



Received 14.03.2018
Reviewed 12.05.2018
Accepted 12.04.2019

A – study design
B – data collection
C – statistical analysis
D – data interpretation
E – manuscript preparation
F – literature search

Geospatial and socioeconomic traits encumbering tractorisation of farmland among crop farmers in Ogun State, Nigeria

Okanlade A. LAWAL-ADEBOWALE^{ABCDEF}✉

orcid.org/0000-0003-3418-4250; Federal University of Agriculture, College of Agricultural Management and Rural Development, Department of Agricultural Extension and Rural Development, Alabata Road, 110001, Abeokuta, Ogun State, Nigeria; e-mail: lawal-adebowaleoa@funaab.edu.ng

For citation: Lawal-Adebowale O.A. 2019. Geospatial and socioeconomic traits encumbering tractorisation of farm land among crop farmers in Ogun State, Nigeria. *Journal of Water and Land Development*. No. 43 (X–XII) p. 96–105. DOI: 10.2478/jwld-2019-0067.

Abstract

The objective of this study was to ascertain the socioeconomic and geospatial traits responsible for little or no usage of tractors for land clearing and cultivation by rural farmers in Ogun State, Nigeria. Data were obtained on the study objectives with use of interview guide, in-depth discussion and field observation a randomly selected 247 arable crop farmers. The obtained data were subjected to frequency count and binominal analysis of variance. Results showed factors such as farmers' inability to afford tractor acquisition and/or hire tractors services ($prop = 1.00, p < 0.05$) as the major economic traits encumbering tractor usage for land preparation. The social traits included inadequate available of tractors to serve the farmers ($prop = 0.76, p < 0.05$), and farmers' apprehension of possible destruction of soil structure and/or farm land ($prop = 0.64, p < 0.05$) as a result of tractor usage for land preparation. The geospatial traits were stump/tree distribution ($prop = 0.97, p < 0.05$) and land fragmentation ($prop = 0.92, p < 0.05$). It was thus concluded that both socioeconomic and farm geospatial traits interactively encumbered farm tractorisation in the study area. It was recommended that farmers should be supported technically and financially by stakeholders in agro-development so as to enable them to afford tractor usage for land cultivation.

Key words: farm tractorisation, geospatial traits, socioeconomic traits, rural farmland, arable crop farmers, Ogun State

INTRODUCTION

Agriculture, though, constitutes the dominant economic activities of rural dwellers in Nigeria, the production system is largely characterised by cultivation of small size farmlands, usually in fragments, with the use of crude implement such as hoe and cutlass for land clearing and cultivation. According to HANSON [undated], majority of the farmers in Africa cultivate less than 5 ha of land and plant less than 20% of the arable lands, in addition to lesser use of fertilizer and poor quality seeds, poor marketing system and little or no production support services to the farmers [FAO 2006; FMARD 2011]. The resultant effect of this was low productivity and food insecurity in the sub-Saharan Africa countries [CHISANGO, OBI 2010; WÓJCIK-LEŃ, SOBOLEWSKA-MIKULSKA 2017]. In addition, utilisa-

tion of crude implements in farming, not only portrays agriculture as a tedious and drudgery occupation, but makes it discouraging to potential entrants in farming profession. To overcome the attendant problems associated with the farming practices among the Nigerian rural farmers and have their production capacity strengthened, integration of farm machineries in the country's agricultural system becomes essential.

Although, development of agriculture depends on a number of interactive factors [LAWAL-ADEBOWALE 2012; MUCHARA 2010], integration of farm machines in agricultural practice is crucial to ensuring efficient farm enterprise production. Farm mechanisation, as largely practised in the advanced countries, accounted not only for increased farm productivity and food sufficiency but puts agricultural occupation in the hands of few famers [Daily

Monitor 2013]. In essence, deployment of farm machines in crop-based farming allow for large hectares of land to be cultivated by a single farmer in a relatively short period of time; and enhance efficient agro-processing and other post-harvest handlings. Based on this, farm machine integration in agriculture, as indicated by MREMA *et al.* [2014], have revolutionised farming in terms of reducing or eliminating drudgery and improving the farmers' productivity.

Realisation of the potentials of farm machines for engendering improved productivity of the farmers and effecting agricultural development informs the inclusion of farm mechanisation in the agricultural transformation agenda of the Federal Government of Nigeria. Alongside this were State Governments' roles in the nations' agricultural development through institutionalisation of agro-service units with the mandate of providing quality agro-inputs, such as fertilizer, improved seeds, agro-chemicals; and tractor hiring services at affordable rates to the rural farmers. Based on this, rural farmers in the country have the possibility of contracting the services of the State Government-based agro service units for tractor hiring and usage in land clearing and cultivation.

Despite the Nigerian Government's, and to some extent private agro-services units, provision of tractor hiring service for farm cultivation by the rural farmers, field observation shows that most of the farmers hardly make use of tractors in the course of land preparation but rather rely on the use of crude implements for their farming activities. Similar practice is the order of the day among Ugandan farmers [Daily Monitor 2013]. With this observation, it implies that none or less utilisation of tractors in crop-based farming is not peculiar to the Nigerian farmers but to farmers in other sub-Saharan African countries. This observation thus necessitates the need to ascertain the factors hindering the farmers' usage of tractors for land preparation in selected rural communities of Ogun State. To achieve this, the following objectives served as guides for the study.

- describe the socioeconomic characteristics of the crop-based farmers in Ogun State,
- identify the mode of farm cultivation by the farmers,
- examine the commonly cultivated crops by the farmers,
- ascertain the characteristic features of the farmers' farms,
- identify the factors hindering the farmers' use of tractors in land cultivation.

Hypothesis: There is no variance in the factors encumbering the farmers' none or less use of tractor in land cultivation.

