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Effect of Animal Traction Technology on Medium-Scale Maize Farmers' Livelihood in Kaduna State, Nigeria

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Abstract

The study analysed the effect of Animal Traction Technology (ATT) on medium-scale maize farmers' livelihood in Kaduna State, Nigeria. Cross-sectional survey design was adopted with multi-stage sampling procedure used to select 309 respondents out of 1573 medium-scale maize farmers across the four agricultural zones in Kaduna State. A structured questionnaire was used as instrument for data collection. The instrument was validated, pilot-tested giving a standardized reliability coefficient of 0.874. The instrument was administered to the respondents. Data collected was analysed using descriptive statistics in the form of frequency, percentages, mean and standard deviation. Logit regression analysis was used to test the null hypothesis. The finding showed that ATT in Kaduna State significantly affects maize farmers' livelihood ($p = 0.000 < 0.05$). It was concluded that the life of medium-scale maize farmers was better after the use of ATT. The study recommends among others the need for Kaduna State Agricultural Development Agency (KADA) to integrate ATT into broader its livelihood improvement programmes to enhance the income and food security of farmers in the State.

Keywords: Animal Traction Technology, Medium-Scale Maize Farmers, Livelihood

Introduction

It has been reported in many parts of the world that farmers have adopted various methods of improving agricultural productivity to meet the numerous demands of life. Among the adopted technologies were; crop rotation, conservation tillage, mechanisation, and the use of animal traction. While these technologies have significantly enhanced farming efficiency, animal traction remains one of the oldest yet most reliable techniques, especially in regions where mechanization is limited. Animal traction entails the use of animals to pull farm equipment, vehicles, and other loads to aid farmers in carrying out various tasks on the farm. The most common draft animals include cattle, oxen, mules, buffaloes, donkeys, and camels (Hafiza, 2020). In many developing countries, including Nigeria, Animal Traction Technology (ATT) as a subset of agricultural mechanization, has long been used for transportation as well as cultivation, harrowing, ploughing, and weeding, the role of which cannot be over-emphasized. The use of ATT for crop production gives room for increased production capacity and improved livelihoods of the farmers (Umar *et al*, 2021). They have been used to increase work efficiency, reduce drudgery, cost of labour and save time that can be used for other productive or socially important tasks.



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The experience in Nigeria on the use of animal traction is that many regard animal traction as a backward technology. However, experience from Kaduna State increasingly sees animal traction as an economically and ecologically appropriate technology that is highly relevant and adopted by the rural farmers. In this regard, the animal traction system commonly practiced can be grouped into five components: the animals, the harness, the implement (plough, harrows, ridges, and cart), the operator, and the soil or load. These components are integral to animal traction but demand different specialties to deliver a holistic output. The ATT operators primarily use the animals on their farms and provide services to neighbours on a hiring basis for cash or in kind. The adoption of ATT is about 6.6% and this is termed a low adoption level (Mbungbo *et al*, 2018). These ATT users cultivate variety of labour and capital-intensive crops such as maize and has increased farmers' profitability and improve their livelihood.

