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FACTORS INFLUENCING SMALLHOLDER FARMERS' MECHANIZATION DECISIONS IN NIGERIA: THE CASE OF TRACTOR USE IN THE FOURTH INDUSTRIAL REVOLUTION ERA

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ABSTRACT
Tractorization is crucial in the agricultural transformation of societies with either large farm size or challenged by a severe labor shortage. However, most smallholder farmers still lag in its use, making it necessary to investigate current tractor use by smallholders. This study investigated the factors that influence smallholder farmers' decision to use tractors in the Delta and Benue States of Nigeria. Specifically, it determined the current level of mechanization (tractor use) in the farming system, estimated the contributions of tractor use among smallholder farmers, and determined the factors influencing smallholder farmers' tractor use decisions in the study area. Multistage sampling techniques were used to collect data from 280 respondents. Descriptive statistics, a logistic model and odds ratio (OR) constituted the analytical framework. The results showed that poor tractor use still exists among smallholder farmers, with as much as 72% of farmers not using tractor in this modern era. The study revealed that the mean income of tractor users was twice as high as that of non-tractor users. The OR result revealed that educational status, household labor, farming experience, alternative occupation, and farm area under cultivation influenced the decision of the smallholder to use tractor services. It would seem that lack of utilizing the benefits of tractorization is a crucial constraint that calls attention to the need for a holistic campaign among the farming population. The practical applications of family labor are likely to remain high.

Contribution/Originality: This study is one of very few to have investigated the mechanization decision of smallholder farmers. This paper reveals current tractor use levels by smallholder farmers in the 21st century and the factors influencing the use of tractors by farmers. The study finds that poor mechanization (tractor use) poses a significant problem and is far beyond the research of smallholder farmers.

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1. INTRODUCTION

The deployment of tractor services in performing agricultural tasks is referred to as tractorization operation (Takeshima, Pratt, & Diao, 2013). Tractorization aids farm product transportation, such as the transporting of farm inputs, fetching of wood, taking the product to market, and powering of farm implements such as the disc ridge, farrow, plough, planter and bucket (Naushad, Muhammad, Musawar, Akhtar, & Niaz, 2009; Takeshima et al., 2013). While there is criticism that the use of the tractor destroys soil properties during land preparation and displaces human labor (Emami, Almassi, & Bakhoda, 2018; Krebstein, Von Janowsky, Kuht, & Reintam, 2014), evidence has been adduced that tractorization does not lead to a reduction in human labor employment. On the contrary, tractor service stimulates an increase in area cultivated, thereby creating more on-farm employment opportunities (Roy & Blase, 1978). A study has shown that tractor usage increases employment on smallholder farms, and users derived higher gross income than non-users (Onomu & Aliber, 2020; Roy & Blase, 1978). Irrespective of the arguments on the importance and limitations of tractor services in farm mechanisation, tractorization was found to be a veritable tool for farmers who expected yield increments (Singha, Jaman, & Chavali, 2012).

For more than a decade, labor-saving technologies have seen an unprecedented level of adaptation. However, their intensification and sustainability have created a bottleneck, especially in developing countries and for smallholder farmers (Pingali, 2007). Hence, most farmers in developing countries, especially in Africa, still use hand tilling as their primary sources of farm power (Rapsomanikis, 2015) and head porterage for farm transport. The use of mechanical power has been recommended as a sure way of resolving problematic farm power challenges. However, the challenge regarding the use of mechanical power (tractor use) remains unabated among smallholders (FAO, 2013; IFC, 2013).