METHODS

The study was conducted in Ogun State, Nigeria. The state, with Abeokuta as its capital, has a land area of about 16,432 km² [Ogun State Government 2017] and is located on latitude 6°30' and 8°10' N of the equator and longitude 2°15' and 4°15' E [BARTHOLOMEW 1990]. The State is structured into 20 Local Government Areas for political administration, and structured into four agricultural zones for administration of agricultural extension service deliv-

ery by the State Agricultural Development Programme (ADP). The agroclimate of the state is characterised by bimodal rainfall system with mean rainfall of 1349.2 mm, mean temperature of 28°C and humidity of about 78%. The first rainy period runs between April and July and thereafter between September and October. The month of August, which is often referred to as 'August break', is characterised by high variation of dry day spell arising from temporary cessation of rainfall. The dry season thus runs between November and March [APANTAKU *et al.* 2004; LAWAL-ADEBOWALE 2002]. Economic activity of the state is largely agriculture with production of arable crops such as maize, cassava, rice, yam, cocoyam, banana, pineapple, pepper and vegetables. Other tree crops produced in the state include oil palm, cocoa, kolanut, rubber and citrus. Alongside crop cultivation is livestock production with poultry (chicken) production, particularly at commercial level, as the most common livestock enterprise. Other common livestock raised in the state are sheep, goats, cattle and pigs. Aside farm-based occupation in the state is non-farm enterprise production such as fabrics in form of tie and dye, merchandising, banking and financial services, educational services and civil service.

The surveyed study population were arable crop farmers in Ogun State with a sampling frame of 1028 of them as listed under the services of the State ADP – Ogun State Agricultural Development Programme (OGADep). Out of the 1028 arable crop farmers, a total of 247 of them were randomly selected based on BARTLETT *et al.* [2001] and WATSON [2001] minimum sample size determination model of ±0.3 margin error, estimated population variance of 10% and 1.96 (95%) confidence level. Data on the study objectives were collected by means of interview guide, field observation and in-depth discussion with the farmers. The data gathering instrument was however subjected to both face and content validity in order to ascertain its validity, and subjected to test re-test-method with a view to ascertaining its reliability. While the face validity was used to ensure that the study variables were actually measured by the instrument, the content validity was used to ensure that the instrument contains a wide range of relevant items to become comprehensive for in-depth coverage of the study construct [BABBIE 2005; BAILEY 1987; DOOLEY 1984].

RESULTS AND DISCUSSION

FARMERS' PERSONAL CHARACTERISTICS

Analysis of personal characteristics of the surveyed farmers, as indicted in Table 1, shows that male farmers (76.5%) dominate the crop-based farming activities in the study area. The dominance by male farmers could however be attributed to their claim of ownership and decision making on cultivation and management of the farms. The male farmers were however largely supported by their female counterparts on production activities. The modal age (39.4%) of the farmers were between 41 and 50 years. This is similar to PROKOPOWICZ and JANKOWSKA-HUFLEJT [2011] observation among the organic meadow farmers in

Table 1. Personal characteristics of the respondents ($n = 247$)

Variable	Frequency	Percentage
Sex		
male	189	76.5
female	58	23.5
Age		
≤30	39	15.8
31–40	21	8.5
41–50	97	39.3
≥51	90	36.4
Marital status		
married	212	85.8
single	35	14.2
Household size		
≤5	63	25.5
5–7	91	36.8
8–10	77	31.2
≥11	16	6.5
Educational level		
no formal education	33	13.4
primary school	101	40.9
secondary school	86	34.8
tertiary education	27	10.9
Attended agro-trainings		
crop production techniques	83	33.6
land/soil management	51	20.6
post-harvest handling	15	6.1
farm tractorisation	23	9.3
no training attended	75	30.4

Source: own study.

the mountain and lowland voivodships farms where the farmers mean age were put at 45.9 and 45.7 years respectively. This age range however suggests that most of the surveyed farmers were not only in their active years, but as well had the vigour for crop cultivation and management. As much as 85.5% farmers were married with 68.0% of them keeping between 5 and 10 persons as household size. The relatively high number of persons kept as household members could be attributed to the farmers' need of supporting hands in farm cultivation and management.

Although, advance education is germane to innovative agricultural production and management, the result shows that most of the farmers in the study area were less educated, with primary school education as their highest level of education. This level of education may have serious implication for the farmers' farm enterprise production largely because they such level of could not have provided the farmers innovative farming knowledge or practices. Consequently, the rural farmers may sustain their rudimentary mode farming. As way to have the farmers' production capacity enhanced, as much 69.6% of them had attended one form of agro-production training or the other. Such training, which is mostly organized by OGADEP, and to some extent, by agricultural extension arms of schools of agriculture in the state, largely ranged between safe land cultivation and management (20.6%) and crop production techniques (33.6). This observation could be attributed to the farmers' consideration of farmland sustainability and improved farm productivity as paramount to their survival and socioeconomic wellbeing. Their less involvement farm tractorisation (9.3%) and postharvest handling (6.1%) was attributed to less provision of such training by relevant agro-services providers.

PRODUCTION CHARACTERISTICS OF THE FARMERS

Production characteristics of the farmers, as indicated in Table 2, show cassava and maize as the dominant crop production among the farmers with all of them cultivating both crops. Alongside maize and cassava was yam production by 80.6% of the farmers. Cultivation of these crops was based on established markets for them all in Ogun State and the country at large owing to the fact that these crops constitutes major staple food in Nigeria. In addition to the staple foods were vegetables and pepper production by 90.3% and 69.2% of the farmers respectively. Vegetables and pepper constitute major complements of staple food consumption in Nigeria and as such, equally had established market for consumption. Production experience of the farmers showed that more than half (55.9%) and some (33.2%) of them had been into crop related farming occupation for 11 to 15 years and more than 16 years, respectively.

Table 2. Production characteristics of the respondents ($n = 247$)

Variable	Frequency	Percentage
Commonly cultivated crops		
maize	247	100
cassava	247	100
yam	199	80.6
cocoyam	72	29.1
vegetables	223	90.3
pepper	171	69.2
Farming experience		
≤5	0	0
6–10	27	10.9
11–15	138	55.9
≥16	82	33.2
Farm size (ha)		
≤1.0	23	9.3
1.0–1.50	107	43.3
1.51–1.99	34	13.8
2.0–2.50	15	6.1
≥2.51	6	2.5
Source of farmland		
family land	51	20.6
inherited	88	35.6
hired	57	23.1
purchased	42	17.0
held in trust	9	3.6
Farmland status		
contiguous	19	7.7
fragment of:		
– two	47	19.0
– three	22	8.9
– four	96	38.9
– five	63	25.5
Annual income per season		
≤N100,000 (US\$277.78) ¹⁾	22	8.9
N100,001–150,000	61	24.7
N150,001–200,000	74	30.0
N200,001–250,000	58	23.5
≥N250,001	32	12.9

¹⁾ N360.00 to US\$1.00.