Livelihood is seen as a set of activities in everyday life conducted over one's life span. These activities among others are; securing water, food, fodder, medicine, shelter, and clothing. The individual's livelihood involves the capacity to acquire enough income to satisfy the basic needs of their households through increased productivity (Nathaniel, 2021). A livelihood is considered sustainable if it can withstand stresses and shocks, recover from them, and retain or improve its capacities, resources, and activities in the present and the future without compromising the natural resource base (Natarajan *et al.*, 2022). Farmers can use their livelihood capital and deploy the best strategies to increase their livelihood and, in this instance, maize farmers use ATT as a tool for sustainable maize production and livelihood. According to the United States Department of Agriculture (USDA, 2023), Nigeria's maize production for the 2023/24 marketing year (MY) is estimated at 11.8 million metric tonnes (MMT), representing a 7.3 percent decline from the 12.735 MMT recorded in 2022/23, primarily due to escalating insecurity, high input costs, and communal violence in key production regions in the North. Despite this output, a significant food deficit persists, as annual maize consumption is projected at 12.3 MMT, outpacing domestic production. Consequently, maize imports are forecasted to rise to 150,000 MT, a 50 percent increase over the previous year, as the government considers limited waivers to mitigate food shortages, despite the Central Bank of Nigeria's restriction on corn importation (USDA, 2023). Despite advancements in agricultural technologies, such as high-yielding crop varieties and agro-chemicals, maize production remains insufficient for huge export (Kamara *et al.*, 2020). Mechanized farming, though efficient, is costly and faces challenges like high maintenance and limited spare parts, prompting farmers to adopt ATT as a supplementary measure. While ATT adoption among medium-scale farmers in Nigeria is growing, its full potential remains underutilized, and its impact on livelihoods is not well understood and much documented in the area. This research analysed the effect of ATT on medium-scale maize farmers' livelihood in Kaduna State, Nigeria. Specific objective of the study is to determine the socio-economic characteristics of medium-scale maize farmers and asses the effect of ATT use on their livelihood.

Hypothesis

H₀₁: Animal Traction Technology has no significant effect on medium-scale maize farmers' livelihood in Kaduna State.

Conceptual framework

A conceptual framework is a tentative theory about the phenomena being studied that informs the entirety of the study's design, noting that this may also be called a 'theoretical framework (van der Waldt, 2024). The conceptual framework comprises your thoughts on the identification of the research topic, the problem to be investigated, the questions to be asked, the literature to be reviewed, the concepts to be applied, the methodology used, procedures and instruments, the data analysis and interpretation of findings, recommendations, and conclusions that will be made. Accordingly, the conceptual framework is the logical conceptualization of your entire research project. A conceptual framework can be simply put as a diagrammatic representation of how the concepts underpinning the study relate to one another. In this study, it is expected that animal traction will result in to change in maize farmers' livelihood through increased yield of crop and standard of living of medium-scale maize farmers. It is assumed that maize farmer's socio-economic characteristics, such as age, gender, education, farmer's experience, and technological factors such as improved seedling and animal traction will be the independent variables that will bring about changes in the farmer's active behaviour using ATT and their livelihoods.

Literature Review

Gona and Mohammad (2019) conducted a study that examined the role of ATT on the profitability and income of small-scale farmers in Kebbi State, Nigeria. Primary data were collected through the use of pre-tested questionnaires in 2017. A



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multistage sampling procedure was used to collect data from two categories of respondents who are ATT users and non-users. Data were analysed using descriptive statistics, net farm income analysis, and gini co-efficient. The result showed that bull (100%), camel (60.26%), and donkey (32.05 %) are the various types of animals used as draught animals in the study area. The result further reveals that ploughing (100%), ridging (98.72%), tillage (97.44%), weeding (88.46%), transportation (65.38%), and fetching of water (12.82%) are the activities performed using draught animals. The result revealed that farmers who are ATT users outperformed farmers who are non-ATT users when using Net Farm Income analysis. Farmers who are ATT users achieved a Net Farm Income of N436,885.36 and non-users achieved about N150,365.38 which shows a significant difference of about N286,519.98. This suggests that ATT users achieved more profit than the non-users. The study was found useful to the on-going study because they both assess the effect of ATT and use descriptive statistics to answer all research questions. Furthermore, a multi-stage sampling procedure was used to draw the desired sample size for both studies. The on-going study is different from the previous study as the previous study examined ATT on the profitability and income of small-scale farmers in Kebbi State whereas the current study evaluated the effect of ATT on livelihood of medium-scale maize farmers in Kaduna State.