Tractor use by smallholder farmers in Nigeria and other African countries is low compared to that in Asia (Takeshima., 2017). Despite the challenges associated with poor tractor use among smallholder farmers, recent research and government policies have focused on the commercialization of the smallholder through value addition and market participation, but have seemingly ignored smallholders' labor (tractor use) challenges, which are the fundament of commercialization (Daum & Birner, 2017; Gwebu & Matthews, 2018). Ironically, the agricultural sector, particularly commercial agriculture, has transformed, with many commercial farmers finding pathways to enhancing mechanization (labor efficiency) while the challenge of labor (tractor use) remains unaddressed among smallholders (Gwebu & Matthews, 2018; Onomu, Aliber, & Agbugba, 2020). This is despite the agricultural sector having more smallholders than commercial farmers (Rapsomanikis, 2015). Market-driven mechanization services, where the individual/cooperative or government renders hire tractor services for smallholders, have been proffered and adopted by some governments in Africa, including that of Nigeria, to remedy smallholders' mechanization challenges. However, the extent to which market-driven mechanization policy has made inroads in enabling most smallholders to use tractors remains unknown. This raises the question: what is the current nature of tractor use among smallholder farmers in this era of the fourth industrial revolution? Without question, low levels of mechanization (tractor use) by smallholders will not only make sustainable market participation, value addition, and growth difficult, but it could exacerbate food insecurity and prevent many young people from taking up agriculture as a career (Daum & Birner, 2017; Emami et al., 2018). It could also retard market demand for mechanization equipment because a larger population of farmers who would have demanded mechanization equipment are smallholders. Hence, this paper investigates the level of mechanization (tractor use) in the farming system, estimates the contributions of tractor use among smallholder farmers in the study area, and determines the factors influencing smallholder farmers' tractor use decisions in the study area. Therefore, this paper contributes to the existing literature on smallholder mechanization. Most importantly, it reveals current tractor use condition by smallholder farmers after implementing government hire tractor services in the study area. At the same time, it also investigates the determinants of tractor use among smallholder farmers in the fourth industrial revolution era.

2. METHODOLOGY

2.1. Description of the Study Areas

The study was carried out in two selected states of Nigeria, namely Benue and Delta. The former is located in northern Nigeria, the latter in the southern part of the country. Nigeria has rich agricultural lands of loamy soil with excellent water-holding capacity (Chukwu, 2018). The country received an average rainfall of 1150 mm in 2014 in all zones. However, the rainfall pattern in Nigeria varies from season to season and from one agro-ecological zone to another (World Bank, 2020). Delta State is located in the Mangrove Forest Agroecological Zone, with an estimated rainfall of 265.06 mm in 2008. Benue State is in the tall Grass Savanna (Derived Savanna), and received an average rainfall of 145.3 mm in 2000. These average rainfall levels are suitable for agricultural activities, mainly arable crop farming which many smallholder farmers practise (Olarenwaju, Akpan, & Buku, 2017; Ologunorisa & Tersoo, 2006; Omonijo, 2014). Nigeria has an annual average temperature of 28^{0}C and climatic conditions favourable for arable farming of such crops as maize, cassava, rice, guinea corn, millet, and yam (USAID, 2014). Agriculture plays a significant role in Nigeria's economy, irrespective of the contribution of oil. It is contended that agriculture forms the base of Nigerian economic growth (Odetola & Etumnu, 2013), employing two-thirds of the total labor force of Nigeria (FAO, 2019). On average, 80% of farmers in Nigeria are smallholders who depend predominantly on a cutlass, hoe, and other primary production resources available to them for their efficiency (Mgbenka, Mbah, & Ezeano, 2015). Nigerian agricultural land law policy is based on the land tenure system (Udoekanem, Adoga, & Onwumere, 2014).

2.2. Model Specification

Subject to different challenges, the smallholder farmer chooses to determine the labor use on the farm (Loughrey et al., 2013). The farmer's decision has the likelihood of being influenced by different explanatory variables (factors), including his/her socioeconomics characteristic. To address the smallholder's discrete choice challenges, there are at least two alternative models to the least squares model that are a better fit, unbiased, consistent, and efficient in the analyses and investigation of factors affecting discrete choice decision as used by Boughton et al. (2007); Chilundika (2011); and Reyes, Donovan, Bernsten, and Maredia (2012). These models are the logistic and probit models, respectively. Greene (2003) opined that the logistic model is similar to the probit model, claiming that it is challenging to distinguish the final outcome as there is little difference in the outcome besides its distribution. While the logistic model follows a logistic distribution, the probit model follows a normal distribution. The functional form of the logistic model is relatively simple compared to the probit model. Marginally, the logistic model has a flatter tail than the probit model, which makes it more robust to outliers and presents estimates over a wider range of data points. The logistic regression model is one of the most preferred and regression methods used in modeling the relationship between a binary dependent variable and independent variables (Korkmaz, Güney, & Yiğiter, 2012). Since its dependent variable is binary, which can have only two possible values, the interpretation is not concerned with how the independent variables predict a score, but how they predict one or other of the two groups of the binary dependent variable (Sperandei, 2014). Ordinarily, one cannot depend on the dependent variable's exact effect on the dependent variable, which is the smallholder decision to use or not to use the tractor. Hence, logistic regression is used to model the logit-transformed probability as a linear relationship with the predictor variables that ensure outcome with individual characteristics through odds (Bruin, 2006). Being transformed from probability, odds range from 0 to infinity: it is the ratio of the frequency of successful outcomes to that of failure. Hence, the process of ensuring the exact weight of the independent variables on a discrete dependent variable in logistic regression is referred to as the odds ratio (Bruin, 2006). The logit link form is expressed as:

$$\text{Logit P} = \text{Log}\left[\text{P} / (1\text{-P})\right] \quad (1)$$

Where:

Log P in Equation 1 is the log of the probability of the smallholder farmer to use the tractor, and P is a probability function in all the equations. Therefore, the probability of the farmer to use a tractor or not is expressed in Equation 2:

$$\text{P} = P_{ti} = \Pr(Y = 1 \text{ I } X = x_i) \quad (2)$$

P_{ti} in Equation 2 is the probability of the farmer decision to use tractor services, and X is the vector of the explanatory variable, with x_1 representing one of the target explanatory variables. Therefore, the probability that the explanatory variable is equal to one, given X, is the probability of using tractor given X, which is expressed in Equation 3 as:

$$P_{ti}\,(\text{Y} = 1 \text{ I } \text{X} = x_1) = P_{ti} = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}} \text{ n} \quad (3)$$

Where

$\text{X} = (x_1, x_2 \ldots\ldots x_n)$ and $\beta = (\beta_o, \beta_1, \beta_2 \ldots\ldots \beta_n)$ in Equation 3. Hence,

β_0 is the constant term in all the equations, the constant term shows the likelihood of the explanatory variable, and $\beta_1, \beta_2, \beta_n$ is the respective coefficients of each explanatory variable.

The probability of not using a tractor is one (1) minus the probability of using a tractor.

Hence, The probability of not using the tractor given X is expressed in Equation 4:

$$P_{t0}\,(\text{Y} = 1\text{-I X} = x_1) = P_{to} = 1 - \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}} \quad (4)$$

From Equation 4, taking the exponential effect of the farmers' likelihood not to use tractor is derived as presented in Equation 5.

$$\text{This implies that } P_{to} = \frac{e^{\beta_0 + \beta_1 X} - e^{\beta_0 + \beta_1 X}}{1 + e^{\beta_0 + \beta_1 X}} \quad (5)$$

In Equation 6, the likelihood outcome of the explanatory variable for the farmer not using a tractor is derived from Equation 5, as presented in Equation 6.

$$\text{Hence, } P_{to} = \frac{1}{1 + e^{\beta_0 + \beta_1 X}} \quad (6)$$

One factor with probability is its ability to compare the probability of success to that of failure. If we do that, we have the outcome as presented in Equation 7:

$$\frac{e^{\beta_0+\beta_1 X}/1+1+e^{\beta_0+\beta_1 X}}{1/1+e^{\beta_0+\beta_1 X}} \quad (7)$$

Equation 7 shows the odds ratio. This is the result of having the odds of using a tractor against not using it. Taking the log of both farmers using and not using tractor services, the resultant effect is shown in Equation 8.

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$$: \text{In}\frac{e^{\beta_0+\beta_1 X}/1+1+e^{\beta_0+\beta_1 X}}{1/1+e^{\beta_0+\beta_1 X}} \quad (8)$$

Where In is an inverse probability log.