Source: own study.

Table 2 also shows that most of the farmers (66%) had or cultivated farm size of less than 2 ha, with 25.5% of them cultivating between 1.0 and 1.5 ha, and 31.2% cultivating between 1.51 and 1.99 ha. About 18.6% of the farmers cultivated between 2.0 and 2.5 ha and 15.4% of

them had farm size of more than 2.5 ha. The modal occurrence of farm cultivation of less than 2.0 ha implies that farm enterprise production is largely on subsistence scale in the study area. Most of the farmers' (79.4%) farmlands were however in fragments of 2 to 5 units per farmer. Only a few (7.7%) of the farmers had their farmland in a contiguous unit with most (92.3%) of them having their farmlands in fragments of 2 or more locations. With fragmentation of the farm lands, it suggests that land remains a scarce production input among the farmers and as such had to source for the natural asset in various location for farm cultivation.

The cultivated farmlands for crop production were gotten from various sources by farmers in the study area. A modal proportion (35.6%) of the farmers had their land by inheritance and a few (20.6%) of them made use of the family land. This observation could have been underscored by the tradition of bequeathing land to the next generations by the aging farmers for continual farming occupation. This goes in line with MCCAULEY [2003] indications that land distribution across Africa is lineage inheritance. In a situation where the family or inherited land is not sufficient for some farmers, such ones sourced for additional farmland either by purchase (17.0%) or rentage (23.1%). In line with the observation of multiples sources of land for farming activities in this study is LEN [2017] reportage of a similar observation among farmers in Drzewica, Poland, where parcels of farmland belongs to sources such as individuals, private ownership, farm owners from towns and cities. With these sources, it became possible for a larger proportion of local non-residents to access plots of land for farming. The observed multiple sources of farmland to farmers in this study not only created the opportunity for farmers to have access to additional farmland, but also accounted for farming in fragmentation in the study area.

Cultivated farm size by a modal proportion of the farmers (43.3%) ranged between 1.0 and 1.5 ha with some (13.8%) of them cultivating between 1.51 and 1.99 ha. This observation goes in line TAKESHIMA *et al.* [2013] submission that land cultivation by farmers in southern Nigeria ranged between 1.13 and 1.57 ha. In the same vein, TAKESHIMA and SALAU [2010] opine that land cultivation by most farmers in the developing countries is usually on the average of 2 ha. As observed among 92.3% of the farmers, the cultivated farm lands in the study area were in fragments of 2 to 5 locations; four locations was the common fragments among 38.9% of the farmers. According to BRUCE [1993], land sharing among lineage members results in fragmentation. The observed land fragmentation among the farmers was thus attributed to the ever increasing competing demands for farmlands by intending users. Much more, the size of family land is ever decreasing due to increased generation of descendants with equal right to a fixed land size. Consequently most of the farmers sought land elsewhere for cultivation. The arising land fragmentation from this situation thus made the use of tractors by such farmers extremely difficult.

Arising from the sales of produced crops by the farmers, Table 2 shows that 30.0% of them made between ₦150,001 and ₦200,000 naira per farming season; 23.5%

had an income of ₦200,000 to ₦250,000 and 12.9% realised above ₦250,000. With a mean annual income of ₦109,818 made from the marketed crops, it implies that crop production by the farmers is at subsistence level.

MODE OF LAND CULTIVATION BY FARMERS

Land cultivation, which constitutes an essential component of farming activities, marks the commencement of cropping activities and is carried out, either manually or mechanically, as may be dictated by the farmers' economic status and the geospatial features of their farms. In view of this, Table 3 shows that 68.0% of the farmers mainly cultivated their farmlands manually, using hoes and cutlasses for land clearing, heaping and turning of the soils. This is in line with BISHOP-SAMBROOK [2003], TAKESHIMA and SALAU [2010] indication that about 86% of the cultivated farmlands in Nigeria is manually done. The farmers' dependent on manual land cultivation was attributed to their inability to bear the high cost of hiring tractors and inhibitive features of the farmland, such as land fragmentation and smallness of the farm sizes [TAKESHIMA, SALAU 2010; Daily Monitor 2013]. A few of them (5.3%) largely used tractors for land cultivation, and as much as 26.7% of the farmers used both manual and tractors for land cultivation. This observation goes in line with MANUWA [1996] submission that tractor is under-utilised in the Nigerian agricultural system and this could be due to high cost of tractor acquisition and/or tractor hiring services. The few farmers who mainly used tractors for land cultivation were observed to be resourceful to bear the financial cost of tractor hiring. The hired tractors were largely used for land clearing, ploughing, harrowing and turning of the soil for ridge making. The use of tractors for land cultivation, as indicated by KHAN [undated], enhances timeliness farming activities and made it possible of increased land unit area to be cultivated within a relatively short period of time. In the same vein, the set of farmers who combined the use of tractor and manual cultivation were somewhat resourceful

Table 3. Mode of land cultivation by farmers ($n = 247$)

Variable	Frequency	Percentage
Mode of land cultivation		
mainly manual cultivation	168	68.0
mainly tractorisation	13	5.3
both tractor and manual	66	26.7
Farm labour use		
mainly self labour	23	9.3
mainly hired labour	63	25.5
mainly family labour	77	31.2
mainly family labour	46	18.6
combined family and hired labour	38	15.4
Source of tractor usage¹⁾		
association of farmers	28	11.3
private hiring services	17	7.0
government agency	59	23.9
Cost of tractor hiring		
≤₦20,000	8	3.2
₦21,000–30,000	17	6.9
₦31,000–40,000	28	11.3
₦41,000–50,000	13	5.3
≥₦51,000	13	5.3

¹⁾ Multiple responses by the farmers using tractors (79 of them).

Source: own study.

to hire tractor usually for clearing and turning the farmland but used manual cultivation method for heaping the soil or making ridges.