Suad, Omeima, and Ezdehar (2022) conducted a study on factors affecting the adoption of animal traction by farmers (west and south Kordofan state) in Sudan. The study used two types of questionnaires one for the farmers who used hand tools and the other for the farmers who used ATT, a sample of 400 farmers, was selected following the systematic random sampling technique on geographical location. The questionnaire data was analysed using the Statistical Package for Social Science (SPSS) to produce graphs, frequency, and percentage tables, and the different parameters were assessed using chi-square test. The results showed that different factors have effects on animal traction adoption, the factors include (age, gender, education, animal type, crop, farm size, land ownership, tools, and extension) and mentioned that there are significant associations between animal traction and these factors. More than half of the respondents 55% educational level (year and education before university). Horses are dominant in West Kordofan and Cows/Oxen are used only in South Kordofan presented by 20% of respondents. Most of the farmers 70% owned land, 40% of the farmers used plough for ploughing, and 50% used hand tools. All extension services concentrated on distributing improved seeds besides farmer visits and ignored other methods and means of extension. The study concluded that extensions in the targeted area were introduced to the farmers poorly, all extension services concentrated on distributing improved seeds besides farmer visits and ignored other methods and means of extension. The study also concluded that land and animal ownership present a major effect on animal traction adoption, the farmers who owned land and animal adopts animal traction more than farmers who do not own land and animal. The study was found relevant to the on-going study as both are on animal traction and use descriptive statistics of frequency and percentages to answer the research questions. The current study differs from the previous study as the previous study used two questionnaires to generate information from the respondents while the current researcher used a researcher-designed questionnaire to collect data from the respondents. Furthermore, the previous study was on factors affecting the adoption of ATT in Sudan while the current study is on the effect of ATT on livelihood of medium-scale maize farmers in Kaduna State, Nigeria.

Methodology

The study employed a cross-sectional survey design to gather data at a specific point in time, enabling the researcher to make inferences about the population of interest. This design was chosen because it allows for efficient collection of data on multiple variables within a short timeframe, making it suitable for describing characteristics and relationships among different variables. The population of the study consisted of 1,573 registered medium-scale maize farmers using animal traction, distributed across the four agricultural zones in Kaduna State. A stratified sampling was used to group medium-scale farmers in Kaduna State into the already existing four (4) agricultural zones, namely Maigana, Lere, Samaru, and Birnin-Gwari. Purposive sampling was used to select three (3) agricultural zones which are Maigana, Lere, and Birnin-Gwari, and proportionate sampling techniques was used to select 309 medium-scale maize farmers in the selected zones. Primary Data was collected using structured questionnaire, written in English language and translated into the local language of the area (Hausa) during data collection. The instrument was validated and tested to ensure its accuracy and reliability. The reliability of the instrument was assessed using the split-half method, which yielded a Cronbach alpha of 0.706 and 0.802 for the two halves, with a correlation coefficient of 0.874. Data was analysed using descriptive statistics and logit regression model. The descriptive statistics, including frequencies, percentages, mean and standard deviations,



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were used to answer the research questions. While the logit regression analysis was employed to examine the relationships between the independent variables (socio-economic characteristics, institutional factors, technological factors, and productivity) and the dependent variables (income, asset possession, household expenditure, and wage-earning opportunities) at 0.05 level of significance.

Presentation of Results

Table 1: Distribution of medium-scale maize farmers by their socio-economic characteristics (N = 309)

Variable	Respondents' type	Frequency	Mean	Percentage	Std. Dev
Age (years)			47.57		0.5749
Sex	Male	263		85.1%	
	Female	46		14.9%	
Educational level	No formal education	14		4.5%	
	Quranic education	21		6.8%	
	Primary education	119		38.5%	
	Secondary education	79		25.6%	
	Tertiary education	58		18.8%	
	Adult literacy	18		5.8%	
Farm size (ha)			2.56		0.1269
Household size			6.9		0.2132
Farming experience (yrs.)			16.98		0.5932
Membership of farmer associations	Yes	193		62.5%	
	No	116		37.5%	
Access to Credit	Yes	103		33.3%	
	No	206		66.7%	
Sources of credit	None	206		66.7%	
	Commercial banks	14		4.5%	
	Bank of Agriculture	20		6.5%	
	Money lenders	30		9.7%	
	Friends/Relatives	39		12.6%	
Extension contact	Yes	187		60.5%	
	No	122		39.5%	