Equation 9 is derived by taking the exponential inverse probability log of Equation 8 to have the exact weighted score of each independent variable, as presented in Equation 9

$$\text{In}\frac{e^{\beta_0+\beta_1 X}/1+1+e^{\beta_0+\beta_1 X}}{1/1+e^{\beta_0+\beta_1 X}} = \beta_0+\beta_1 X \quad (9)$$

Hence, the functional form of the logistic regression model is summarized in Equation 10:

$$\log\left[\frac{pi}{1-p_i}\right] = \log it(p_i) = \beta_0 + \beta 1 x_1 \quad (10)$$

2.3. Sampling Procedure and Sample Size

A multistage sampling technique was employed to select the study areas and households. A purposive sampling technique was employed in the first stage of data collection to select two states (Benue and Delta States, from northern and southern Nigeria, respectively). The second stage involved random selection of two local government areas (LGAs) from each state after purposefully excluding the commercial cities and those LGAs with relatively low farming activities. Hence, a total of four LGAs were selected: Ethiope East and Oshimili North in Delta State, and Agatu and Konshisha in Benue State. In the third stage, seven communities were randomly selected from each LGA in Delta State, and seven wards were randomly selected from each LGA in Delta State. In the fourth stage, ten smallholder farmers were selected randomly.

Data were collected from two hundred and eighty (280) smallholder farmers in structured interviews using survey questionnaires. In Delta State, the Development Finance Department of the Central Bank of Nigeria, in charge of the Anchor Borrowers' Programme attached to the Delta State Ministry of Agriculture, provided details on registered farmers. In Benue State, information on the population of the smallholder farmers was provided by the All Farmer Association of Nigeria (AFAN) in the Benue State Ministry of Agriculture. In the Oshimili North and Ethiope East LGAs there were 970 and 1350 registered smallholder crop farmers, respectively. In Benue State, there were 2555 and 2160 registered smallholder farmers in Agatu and Konshisha LGA, respectively.

2.4. Collinearity Precaution

A collinearity diagnostic test was performed using the variance inflation factor (VIF), which is a good measure for detecting multicollinearity in regression analysis because it allows the simultaneous accommodation of different predictors (Graham, 2003). Using VIF to detect and prevent multicollinearity, the researchers regressed each predictor variable against other predictor variables. Any variable with VIF >5 was removed from the analysis.

2.5. Description of Variables Used

The variables used are presented in Table 1.

2.6. Analytical Techniques

Descriptive statistical techniques including frequency counts, percentages and mean distribution were used to investigate the respondents' socioeconomic and demographic characteristics, the level of mechanization (tractor use) in the farming system, and the contributions of tractor use among smallholder farmers in the study area. Logistic model and odds ratio likelihood was used to determine factors influencing smallholder farmers' tractor use decisions.

3. RESULTS

This section presents the results of the analysis. The section starts with the presentation of the socioeconomic and demographic characteristics and tractor use distribution of smallholders. It further presents and interprets the results of the logistic regression and the odds ratios.

3.1. Descriptive Analysis of Respondents

The socioeconomic and demographic characteristics of the respondents as they relate to tractor use are presented in Table 2. These include age, gender, marital status, education status, household labor use, and occupational status.

Table-1. Description, measurement and expected outcome for the logit variables.

Variable	Description of variable	Measurement of variable
Dependent variable Using tractor as labor or otherwise **independent variable** Gender of household head	Whether the household head currently use a tractor for farm activity Gender of household head	If male = 1, other = 0 If male = 1, other = 0
Age of household head	Number of years of household head	Continuous
Education status	Years of schooling	Continuous
Marital status	Whether the household head currently has a husband/wife	Yes = 1, otherwise = 0
Household labor use	Involvement of household member in farming	Use = 1, otherwise = 0
Farming experience	Numbers of years actively involved in farming as household head	Continuous
Other occupation	Involvement in other occupation as a source of income	Yes = 1, otherwise = 0
Area cultivated	Total area cultivated	Ha
Use of tractor	Whether the farmer is currently using tractor services	Yes = 1, otherwise = 0

Table-2. Summary statistics of socioeconomics and demographic variables.