Given the tedious nature of land cultivation and farm production in general, Table 3 shows that only a few of the surveyed farmers (9.3%) embarked on land cultivation by self or personally. As much as 90.7% of the farmers engaged other hands, either in form of family or hired labour, for land cultivation. This is similar to PROKOPOWICZ and JANKOWSKA-HUFLEJT [2011] submission that the needs for manpower for control of weeds and protection of plants calls for hired labour in farms. In addition, as much 25.5% of the farmers, who were probably financially resourceful, mainly engaged hired farm labours for land cultivation; some (31.2%) of them mainly use members of their households as family labour and up to 15.4% of the farmers combined the services of hired and family labour for accomplishment of their farm production tasks. The modal occurrence of the use of family labour could have stemmed from the tact of saving labour cost that would have resulted in increased production cost. In view of this, it suggests that human power remains a dominant tool of land preparation in the study area, and as indicated by DAUDA *et al.* [2010], in Nigeria at large. This goes in line with FAO, UNIDO [2008], TAKESHIMA and SALAU [2010] submission that, out of all the farm power use by farmers in the developing countries, human accounts for two-third of the power inputs, with animals and machine respectively accounting for a quarter and one-tenth of the power inputs.

An investigation of where tractors were sourced by the farmers shows that government agency constitutes the place where 23.9% of the farmers sourced tractors for use. Further probe on why the farmers depend on government agro-services agency for tractor hiring revealed that it was cheaper and more reliable to get whenever it is needed for farming activities. Alternative to government agency as source of tractor hiring were the private agro-services providers where as 11.3% of the farmers sourced the farm-power machine. Patronage of the private agro-services providers, even though a little bit expensive than what it cost to hire from government agency, becomes the next point of call where that of the government agency is not readily accessible. Against the practice of individual hiring of tractors for land cultivation among the farmers were pooled efforts in form of association by the farmers to get tractors from either the government agency or private agro-service providers for collective use on their farms. With this collective action, the farmers thus cooperatively share the cost of hiring and operations among themselves thereby reducing the borne cost by each of them.

Examination of cost implication of tractor hiring among the farmers who had used the farm-powered machine for land cultivation shows that they spent an average of ₦36,759 for land preparation. In view of this, a modal number of the farmers (11.3%) spent between ₦31,000 and ₦40,000 to meet the cost of the tractor, fueling and caring of the machine operators. Interactive discussion with the farmers on the breakdown of such expenses showed that tractor hiring officially cost ₦4,000 per hectare, provision of 10 litres of fuel per hectare, at ₦150 per liter, and an

payment of unofficial ₦2,000 as tip for the tractor operator. The high cost of fueling the tractor cannot unconnected with EDWARDS [2017] indications that large machinery consumes more fuel per hour. The unofficial paid amount of ₦2000 as tips for the tractor operators in the study area is corroborated by ALABADAN and YUSUF [2013] observation of the same practice among farmers in Abuja (the Federal Capital Territory – FCT), whereby the farmers had to tip the tractor operators with certain amount ranging between ₦1,500 and ₦2,500 as way to ensure that the task of land preparation is well done and done promptly. This submission suggests that demand for tips was a usual practice among tractor operators in the country.

FARMERS' SOCIOECONOMIC TRAITS ENCUMBERING FARM TRACTORISATION

In Table 4 are socioeconomic traits encumbering farm tractorisation among the rural farmers in the study area. Prominent among the factors are inability of all the farmers to personally acquire tractors; and a high cost of hiring tractors for farm cultivation. This observed situation among the farmers suggests that rural farmers lacked the financial capacity to either own or hire a tractor for farm cultivation. According to EDWARDS [2015] a 180-PTO (power takeoff) horsepower tractor cost between US\$180,000 and US\$200,000. On a similar note, online price list of tractors by CostOwl [2018] puts a bare-bone compact tractor at US\$10,000 or less; mid-size tractors of 30 to 70 horsepower at US\$25,000 to \$75,000; larger tractors of about 100 horsepower and powerful tractors of about 100–150 horsepower at US\$75,000 to \$150,000. Given the exchange rate of ₦360 to US\$1, it implies that the varying tractors would cost between ₦3,600,000 and ₦54,000,000 in Nigeria, which of course is beyond the reach of the rural farmers. With the high cost of tractors, the available option for tractor usage by the rural farmers is tractor hiring from the service providers. However, requirement for hiring of tractors, which include payment of service charge for the tractors, fueling of the tractors and care of the tractor operators, makes the hiring relatively expensive for most of the farmers. Although, most of the farmers found the service of charge of tractor hiring, put at ₦4,000 per hectare, relatively affordable, as much as 85.8% and 53.4% of the farmers respectively regarded the

Table 4. Farmers' socioeconomic traits encumbering farm tractorisation ($n = 247$)

Variable	Frequency ¹⁾	Percentage
None availability of tractor hiring services	110	44.5
Causation of land degradation	159	64.4
Associated risk or hazard of usage	116	47.0
None availability competent tractor operators	129	52.2
Inability to personally afford tractor acquisition	247	100.0
High cost of tractor hiring	247	100.0
Extra cost of fueling the tractor	212	85.8
Cost of caring for tractor operators	132	53.4
Inadequate availability of tractor to serve the farmers	188	76.1

¹⁾ Multiple responses.

Source: own study.

extra cost of fuelling the tractors and caring for the tractor operators as underlying basis for expensiveness of tractor hiring in the study area. In view of this, SINGH [2009] adduced high cost of tractor usage as a reason for none or less usage of tractor in crop cultivation by farmers in the sub-Saharan countries and given the poor resource level of the farmers. TAKESHIMA and SALAU [2010] submitted that most of the Nigerian smallholder farmers were too poor to employ the services of tractor or any other modern implements for land cultivation and other farming activities.

On another note, none availability of tractors (75.3%) in proximity to the farmers or within the farming communities accounted as encumbrance; and where available, it was inadequate to serve all the farmers (76.1%). This submission cannot be unconnected with the cost of tractor acquisition which is somehow expensive for either the farmers or most individuals to bear. With government as the major provider of tractor hiring services, available tractors for use of the farmers were extremely inadequate to serve them all. According to ESSIET [2015], an estimated 45,000 units of available tractors in Nigeria translate to 5.7 tractors per 100 km² or 0.1 horsepower per hectare [VANGUARD 2013] in the country. In addition to this is Vanguard's submission that average of three tractors is available to serve several hundreds of farmers in Nigeria.