Table 1 indicated that the average age distribution of the respondents was 48 years. This finding showed that the medium-scale maize farmers in the study area were in their agricultural productive age. This is in line with the work of Owolabi, Ajayi and Oyeyemi (2018) who found that most farmers in northwestern Nigeria were within the age bracket of 40-49 years. Furthermore, the results indicated that male respondents dominated medium-scale maize farming comprising of 85.1%. This is in agreement with the work of Ayodele *et al.* (2020) and Ja'afar-Fur *et al.* (2024) whom revealed that maize farming is male-dominated activity due to its high labour and cost demand. The educational level of the respondent showed that the majority had a low level of education, with most having primary school education (38.5%) only. Education is an important index for the adoption of agricultural technologies, and it is expected that farmers with a high level of education or some form of literacy would accept new technologies more easily and quickly. This finding aligns with the finding of Bello, Frederick, Nazeer and Ibrahim (2020) who conducted a study on the Profitability of Small-Scale Maize Production in Nigeria: A Case Study of Bichi Local Government, Kano State, Nigeria. The average mean farm size of the medium-scale maize farmers in the area was 2.56 hectares, indicating that most of the farmers owned about 3 hectares of land for maize cultivation. Farmers with large holdings were more likely to take risks with complex technologies than those with small holdings, which showed that the respondents in this study were more likely to adopt the use of ATT without any apprehension. The finding is also consistent with the work of Fadeyi, Ariyawardana and Aziz (2022) who found that small-scale farmers in Nigeria. However, landholding sizes may vary slightly depending on the scale of farming. The mean household size of the respondents was about 7 persons per household. The average household size of 7 members is not in line with findings from Owolabi *et al.* (2016), who reported a mean household size of 11 persons per household head, indicating that larger households are common in rural agricultural settings. Results on membership in farmer associations also showed that the majority of the respondents (62.5%) belonged to farmers' organizations in the area. However, the



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finding that most farmers belonged to cooperative societies negates the finding of Omotilewa, Jayne, Muyanga, Aromolaran, Liverpool-Tasie and Awokuse (2021) who found that only a small percentage of farmers in Nigeria, were members of cooperatives. This discrepancy could be due to regional differences in the prevalence and effectiveness of cooperative societies. In Kaduna State, cooperatives may be more established or actively promoted by local governments or Non-Governmental Organizations, leading to higher membership rates among farmers. Further results from the table shows that the majority (66.7%) of the farmers did not have access to credit, among those who had access to credit, the most common source was friends and relatives (12.6%). suggesting a reliance on informal financial networks. Institutional sources such as the Bank of Agriculture (6.5%) and commercial banks (4.5%) were less frequently utilized, possibly due to stringent loan requirements, high interest rates, or lack of collateral. The farmers without access to credit highlighted a potential constraint on agricultural productivity, as limited financing restricted investments in improved farming inputs, technology, and expansion efforts. The is consistent with the finding of Zantsi and Bester (2019), who highlighted the financial constraints faced by smallholder farmers in South Africa. Similarly, Balana and Oyeyemi (2021) found that access to credit and other financial services was a significant barrier to the adoption of animal traction technology in Nigeria. This suggests that financial constraints are a widespread issue affecting farmers' livelihoods across different regions.

Table 2: Estimated assets of medium-scale maize farmers (N = 309)

Variable	Mean	Standard deviation (std)
Income generated	₦3,629,882.18	16.4301
Household assets possession	₦2,414,592.52	13.9332
Household expenditure	₦1,253261.37	13.4284
Wage earning opportunities	₦451,684.92	9.4211

The result in Table 2 shows that the average mean income of medium-scale maize farmers before using ATT was ₦3,629,882.18 due to the use of ATT, the standard deviations showed a significant variation among the farmers. An indication that maize farmers earnings is relatively high. The result also showed that the farmers are relatively endowed (₦2,414,592.51) when in terms of possession of fixed assets in the form of livestock, machinery and consumer durables. On the other hand, household expenditure among the respondents summoned to about ₦1,300,000, this shows that household expenditure constitutes a major share of the farmers income in the study area. There is an indication of low livelihood diversification among the farmers as wage earnings is only ₦451,684.92 in the study area.