Variable	Smallholder farmer		Not using a tractor		Using a tractor	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Age (years)						
≤30	3	1	3	2	0	0
31-40	26	9	16	8	10	13
41-50	88	32	44	22	44	56
51-60	100	36	75	37	25	31
61-70	57	20	57	28	0	0
≥71	6	2	6	3	0	0
Total	280	100	201	100	79	100
Gender						
Male	160	57	111	55	49	62
Female	120	43	90	45	30	38
Total	280	100	201	100	79	100
Marital status						
Married	240	86	163	81	77	97
Single	7	2	5	3	2	3
Divorce	6	2	6	3	0	0
Widower/Widow	27	10	27	13	0	0
Others	0	0	0	0	0	0
Total	280	100	201	100	79	100
Education status						
Informal education	55	20	55	27	0	0
Primary education	108	38	97	48	11	14
Secondary	98	35	46	23	52	66
Tertiary education	19	7	3	1	16	20
Total	160	100	201	100	79	100
Household labor use						
Do not use (0)	6	2	2	1	4	5
3 Jan	135	48	97	48	38	48
6 Apr	110	39	86	43	24	31
10 Jul	22	8	13	6	9	11
≥11	7	3	3	2	4	5
Total	280	100	201	100	79	100
Occupation status						
Farming only	173	62	120	60	53	67
Trading and farming	56	20	38	18	18	24
Artisan and farming	26	9	23	11	3	4
Employed as wage earner & farming	6	2	4	2	2	2
Retired staff and farming	8	3	7	4	1	1
Casual laborer and farming	11	4	9	5	2	2
Total	280	100	201	100	79	100

Table 2 shows that fewer young people are involved in agriculture to date, with only 3 of the 280 respondents in the lower age group of 0–30 years engaging in agriculture in the study area. The gender distribution result showed

that both male and female household heads are actively engaged in farming activities. There is a wide margin in the use of tractor by the gender of the household head. While the majority (62%) of smallholder household heads who use tractor are male, only 38% are female. Tractor use appears to have a relationship with marital status, with almost all tractor users in the study area being married. The study also revealed that most smallholder farmers in the study area have low levels of education, but tractor users are more educated. As is typical of smallholder farmers, only 2% of the respondents were not using household members as labor. This result is line with Kuivanen et al. (2016). Unbelievably, both smallholder tractor users and non-users actively use household labor. In this study, 62% of respondents did not have any other form of occupation except farming (See Table 2). As indicated in Figure 1, only a few (10%) of household heads had farming experience of 1–10 years. In other words, very few household heads in the study area had entered into farming in recent times (in the past ten years).

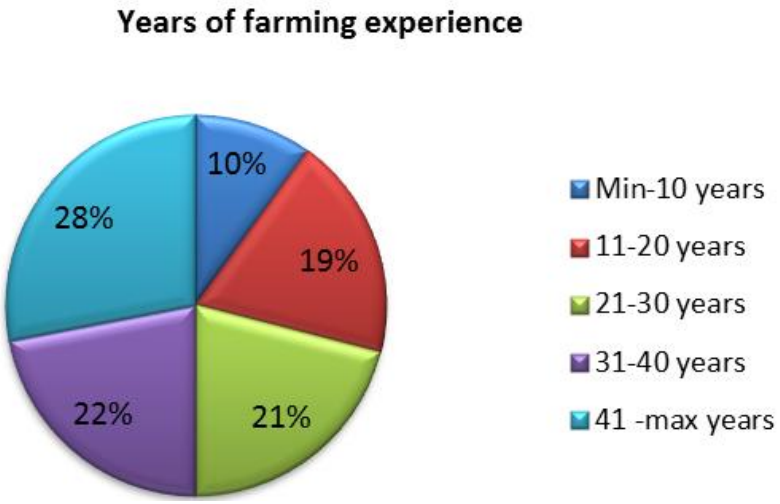

Figure-1. Years of farming experience.

3.2. Incidence of Use of Tractor Services in Delta State versus Benue State

Table 3 presents the incidence of the use of tractor services in the study areas. Despite efforts to ensure that most smallholder farmers mechanized their farming practices, only a relatively small share of them used tractor services. Of the 280 smallholder farming households sampled in both states, only 79 respondents (28%) of the sampled respondents used tractor services. This means that a far higher proportion of smallholders depend on crude implements in the fourth industrial revolution era.

Table-3. Incidence of tractor service use in the study area.

Variable	Tractor use in both states		Delta State		Benue State	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Do not use tractor services	201	72	113	81	88	63
Use tractor services	79	28	27	19	52	37
Total	280	100	140	100	140	100

Although the proportion of non-tractor users is higher in both states, the number of farmers not using tractor services is higher in Delta State than in Benue State.