Also encumbering farm tractorisation among the surveyed farmers were the farmers' perceived danger of having their farm land degraded (64.4%) and the possible risk of injury (47.0%) arising from the use of tractors for land cultivation. Possible degradation of farmland as a result of tractorisation could have been brought about by farmers' poor understanding of the nature of the farm soils and lack of technical know-how on the part of the tractor operators [USMAN, UMAR 2003]. According to NEJABAT *et al.* [2017], weakened soil is readily and easily eroded and degraded especially by water erosion. In line with this is FAO [1998] and SINGH *et al.* [2015] indication that tractors cause greater soil erosion, bring about soil compaction and in turn affects the soil physical properties, roots, plant growth and consequently crop yield.

The attendant perceived risk or hazard of tractor usage, as emphasised by WHITWORTH [2014], was borne out of the fact that tremendous power is involved in tractor operation thereby making its operation in the farms hazardous to both the operator and bystanders. Poor handling of tractor, as indicated by SPRING, injures the body parts, which sometimes may be fatal.

GEOSPATIAL TRAITS ENCUMBERING FARM TRACTORISATION

Tractor usage for land cultivation is though crucial to achieving efficient farm enterprise production and fostering increased productivity, a number of interactive factors, ranging from farm size, cropping pattern, crop intensity, farmers' resource-base, to the characteristic features of the farms [CLARKE 2000; EDWARDS 2017; GHANDI, PATEL 1997; SHARMA, GROVER 1998], determine the success of farm tractorisation. According to Daily Monitor [2013] farm characteristic features such as trees, bushes, anthills and other contouring features constitute the geospatial fea-

tures hindering smooth running of the heavy machine on the farms. In the light of this were observation of geospatial traits (Tab. 5) such as stumps (96.8%) and trees (85.4%) distributions as the major hindrances to tractor usage for land cultivation among the surveyed farmers. Interaction with the farmers shows that such geospatial features require engagement of bulldozers for stumping or falling of trees which of course was found much more expensive than tractor hiring.

Table 5. Geospatial features encumbering farm tractorisation ($n = 247$)

Variable	Frequency ¹⁾	Percentage
Sandy soil	23	9.3
Marshy soil	73	29.6
Stony/rocky farmland	181	61.3
Undulating topography	87	35.2
Tree distributions	211	85.4
Stump distribution	239	96.8
Land fragmentation	228	92.3
Running rivers	23	9.3
Lack of access road to the farm	194	78.5

¹⁾ Multiple responses.

Source: own study.

In addition to the issue of stumps and trees as geospatial traits in the surveyed farms were lack of access road to the farms and land fragmentation as observed among 78.5% and 79.4% of the farmers respectively. This is similar to WÓJCIK-LEŃ and SOBOLEWSKA-MIKULSKA [2017] observation intensive fragmentation of arable lands in rural agricultural practice. According to

RIJK [undated], small and fragmented farms are not suitable for machinery integration, especially the expensive and complex agricultural machinery. In essence, farmers with multiple farms, each of which are usually in small sizes or less than one hectare and located in two or more places find it extremely difficult to engage the services of tractor for land cultivation on the ground that tractor service providers only agree to operate on a minimum of one hectare of a single stretch. And where the farmers had the willingness to make use of tractor for land cultivation, they find it difficult to have the tractors moved into their farms due to remoteness of the farms and lack of access road to the farms.

Similar geospatial features encumbering farm tractorisation among the farmers are the naturally existing rocks (35.2%) and pebbles of stones (24.7%) in the farms. Existence of rocks and mass of stones in the surveyed farms hinder tractor operations, not just in terms of making it difficult to have the soils turned, but equally heighten the chances of faster of rate wear and tear of the coupled blades to the tractor. In addition, the revolving blades, while in operation on stony farms posed the danger of forcefully hitting stones against persons or farm workers thereby causing injuries and endangerment of lives. This observation goes in line with FAO [2006], cited by TAKESHIMA and SALAU [2010], indications that unsuitable shape of fields and insufficient distances between fields are serious geospatial features encumbering farm mechanization in most developing countries. Other seemingly less geospatial features, but of importance in farm tractorisation

encumbrance were sandiness of the farm soil and running rivers across the farms. This is because sandy soil too fragile for tillage and cultivation by the use of tractors. The running rivers on the other hand hinders smooth operation of tractors and implements.

TEST OF STUDY HYPOTHESIS

BINOMIAL ANALYSIS OF THE SOCIOECONOMIC TRAITS ENCUMBERING FARM TRACTORISATION AMONG THE FARMERS

Table 6 shows the result of the binomial analysis of variance in the farmers’ socioeconomic traits encumbering tractor integration in land preparation. It was observed that socioeconomic traits such as causation of land degradation, associated risk/hazard of usage, inability to personally afford a tractor, high cost of tractor hiring, extra cost of fueling and inadequate availability of tractor hiring services significantly ($p < 0.05$) hindered the use of tractors among the surveyed rural farmers. In essence, the higher frequency of yes responses to these variables implies that the highlighted socioeconomic traits are common factors hindering the usage of tractor for land preparation in the study area.

Table 6. Binomial analysis of the socioeconomic traits encumbering farm tractorisation among the farmers ($n = 247$)

Socioeconomic variable	Category	Answers number	Observed prop.	Test prop.	Asymp. sig.
None availability of tractor hiring services	yes	110	0.45	0.50	0.098 ^a
	no	137	0.55		
Causation of land degradation	yes	159	0.64	0.50	0.000 ^a
	no	88	0.36		
Associated risk or hazard of usage	yes	116	0.47	0.50	0.373 ^a
	no	131	0.53		
None availability competent tractor operators	yes	118	0.48	0.50	0.525 ^a
	no	129	0.52		
Inability to personally afford tractor acquisition	yes	247	1.00	0.50	0.000 ^a
	no	0			
High cost of tractor hiring	yes	247	1.00	0.50	0.000 ^a
	no	0			
Extra cost of fueling the tractor	yes	212	0.86	0.50	0.000 ^a
	no	35	0.14		
Cost of caring for tractor operators	yes	132	0.53	0.50	0.309 ^a
	no	115	0.47		
Inadequate availability of tractor to serve the farmers	yes	188	0.76	0.50	0.000 ^a
	no	59	0.24		

Explanations: observed prop. = observed proportions, test prop. = test proportion, asymp. sig. = asymptotic significance, ^a based on Z approximation.

Source: own study.

