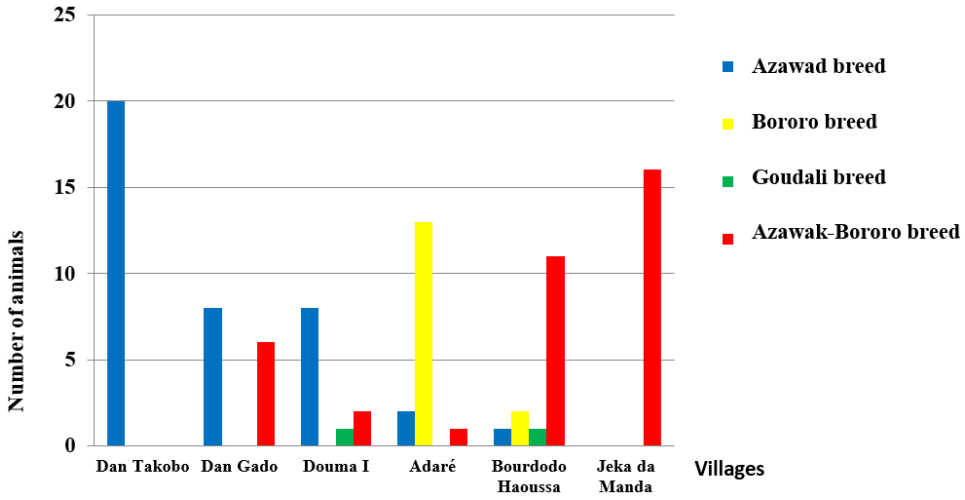

Fig. 5: Distribution of the use of traction cattle breeds per village

Table 1: Types of frequent breakdowns according to the coupling equipment

Coupled equipment	Types of breakdown	Number of equipment	Frequency (%)
Cat	Tires puncture	67	44.37
	Tires wear	38	25.17
	Screwing up nuts	1	0.66
	Rim cracking	1	0.66
	Chassis break	9	5.96
	Broken pipes	10	6.62
	Bearing wear	15	9.93
	Plank break	10	6.62
Plow	Interruption of the traction chain	1	2.63
	Ploughshare wear	20	52.63
	Breaking of the ploughshare	13	34.21
	Caster wear	3	7.89
	Twisting of the prop	1	2.63
Seeder	Wear of the pinion	10	41.67
	Wear of the drive shaft;	10	41.67
	Lack of pin	4	16.67
Hoe	Interruption of the traction chain	1	1.00
	Ploughshare wear	42	42.00
	Breaking of the ploughshare	36	36.00
	Caster wear	11	11.00
	Twisting of the prop	4	4.00
	Screwing up nuts	6	6.00

Table 2: Availability of spare parts according to the villages surveyed

		Parts availability	
Regions	Villages	Local availability	Availability in cities
Zinder	Adare	11	12
	Bourdodo Haoussa	9	7
	Jeka da Manda	10	7
Maradi	Dan Gado	15	9
	Dan Takobo	20	2
	Douma	10	4

Table 3: Category of draft animals purchased per village

			Name of villages						
			Adare	Bourdodo haoussa	Dan gado	Dan takobo	Douma 1	Jeka da manda	Total
Category of traction animals for purchase	youth	Effective	6.0	9.0	5.0	16.0	1.0	14.0	51
		% in Category	11.8	17.6	9.8	31.4	2.0	27.5	100.0
	medium	Effectif	5.0	3.0	6.0	4.0	10.0	2.0	30
		% in Category	16.7	10.0	20.0	13.3	33.3	6.7	100.0
	adult	Effective	4.0	2.0	4.0	0.0	0.0	0.0	10
		% in Category	40.0	20.0	40.0	0.0	0.0	0.0	100.0
Total		Effective	15.0	14.0	15.0	20.0	11.0	16.0	91%
		% in Category	16.5	15.4	16.5	22.0	12.1	17.6	100.0

Table 4: Farming area according to animal energy use

			Field area (ha)			
Regions	Type of farmers	Effective	Mean	Standard deviation	Maximum	Minimum
Maradi	Farmer with animal traction	50	4.35	±4.62	30	0.5
	Farmer without animal traction	10	3.07	±1.38	6	1.0
Zinder	Farmer with animal traction	58	8.27	±4.34	22	1.0
	Farmer without animal traction	2	6.5	±4.95	10	3.0