3.3. Differences between Mean Income of Tractor and Non-Tractor Users

Table 4 reveals the mean income difference between tractor and non-tractor users: the mean income of the former was twice that of the latter. The test result shows that tractor use can contribute to enhanced smallholder welfare.

Table-4. Mean income by tractor and non-tractor users.

Variable	Observed	Mean (Naira)	Std. deviation
Do not use tractor	201	16,688.56	34,427.3
Use tractor	79	288,897.8	127,203.7
Total	280	93,490.5	142,950.1

3.4. Mean Area Cultivated under Tractor or Human Labor

The average areas cultivated by tractor and non-tractor users are presented in Table 5. On average, farmers who used a tractor cultivated larger farm land areas than those who used human labor only. None of the respondents mentioned that they used animal traction, nor did the researcher observe any evidence of animal traction in the study areas during the fieldwork.

Table-5. Description of mean area cultivated by tractor and non-tractor users.

Variable	Observed	Mean	Std. deviation
Do not use tractor	201	1.3764	1.34894
Use tractor	79	4.3165	1.85565
Total	280	2.2059	2.00602

3.5. Land Area Cultivated

Table 6 reveals that 47% of respondents in the categories of land size farmed by respondents cultivated 2 ha or less in the study area. This result is consistent with the findings of Hlomendlini (2015), who opined that the majority of smallholder farmers in South Africa cultivated land areas that ranged from 2 ha and below. The small area of land cultivated by the respondents could affect them in various ways, impacting their growth and poor use of mechanical technologies such as tractors.

Table-6. Farm area cultivated by smallholders.

Area cultivated (ha)	Smallholder farmers		Not using tractor to plough		Using tractor to plough	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
≤2	131	47	129	64	2	2
2.01-4	60	21	50	25	10	13
4.01-6	44	16	14	7	30	38
6.01-8	16	6	3	2	13	16
8.01-10	18	6	4	2	14	18
≥10.01	11	4	1	0	11	13
Total	280	100	201	100	79	100

Although the larger portion of the smallholder respondents cultivated 2 ha or less, some respondents cultivated >8 ha. A high proportion of household heads who cultivated >8 ha used a tractor. This result suggests that as the area cultivated increases, farmers tend to depend on the use of farm machinery rather than human labor.

3.6. Average Farm Area Cultivated by Farmers in Delta and Benue States

As indicated in Table 7, the average farm area cultivated by smallholder farming households in the Delta State subsample is lower than in the Benue State subsample. In the former, the average area cultivated was 1.6 ha, versus 2.8 ha for Benue. This result could be ascribed to the fact that more tractor service providers are available to smallholder farmers in Benue State than in Delta State.

Table-7. Mean area cultivated in Benue and Delta States.

Variable	Observed	Mean	Std. deviation
Benue	140	2.7804	2.26910
Delta	140	1.6314	1.50453
Total	280	2.2059	2.00602

3.7. Analysis of Factors Influencing the Use of Tractor Services by Smallholder Farmers

This subsection determines the factors influencing smallholder farmers' tractor use decisions in the study area. It seeks to explain the factors associated with tractor use in the study area to suggest ways forward. Data from 280 smallholders were used. The logistic model and odds ratio were used to test factors influencing the likelihood of smallholders to use a tractor, and the extent to which those factors influence their decision.

Table-8. Factors affecting farmers' decision to use tractor services.

Variable	Coef.	Std. error	*Z*	*P*>|*z*|	95% Conf.	Interval
Gender of household head	0.568	0.447	1.27	0.203	-0.307	1.444
Age of household head	0.001	0.038	0.01	0.995	-0.074	0.074
Educational status	0.256	0.060	4.27	0.000***	0.138	0.374
Marital status	0.645	0.898	0.72	0.473	-1.115	2.406
Household labor use	-2.404	1.408	-1.71	0.088*	-5.163	0.354
Farming experience (years)	-0.055	0.027	-2.06	0.040**	-0.107	-0.002
Other occupation	-1.470	0.485	-3.03	0.002***	-2.419	-0.520
Area cultivated	0.643	0.137	4.70	0.000***	0.375	0.911
Con	-1.242	2.287	-0.54	0.587	-5.725	3.241

Note: Number of observations = 280, LR chi²(8) = 180.00, $P > \text{chi}^2 = 0.000$, log likelihood = −76.591 and pseudo-$R^2 = 0.540$. ***Significant at 1% level; ** significant at 5% level; * significant at 10% level.