Test of hypothesis: Animal Traction Technology has no significant effect on medium-scale maize farmers' livelihood in Kaduna State, Nigeria.

Table 3: Regression estimates showing the effect of ATT ownership on medium-scale maize farmers' livelihood

Variables	Coefficient	t
Age	-8153.33**	-2.61
sex	-14776.32***	-3.53
Level of education	-15432.65***	-5.00
Household size	-25432.50***	-8.43
Farm size	24369.79***	5.53
Years of experience	4891.179***	4.08
Access to credit	31838.33***	3.53
Do you own the ATT	-19531.63***	-3.33
Membership of cooperative	-147416.8***	-13.23
Seeds (kg)	-7518.503***	-4.35
fertilizers	61580.50***	8.91
Agrochemicals	-2185.527***	-20.82
Source of labour	-24029.53***	-6.22
Access to extension contact	2871.661	0.64
Do you use ATT to cultivate your maize	2245.894***	4.21
Level of income after using ATT	2078.072***	3.08
Constraint to ATT Usage	-219672.5***	-7.16
R ²	0.9797	

Source: Field survey (2024) *** significant at 1% and ** significant at 5%



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Estimated result for establishing a relationship between maize output and ATT ownership are presented in Table 3. The result of the analysis reveals that the estimated R^2 (0.9797) shows that 97.97% of the variation in the dependent variable (medium-scale maize farmers' livelihood) has been predicted by the independent variables. This high value reflects a strong goodness-of-fit for the regression model. Among the socio-economic variables, age had a negative and statistically significant coefficient (-8153.33) at the 5% level, implying that as farmers grow older, their livelihood (as proxied by production or income) declines, possibly due to diminishing physical ability and adoption of technology. This is in agreement with the work of Ja'afar-Furo *et al.* (2020) who carried out a study on the Analysis of Socio-economic Factors Affecting the Adoption of Improved Maize Varieties among Rural Communities, in Adamawa State, Nigeria. It was stated that the majority of the maize farmers (73.4%) belong to the middle age group. Whereas 8.16 percent belong to old age and 2.04 percent belong to young age. This is in agreement with the work of Ayodele *et al.* (2020) which revealed that maize farming is male-dominated with 87 percent of the respondents being men. Sex was also negatively significant (-14776.32), indicating that female farmers may be at a disadvantage in terms of productivity or benefits from ATT, likely due to gender-based disparities in access to resources.

Level of education and household size had strong negative effects on livelihood, both significant at the 1% level. While education is typically expected to have a positive influence, its negative coefficient (-15432.65) could suggest a mismatch between formal education and practical farming skills, or perhaps that more educated individuals are less engaged in hands-on farming. This negates the work of Bello, Frederick, Nazeer and Ibrahim (2020) who conducted a study on the Profitability of Small-Scale Maize Production in Nigeria: A Case Study of Bichi Local Government, Kano State-Nigeria. It was reported that 33.3 percent of the respondents finished primary school, 16.67 percent of them finished secondary school, and only 3.3 percent of them have tertiary education while the majority (46.7%) have a non-formal education. The negative impact of household size (-25432.50) may reflect higher dependency burdens reducing available labor or productive input per household member. Conversely, farm size (24369.79), years of farming experience (4891.18), and access to credit (31838.33) all had positive and significant effects, reinforcing the importance of productive assets, expertise, and financial capacity in improving livelihood outcomes. These findings suggest that larger, more experienced, and better-financed farmers are more likely to benefit from or effectively utilize ATT.