On a more specific note, the farmers’ inability to afford tractor acquisition and hiring of tractor services (both at $observed\ prop = 1.00, p < 0.05$) constitutes major economic traits encumbering tractor usage for land preparation. In the same vein, the farmers found the requirement to fuel the tractor ($observed\ prop = 0.86, p < 0.05$), in addition to the hiring cost as encumbrance to making use of the farm-powered machine for land preparation. Other observed encumbrances to farm tractorisation, termed the social traits, include inadequacy of available tractors or

tractors service providers ($observed\ prop = 0.76, p < 0.05$) to serve the farmers whenever the need for tractor usage arises. In addition to this was the farmers’ apprehension of possible destruction of soil structure and/or farm land ($observed\ prop = 0.64, p < 0.05$) as a result of tractor usage for land preparation.

On the other hand, the observed none significant variation in the farmers’ responses to factors such as none availability of tractor hiring services ($observed\ prop = 0.45, p > 0.05$), associated risk or hazard of tractor usage ($observed\ prop = 0.47, p > 0.05$), none availability of competent tractor operators ($observed\ prop = 0.48, p > 0.05$) and cost of caring for tractor operators ($observed\ prop = 0.53, p > 0.05$) suggests that the farmers had similar position with respect to these factors as encumbrance to farm tractorisation. In other words, the close range between the farmers’ indications of yes and no on the highlighted social traits implies that the factors were indifferently considered as encumbrance to farm tractorisation by the farmers. In essence, the social traits are not generally considered as encumbrance to tractor usage by the farmers.

BINOMIAL ANALYSIS OF THE GEOSPATIAL TRAITS ENCUMBERING FARM TRACTORISATION AMONG THE FARMERS

Analysis of the geospatial traits encumbering farm tractorisation among the farmers, as indicated in Table 7, shows that the farmers’ dichotomous responses on all the considered geospatial features varies significantly at $p < 0.05$ level. The observed high responses of yes on stump distribution ($observed\ prop = 0.965, p < 0.05$), land fragmentation ($observed\ prop = 0.92, p < 0.05$), tree distribution ($observed\ prop = 0.85, p < 0.05$), lack of access road to the farms ($observed\ prop = 0.79, p < 0.05$) and stony/rock farmland ($observed\ prop = 0.73, p < 0.05$) suggests that farm tractor integration for land cultivation is greatly hindered by these geospatial traits. In essence, it is invariably impossible to have tractor operated on farmland with trees and stumps widely distributed, and similarly where the farmland has a large of amount of dispersed stones and/or rocks. These features not only hinder the movement of tractors on the farms but also hasten the wear and tear of the tractor blades. In addition, lack of access roads to the farms made it impossible to move the tractors into farms for use. And where there is access road for movement of tractors, the farms are in fragments thereby encumbering efficient tractor operation.

Higher responses of on geospatial traits, such as sandy nature of the soils ($observed\ prop = 0.91, p > 0.05$), marshy soils ($observed\ prop = 0.73, p > 0.05$) and running rivers ($observed\ prop = 0.91, p > 0.05$) implies that these geospatial features were less encumbrance to tractor operation on the farms. In order words, even though a few of the farmers considered these features as encumbrances to farm tractorisation, majority of them did considered these features as hindrances to the usage of tractor in farm operation. This indication cannot be unconnected with the fact that most of the surveyed farmers’ were devoid of sandy and marshy soils and running rivers across the farms.

Table 7. Binomial analysis of the geospatial traits encumbering farm tractorisation among the farmers ($n = 247$)

Geospatial variable	Category	Answers number	Observed prop.	Test prop.	Asymp. sig.
Sandy soil	yes	23	0.09	0.50	0.000 ^a
	no	224	0.91		
Marshy soil	yes	73	0.30	0.50	0.000 ^a
	no	174	0.70		
Stony and rocky farmland	yes	181	0.73	0.50	0.000 ^a
	no	66	0.27		
Undulating topography	yes	87	0.35	0.50	0.000 ^a
	no	160	0.65		
Tree distributions	yes	211	0.85	0.50	0.000 ^a
	no	36	0.15		
Stump distribution	yes	236	0.96	0.50	0.000 ^a
	no	11	0.04		
Land fragmentation	yes	228	0.92	0.50	0.000 ^a
	no	19	0.08		
Running rivers	yes	23	0.09	0.50	0.000 ^a
	no	224	0.91		
Lack of access road to farm	yes	194	0.79	0.50	0.000 ^a
	no	53	0.21		

Explanations as in Table 6.

Source: own study.

CONCLUSION AND RECOMMENDATIONS

In view of the obtained result from the analysed data on the study objectives, it is suffice to conclude that a number of socioeconomic and geospatial features hindered integration of tractors in land preparation among the surveyed farmers in Ogun State, Nigeria. While factors such as farmers' inability to afford tractor acquisition, cost of hiring tractors and fuelling constitutes the major economic traits hindering farmers' usage of tractor in farm operations, inadequate tractor availability or tractor service providers, and farmers' apprehension of possible destruction of soil structure and/or farm land construed the social traits. The geospatial traits include stump and tree distribution, land fragmentation, lack of access road to the farms and stony/rocky farmlands. In an attempt to overcome these barriers to farm tractorisation by farmers in the study area, the following recommendations are proffered.

1. The poor-resource farmers need to be supported financially, either by means of credit or subsidy intervention by stakeholders in agro-development so as to be able to meet the financial implication of tractor hiring or ownership.
2. The small farmers need to pool resources, either as cooperative or thrift contribution, for joint acquisition of tractor(s) for use.
3. Farmers should ensure that their farmland is in contiguous form for efficient tractor operation
4. Farmers should ensure that their farms are free of stumps and trees, and stony or rocky features for easy tractor movement and operation.
5. Farmers should ensure that access road to their farms is created by clearing off the roads to be free from trees, stumps and rocks for easy transportation of tractor into the farms.