Gender of the household head, age of household head, educational status, marital status, household labor use, farming experience (years), involvement of the household in other occupations, and area cultivated were the explanatory variables used in the logistic and odds ratio analysis. Of the explanatory variables fitted to explain factors affecting smallholders' decision to use a tractor, educational status, the use of household members, farming experience, involvement in other occupation as sources of income, and area cultivated all had a significant association with the decision to use a tractor.

The logistic regression indicated that if the smallholders' educational status increases, smallholder farmers will likely increase their decision to use a tractor. This result could be attributed to the fact that as the smallholders become more enlightened through education, they may have more knowledge about the benefits of tractor use, which may influence their decision to use a tractor. Smallholder farmers who depend on household members as sources of labor are less likely to use tractor services. In other words, while the use of household labor is significant to the farmer due to lack of capital, the research outcome shows that the dependency of the smallholder farming household head on household labor has the probability of impeding their decision to use a tractor. The logistic result revealed that the involvement of the smallholder farming household head in another occupation as a source of income tends to prevent them from using tractor services. It has the likelihood of diverting the farmer's attention from full engagement in agricultural activities, which could stimulate his/her decision not to use a tractor. The area cultivated has a positive association with the decision of smallholder farmers to use tractor services. The result for areas cultivated on smallholders' decision to use a tractor could be stimulated because the higher the area cultivated, the greater the likelihood of the farmer using labor-enhancing technology such as the tractor.

The odds ratio explains the constant effect of the predictor on the likelihood that one outcome will occur. It interprets the group that has better odds of success. The odds ratio result is presented in Table 9.

Table-9. Odds ratio likelihood estimate of logit model for factors affecting the use of tractor services.

Variable	Odds ratio	Std. error	*Z*	*P*>|*z*|	95% Conf.	Interval
Gender of household head	1.765	0.789	1.27	0.203	-0.307	1.444
Age of household head	1.000	0.038	0.01	0.995	-0.074	0.074
Educational status	1.292	0.078	4.27	0.000***	0.139	0.374
Marital status	1.906	1.712	0.72	0.473	-1.115	2.406
Household labor use	0.090	0.127	-1.71	0.088*	-5.163	0.354
Farming experience (years)	0.947	0.025	-2.06	0.040**	-0.107	-0.002
Other occupation	0.230	0.111	-3.03	0.002***	-2.419	-0.520
Area cultivated	1.902	0.260	4.70	0.000***	0.375	0.911
Con	0.289	0.661	-0.54	0.587	-5.725	3.242

Note: Number of observations = 280, LR chi²(8) = 180.00, *P* > chi² = 0.0000, log likelihood = −76.591365 and pseudo-R^2 = 0.5402. ***Significant at 1% level; ** significant at 5% level; * significant at 10% level.

The odds ratio result shown in Table 9 indicates that if education status increases by one level, the smallholder decision to use a tractor will increase by 29%. Among other things, the knowledge gained from education on the importance of tractor use in enhancing labor productivity could be why it influences the smallholders' decision to use a tractor. This outcome contrasts with the research of Kehinde (2011), which stated that education reduces determination to use a tractor. Enhanced education could also enable the smallholder to take advantage of mechanization opportunitities that come his/her way. The farmer as an adult might not leave the farming profession for education; he/she can enrol in adult education alongside their farming activities. Alternatively, in collaboration with extension officers and education departments, the government could arrange a special weekend or monthly education program covering various aspects of education, including agricultural education for the farmer. This will enhance smallholders' farming abilities and provide employment opportunities for those engaged in training farmers. As indicated by the odds ratio result in Table 9, the influence of household labor on smallholders' tractor use decisions could be for several reasons. The use of household labor prevents tractor use because the household head may not be willing to spend more money to hire a tractor since she/he already has household labor as a substitute for mechanical labor (tractor use). Again, the odds ratio result revealed that as the smallholder household head increases his/her dependency on household labor by an additional household member, the chances that they will use a tractor will decrease by 090 units.