Discussion

In Niger, due to the subsidy of agricultural equipment which has been carried out since independence to date, to the creation of agricultural credit institutions and public manufacturing workshops for the farming equipment as well as to the proliferation of private manufacturing workshops, the distribution of agricultural equipment has experienced a relatively important development. Despite this subsidy, motorization remains very low. This corroborates the work of Stephane (2013) who reported that less than 5% and most often less than 1% of farms in Sub-Saharan Africa have their tractors.

The animal-drawn plow and seed drill are used by 41.67 and 11.67% of farmers, respectively. These results are different from those of Stephane (2013) where the possession rate of animal-drawn plows in Sub-Saharan Africa varies between regions from 66.1 to 46.1%. Transport using the cart is one of the most developed hitching activities. The cart used by 87.5% of farmers is used to transport manure to the field, farm equipment, and harvest products and is also used as a means of locomotion for transporting laborers. This confirms the results of Lhoste *et al*. (2010) who reported that draft animals also play an important role in transporting people and various materials useful for family farming. This multiple-use makes the cart the most used agricultural equipment by farmers (48.47% of agricultural equipment). This is approved by Dugue (1994) who affirms that the local farmers are very demanding of this material which is used for several purposes (transport of goods, bricks, etc.,).

Breakdowns of these farming tools are much more observed in working parts that are in direct contact with the ground and transmission systems due to wear. This confirms the work of Warouma (1999) according to which wear failures under modern conditions represent 80 to 90% of total failures. The failure rate is especially higher for tillage parts, the wear of which leads to reduced crop yields, due to the violation of agrotechnical requirements. Draft animals contribute by their pulling power to the fulfillment of the agricultural calendar. This was approved by Vall and Bayala (2007) who underlined that animal traction mechanization intervenes in soil preparation (plowing, scarifying, etc.,), sowing, weed control (plowing, weeding, ridging), water management (plowing, scarifying, ridging), maintenance of fertility (burying organic matter, production of manure) and multiple transport operations.

Several animal species are used including cattle more particularly zebus which are the most dominant. Among the breeds available locally, the Azawak breeds and the Azawak-Bororo mestizo are the most used in animal traction for fieldwork. Cattle are employed by 98.15% of animal traction users, followed by donkeys (1.85%) and camels (0.93%). The preferences of the bovine species over other species are largely due to habit and the possibility of saving capital after culling.

The total area worked in animal traction is estimated at 694.25 ha (94%) against 43.75 ha (6%) worked manually. These results are different from those of Clarke and Bishop (2002) who reported that in sub-Saharan Africa, the energy required for agricultural production is 65% human, 25% animal, and only 10% mechanical.

Conclusion

This study allowed us to understand the level of agricultural mechanization and the main equipment used in Niger and more particularly the role played by animals in conducting agricultural work. At the national level, the

motorization of fieldwork remains very limited. Farmers, depending on their cultivation systems and depending on the locality, use all kinds of coupling tools in their production systems, such as the cart, the plow, the seed drill, the hoe, etc. The various breakdowns of these agricultural tools are much more observed at the level of the working parts which are in direct contact with the ground and the transmission systems. Much of the repair of these breakdowns is done locally. The animal is mainly used by farmers as a source of energy for carrying out fieldwork. Several animal species are used, of which cattle, more particularly zebus, remain the most dominant. Among the breeds available locally, the Azawak breeds and the Azawak-Bororo mestizo are the most used. This study showed that the animal, as a source of energy, largely contributes to the influence of agricultural mechanization in the study areas of Niger.

Author's Contributions

Warouma Arifa: Conceived and designed the experiments, performed the experiment and processed the data, analyzed the data, and wrote the manuscript

Chaibou Mahamadou: Supervised the research, analyzed data, interpreted the data, and revised the manuscript.

Saley Adamou Laouali: Co-supervised the research and revised the manuscript.

Ethics

This article is original and contains unpublished material. It is confirmed that all of the authors have read and approved the manuscript and there are no ethical issues involved.

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