The variable "Do you own the ATT" was significant and negative (-19531.63), which may initially appear contradictory to expectations. However, this might indicate that merely owning the ATT does not translate to higher productivity unless effectively used or supported by other factors (like training or infrastructure). In contrast, "Do you use ATT to cultivate your maize" was positively significant (2245.894), highlighting that actual utilization rather than ownership is what contributes positively to livelihood outcomes. Interestingly, "level of income after using ATT" also had a positive and significant effect (2078.072), which validates that ATT usage can improve financial outcomes, likely by enhancing productivity. However, constraints to ATT usage had a large negative impact (-219672.5), underscoring those challenges like cost, accessibility, or technical difficulties can severely undermine the potential benefits of ATT. Other notable findings include significant negative effects from inputs such as seeds (-7518.50), agrochemicals (-2185.53), and source of labor (-24029.53). These could indicate inefficiencies or high costs associated with these inputs. Conversely, fertilizers showed a strong positive influence (61580.50), suggesting their critical role in boosting productivity. Also, membership in cooperatives was negatively significant (-147416.8), which might reflect internal inefficiencies, mismanagement, or inadequate support within cooperative structures.

Test of Hypothesis

The result of the regression analysis (Table 3) shows that ATT has significant effects on medium-scale maize farmers' livelihood in Kaduna State, Nigeria. Therefore, the hypothesis that ATT has no significant effect on medium-scale maize farmers' livelihood was rejected.

Conclusion

The findings of this study provide crucial insights into the demographic and socio-economic characteristics of medium-scale maize farmers in the study area, highlighting key factors that influence their productivity and adoption of agricultural technologies. The average age of 48 years suggests that the majority of the farmers are within their productive years, which aligns with previous studies indicating that most farmers in Nigeria fall within the age bracket of 40–49 years. The



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dominance of male farmers (85.1%) in maize farming further corroborates existing literature that agriculture, particularly maize cultivation, remains a male-dominated sector due to cultural, social, and economic factors. Additionally, the educational level of the farmers indicates a relatively low level of formal education, with the majority having primary and secondary education, which could influence their ability to adopt and implement modern agricultural technologies effectively. This trend aligns with earlier studies that emphasize the role of education in enhancing technology adoption. The mean farm size of 2.56 hectares suggests that most farmers in the study area operate on relatively moderate land holdings, which could facilitate their willingness to adopt advanced farming techniques compared to small-scale farmers. Furthermore, the average household size of seven members highlights the potential availability of family labour, which is crucial for medium-scale farming operations. The high membership rate in farmer associations (62.5%) indicates that cooperative societies play a significant role in agricultural activities in the study area, although regional differences may affect participation levels. However, a major constraint identified in the study is the limited access to credit, with 66.7% of the farmers lacking financial support, thereby restricting their ability to invest in improved inputs and farming technologies. This financial limitation aligns with findings from previous studies, which emphasize that access to credit remains a critical challenge for farmers, ultimately affecting their productivity and expansion efforts. The heavy reliance on informal credit sources such as friends and money lenders further necessitate the need for improved institutional financial support tailored to farmers' needs. These findings show the importance of addressing key constraints such as financial accessibility, education, and landholding sizes to enhance maize farming productivity among medium-scale farmers in Nigeria. Policies and interventions should focus on improving access to credit, strengthening cooperative societies, and promoting educational initiatives that enhance farmers' knowledge and willingness to adopt modern agricultural practices, ultimately contributing to food security and improved livelihood of farmers in the study area.

Recommendations

- i. Agricultural extension agents and Kaduna State Government programmes should incorporate adult literacy classes and skill-based agricultural training to help farmers better understand the use of ATT. This will enhance their ability to adopt more modern farming practices and improve maize production.
- ii. Kaduna State Agricultural Development Agency should integrate ATT into broader livelihood improvement programs to enhance income and food security for medium-scale maize farmers.

Conflict of Interests

Authors declare that they have no conflict of interest.

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