Smallholders' farming experience, as measured by years of farming, negatively determines their decision to use a tractor. This could be a result of years of the subsistent nature of smallholder farming, demonstrating that the longer the smallholder farmer remains at the subsistence level of farming, the less he/she is likely to use improved technology such as the tractor due to long years of non-transformation.

The odds ratio result also revealed that smallholders' involvement in other occupations reduces their determination to use a tractor by 23%. This could better explain why some of the households involved in another occupation do not actively participate in farming. Smallholders' involvement in another occupation could distract significantly from their farming activities and could make them have less inclined to use the technology that might have transformed their farm.

The odds of using a tractor by smallholders increase as the area cultivated increases. Table 9 reveals that a 1-ha increase in area cultivated increases the odds of using a tractor by 90%. This result shows the significance of adequate land availability in smallholder mechanization (tractor use), and is similar to the findings of Kehinde (2011). The

result of the role of land on smallholders' tractor use decision points to the need to address factors such as the land tenure system that impedes land availability to smallholders. In other words, not tackling the smallholder land challenge is a systematic way of perpetually preventing them from adopting mechanization.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

This study investigated tractor use and its contributions to smallholder farming. It also investigated the factors influencing smallholder farmers' decision to use a tractor in Delta and Benue States, Nigeria, using a logistic model and odds ratio. The level of tractor use among these smallholders is low, at only 28%, and this is irrespective of the role of tractor use in the enhancement of smallholder's income. The incomes of smallholders who used a tractor are far higher than for non-tractor users. Tractor users also cultivate a larger farm area than their non-tractor-using counterparts. The role of tractor use in smallholder income and area cultivated transformation is an indication that the use of tractors is vital to food production and the agribusiness management supply chain. Marital status and the gender of the household head do not significantly determine the use of a tractor by smallholder farmers. Farming experience, dependency on household labor, the involvement of the smallholder in another occupation as a source of income generation, and the area cultivated all influenced the use of tractor services by smallholder farmers. A more holistic approach is needed to persuade smallholders to abandon the use of crude implements. Recommendations were made based on the finding of the work.

4.2. Recommendations

Since most smallholder farmers using a tractor were either young or in early adulthood, efforts should be made to make more tractors available because this might encourage more younger people to become involved in agriculture. An attempt should be made to get more educated people into agriculture while encouraging those who are already involved to get more education as they carry out their farming activities. Farmers should not be dependent on the sole use of household labor. The smallholder farmer who wants growth in farming activities, including use of a tractor, should not be involved in another occupation as a source of income. Rather than engaging in another occupation as a source of income, farmers should take out a loan while concentrating on their farming activities should additional money needs arise. This means that the bureaucracies and barriers preventing the smallholder's access to loans should be seriously dealt with. More land should be made available for farmers and the challenge associated with land availability for the smallholder, including that of the land tenure system, should be addressed. In this regard, smallholders' farming reserves can be created within a community just as forest and game reserves are. This will nurture cooperation among farmers, sharing of knowledge, and efficient use of mechanization among smallholders. Efforts should be intensified to persuade smallholder farmers to use tractors rather than remaining dependent on hand implements and household labor. In this regard, a two-wheeled tractor that is affordable and supports climate-resilient agriculture should be made available to smallholders. Policy reform and new strategies should be promoted to ensure the use of the tractor by smallholder farmers.

5. IMPLICATIONS OF THE STUDY FINDINGS FOR AGRIBUSINESS

This research contributes to the awareness of tractor use practices, and to the benefits and information on how some smallholders could gradually transform their agribusiness through tractor use.

Farmers who used tractors also cultivated larger areas, implying that tractor use influences the expansion of farm size. Extension services can include this relationship in their messages to encourage farmers to adopt tractor use. There is a high probability that these will positively influence food production and income among smallholders.

An increase in farm size will likely result in increased farm output, which will positively influence prices, incomes, and farm employment

Increased use of tractors by farmers, leading to larger farm sizes, is likely to increase the establishment of businesses servicing the farm sector's tractorization programme.

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