REFERENCES

- ALABDAN B.A, YUSUF Y. 2013. Tractor hiring schemes in Nigeria: A case study of Federal Capital Territory (FCT). *African Journal of Agricultural Research*. Vol. 8. Iss. 47 p. 5962–5966.
- APANTAKU S.O., LAWAL-ADEBOWALE O.A., OMOTAYO A.M. 2004. Rainfall distribution pattern and its implications for seasonal farming calendar of agricultural extension services in Ogun State, Nigeria. *Journal of Agricultural Science, Sciences, Environment and Technology*. Ser. A. Vol. 4. Iss. 1 p. 177–187.
- BABBIE E. 2005. *The basics of social research*. 4th ed. Thomson. Wadsworth. ISBN 0534630367 pp. 519.
- BAILEY K.D. 1987. *Methods of social research*. 3rd ed. New York, N.Y. The Free Press. ISBN 0029014506 pp. 533.
- BARTHOLOMEW J.C. 1990. *The time atlas of the world*. London. Times Books. ISBN 0723003467 pp. 225.
- BARTLETT II J.E., KOTRLIK J.W., HIGGINS CH.C. 2001. Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*. Vol. 19. Iss. 1 p. 43–50.
- BISHOP-SAMBROOK C. 2003. Labour saving technologies and practices for farming and household activities in eastern and southern Africa: Labour constraints and the impact of HIV/AIDS on rural livelihoods in Bondo and Busia districts, western Kenya. Rome. FAO pp. 62.
- BRIAN S., JOSEF K. 2016. Farm power and mechanization for small farms in sub-Saharan Africa smallholders [online]. Food and Agriculture Organisation of the United Nations, Rome. [Access 21.09.2019]. Available at: <http://www.fao.org/3/aa0651e.pdf>
- BRUCE J.W. 1993. Do indigenous tenure systems constrain agricultural development? In: *Land in African agrarian systems*. Eds. T.J. Bassett, D.E. Crumme. Madison, WI. University of Wisconsin Press p. 35–56.
- CHISANGO F.F.T., OBI A. 2010. Efficiency effects Zimbabwe's agricultural mechanization and fast track land reform programme: A stochastic frontier approach. [The joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference]. [19–23.09.2010 Cape Town, South Africa] pp. 24.
- CLARKE L.J. 2000. Strategies for agricultural mechanization development: The roles of the private sector and the government. Rome, Italy. Agricultural Support Systems Division FAO pp. 14.
- CostOwl 2018. How much does a new tractor cost? [online]. [Access 25.05.2018]. Available at: <http://www.costowl.com/b2b/industrial-equipment-new-tractors-cost.html>
- Daily Monitor 2013. Lessons for Ugandan farmers in using mechanised agriculture [online]. [Access 8.08.2016]. Available at: <https://www.monitor.co.ug/Magazines/Farming/Lessons-for-Ugandan-farmers-in-using-mechanised-agriculture/689860-1902044-4uiyas/z/index.html>
- DAUDA S.M., AGIDI G., SHOTUNDE M.A. 2010. Agricultural tractor ownership and off-season utilization in Ogun State, South Western Nigeria. *African Journal of General Agriculture*. Vol. 6. Iss. 3 p. 95–103.
- DOOLEY D. 1984. *Social research methods*. Englewood Cliffs. Prentice-Hall, Inc. ISBN 0138181217 pp. 430.
- EDWARDS W. 2015. Estimating farm machinery costs. *Ag Decision Maker*. File A3–29 [online]. Iowa State University Extension and Outreach pp. 11. [Access 25.05.2018]. Available at: <https://store.extension.iastate.edu/Product/Estimating-Farm-Machinery-Costs-pdf>

- EDWARDS W. 2017. Farm machinery selection. Ag Decision Maker. File A3–28 [online]. Iowa State University Extension and Outreach pp. 9. [Access 25.05.2018]. Available at: <https://store.extension.iastate.edu/Product/Farm-Machinery-Selection-pdf>
- ESSIET D. 2015. Tractors: Beyond farmers' reach [online]. The Nation Online Newspaper. 10 July 2015. [Access 4.07.2016]. Available at: <https://thenationonline.ng.net/tractors-beyond-farmers-reach/>
- FAO 1998. Motorized soil tillage in West Africa [online]. Rome. Food and Agriculture Organization. [Access 5.05.2017]. Available at: <http://www.fao.org/WAICENT/FAOINFO/AGRICULT/ags/AGSE/TILPAP.htm>
- FAO, UNIDO 2008. Agricultural mechanization in Africa ... Time for action. Planning investment for enhanced agricultural productivity [online]. Report of an Expert Group Meeting January 2008, Vienna, Austria. Rome – Vienna. Food and Agriculture Organisation of the United Nations, United Nations Industrial Development Organisation pp. 36 [Access 10.17.2019]. Available at: <http://www.fao.org/3/k2584e/k2584e.pdf>
- FMARD 2011. Agricultural transformation agenda: We will grow Nigeria's agricultural sector. Draft for discussion [online]. Federal Ministry of Agriculture and Rural Development pp. 89. [Access 25.05.2018]. Available at: <http://unaab.edu.ng/wp-content/uploads/2012/10/Agricultural%20Transformation%20Blue%20Print.pdf>
- HANSON S. 2013. Adopting a scalable operating model tailored to African smallholders [online]. [Access 20.05.2019]. Available at: <https://stephaniehanson.com/2013/05/31/adopting-a-scalable-operating-model-tailored-to-african-smallholders/>
- KHAN S.M. undated. Farm machinery and its role in development [online]. Pakistan Engineering Congress. Paper 144. [Access 25.05.2018]. Available at: <https://pecongress.org.pk/images/upload/books/Paper144.pdf>
- LAWAL-ADEBOWALE O.A. 2002. Assessment of rainfall distribution pattern and its implications for planning agricultural extension programme in Ogun State. M. Agric. Thesis. Abeokuta. University of Agriculture pp. 377.
- LAWAL-ADEBOWALE O.A. 2012. Cognition of agroclimate change: An essentiality for amenable farm enterprise production and responsive extension service delivery in Nigeria. Proceedings of Agricultural Extension Society of Nigeria (AESON) p. 260–271.
- LEŃ P. 2017. The size of the external patchwork of fields as an indicator of the need for land consolidation and exchange in the villages of the commune of Drzewica. Journal of Water and Land Development. Vol. 33 (IV–VI) p. 99–106. DOI 10.1515/jwld-2017-0024.
- MANUWA S.I. 1996. Management of agricultural tractors and implements in tropical setting in Nigeria. [17th annual conference of N.S.A.E]. [Akure, Nigeria. Federal University of Technology].
- MCCAULEY J.F. 2003. Plowing ahead: The effects of agricultural mechanization on land tenure in Burkina Faso [online]. Journal of Public and International Affairs. Vol. 14 pp. 27. [Access 10.05.2017]. Available at: <https://jpia.princeton.edu/sites/jpia/files/2003-6.pdf>
- MREMA G., SONI P., ROLLE R.S. 2014. A strategy for sustainable agricultural mechanization: Sustainable mechanization across agri-food chains in Asia and the Pacific Regions [online]. Bangkok. Food and Agriculture Organisation of the United Nations Regional Office for Asia and the Pacific. [Access 13.10.2017]. Available at: <http://www.fao.org/3/a-i4270e.pdf>
- MUCHARA B. 2010. Implications of the fast track land reform programme on markets and market relationships for livestock, cotton and maize in Mwenzi District of Zimbabwe [online]. Working Paper 12. In: Livelihood after land reforms in Zimbabwe. Working Paper Series pp. 35. [Access 20.05.2019]. Available at: https://www.researchgate.net/publication/283017912_Implication_of_Fast_Track_Land_Reform_on_markets_and_market_relationship_for_cattle_cotton_and_maize_in_Mwenezi_District_of_Zimbabwe
- NEJABAT M., NEGAHDARSABER M., GHAHARI G. 2017. Range of soil and climate characteristics appropriate for *Pistacia atlantica* forest development and rehabilitation (case study: Fars province, Iran). Journal of Water and Land Development. No. 32 (I–III) p. 71–78. DOI 10.1515/jwld-2017-0008.
- Ogun State Government 2017. Ogun State in brief. Fact file. [online]. [Access 21.09.2019]. Available at: <http://ogunstate.gov.ng/ogun-state/>
- PROKOPOWICZ J., JANKOWSKA-HUFLEJT H. 2011. Productive and economic factors affecting the development of mountain meadow organic farms in the years 2004–2009. Journal of Water and Land Development. No. 15 p. 115–126.
- RIJK A.G. undated. Agricultural mechanization strategy [online]. [Access 15.05.2018]. Available at: http://www.un-csam.org/publication/CIGR_APCAEM_Website.pdf
- SHARMA M., GROVER D.K. 1998. Determinants of demand for tractor – A comparative study of India and Punjab. Journal of Agricultural Development and Policy. No. 10 p. 11–21.
- SINGH J., SALARIA A., KAUL A. 2015. Impact of soil compaction on physical properties and root growth: A review. International Journal of Food, Agriculture and Veterinary Sciences. Vol. 5 Iss. 1 p. 23–32.
- SINGH S. 2009. Agricultural machinery in India: A study growth, marketing structure, and business strategies. CMA Publication No. 230. Centre for Management in Agriculture/India Institute of Management
- TAKESHIMA H., PRATT A.N., DIAO X. 2013. Mechanization and agricultural technology evolution, agricultural intensification in sub-Saharan Africa: Typology of agricultural mechanization in Nigeria. American Journal of Agricultural Economics, Vol. 95. Iss. 5 p. 1230–1236. DOI 10.1093/ajae/aat045.
- TAKESHIMA H., SALAU S. 2010. Agricultural mechanization and smallholder farmers in Nigeria. Nigeria Strategy Support Program: Policy. No. 26. Abuja. International Food Policy Research Institute pp. 5.
- Vanguard 2013. Private sector key to agric mechanization in Nigeria – stakeholders. [online]. AgroNigeria. 6.08. 2013. [Access 2.08.2016]. Available at: <http://www.vanguardngr.com/category/business>
- WATSON J. 2001. How to determine a sample size: Tipsheet #60 [online]. University Park, PA: Penn State Cooperative Extension. [Access 17.03.2014]. Available at: <http://www.extension.psu.edu/evaluation/pdf/TS60.pdf>
- WHITWORTH T. 2014. Agricultural machinery hazards – Be aware of inherent risks [online] p. 16–18. Spring Edition. [Access 7.05.2017]. Available at: <http://archive.lib.msu.edu/tic/stnew/article/2004spr16.pdf>
- WÓCIK-LEŃ J., SOBOLEWSKA-MIKULSKA K. 2017. Issues related to marginal lands with reference to selected agricultural problematic areas. Journal of Water and Land Development. No. 35 p. 265–273. DOI 10.1515/jwld-2017-0093.

Okanlade A. LAWAL-ADEBOWALE

Geoprzestrzenne i społeczno-ekonomiczne czynniki ograniczające mechanizację rolnictwa w stanie Ogun w Nigerii

STRESZCZENIE

Celem badań było ustalenie społeczno-ekonomicznych i geoprzestrzennych powodów niewielkiego bądź zerowego wykorzystania ciągników w pracach polowych w stanie Ogun w Nigerii. Dane do badań pozyskiwano metodą wywiadu, dyskusji i obserwacji w terenie u losowo wybranych 247 rolników uprawiających ziemię orną. Uzyskane dane poddano obliczeniom częstości i analizie wariancji. Wyniki wskazują na niemożność nabycia ciągnika lub wynajęcia usług z użyciem ciągnika ($prop = 1,00, p < 0,05$) jako główną ekonomiczną przyczynę ograniczającą mechanizację prac polowych. Powody społeczne obejmowały niedostępność ciągników do obsługi rolnictwa ($prop = 0,76, p < 0,05$) oraz obawę rolników przed możliwym zniszczeniem struktury gleby ($prop = 0,64, p < 0,05$) w wyniku stosowania ciągników do pracy w polu. Do przyczyn geoprzestrzennych zaliczono rozmieszczenie pni/drzew ($prop = 0,97, p < 0,05$) i fragmentację pól uprawnych ($prop = 0,92, p < 0,05$). We wnioskach stwierdzono, że czynniki społeczno-ekonomiczne i przestrzenne, działając łącznie, ograniczają mechanizację prac polowych na badanym obszarze. Zaleca się wsparcie techniczne i finansowe rolników przez interesariuszy sektora rolniczego, aby umożliwić im wykorzystanie ciągników w uprawie ziemi.

Słowa kluczowe: *mechanizacja gospodarstw rolnych, rolnicy, stan Ogun, uwarunkowania geoprzestrzenne, uwarunkowania społeczno-ekonomiczne, ziemię uprawne*