Article citation info:
Enemaku L. E., Ogunlade Ch. B. 2025. Study on agricultural mechanization production: a case study of farmers perception within Ibaji farming communities in Kogi State, Nigeria. *Journal of Research and Applications in Agricultural Engineering* 70 (2): 8–14. https://doi.org/10.53502/jraae-214877

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Journal of Research and Applications in Agricultural Engineering

Journal website: https://www.jraae.com/

Study on agricultural mechanization production: a case study of farmers perception within Ibaji farming communities in Kogi State, Nigeria

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Article info
Received: 23 September 2025
Accepted: 28 November 2025
Published: 17 December 2025

Keywords
literacy
productivity
farmers
mechanization
inputs
Ibaji

The relationship between agricultural productivity to applied on-farm field mechanized practices can never be overemphasized. The level of mechanization techniques applied by farmers for various agricultural operations in Ibaji Local Government Area (ILGA) was a determinant of their productivity output. Research analysis findings revealed that both manual and mechanical power sources at varying levels of utilization were used among the farmers. In assessing these impacts on their agricultural productivity, farmers' low literacy level of 18% negatively affected agricultural mechanization practice. This was determined by establishing a relationship between mechanical farm power inputs and the level of human involvement in each operation. Mechanization Index (MI) for the level of mechanical power used was also determined. Other productivity functions were used as indicators. From the results, 55.31 and 23.73% were recorded as the highest and lowest levels of mechanical power inputs, respectively. While 0.9822 and 0.9659 represented the highest and lowest average MI, respectively, it revealed the underutilization of mechanical power, hence, the high reliance on human power for most farming operations, which contributed only to 0.014 ha/kwhr as the largest cultivated farmland by farmers across the studied ten (10) communities in ILGA.

DOI: https://doi.org/10.53502/jraae-214877

1. Introduction

The choice of agricultural machines and its requisite implement operations in agricultural production has been recognized as agricultural mechanization [1, 6]. It doesn't encompass only, the utilization of machines for agricultural operations; rather, it covers all effective factors such as energy utilization, economic management and sustainability of farming systems. Agricultural mechanization has been attributed among one of the epoch of engineering gains within the 20th century. Though technology as introduced was a sophisticated process whereby, it's rating and predictive indices rely on each nation's unique features and advancement level within the agricultural sector. By implications, these predictive indices are not universally acceptable as standard guidelines. Overtime, the Nigeria agricultural food crop production sector has fallen short of providing substantial amount of economic returns into the national economy as Gross Domestic Growth (GDP) [10]. The fall out of the agricultural crop production industry has been often attributed to lack of adequate mechanization operation. [2], revealed the involvement of human, animal and mechanical equipment power in agricultural production relative to technical skills know-how, economic affluence, accessibility per time. [7], confirmed the failure experienced by successive Nigeria government to enact and promote relevant and favourable agricultural policies that imbibes the use of advanced technologies towards the nation agricultural food production sector.

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Correlating the various sources of farm power such as human, animal, and machine ratios with what is obtainable globally, Latin America has 10%, 15%, 75%, while Africa has 57%, 23%, 20% and Nigeria has 65%, 25%, 10% respectively [11–12]. Considering these outcomes, these are clear indications of low application of mechanization techniques in farming operations; where human manual power application accounts for 86%, while animal power records 4% and only 10% of mechanical engine power utilization is achieved. These occurrence of this low level of mechanization practice within the Nigeria agricultural sector has been due to factors such as insufficient number of available farm machinery, inadequate distribution of available numbers among farmers who have critical need of these machines and equipment for productive farm operations [12].

Furthermore, varying weather conditions across farm zones within Nigeria agro-geographical zones have been observed to have significant influence on the choice of mechanization techniques adopted. Where zones with poor precipitation, and high temperature occurrences have experienced difficulty of utilizing machines and equipment that can preserves the soil structure. Consequently, the use of alternative mechanization machine and equipment are implored to suite each zones climatic challenges and demands [7].

Before the year 2009, the Nigerian farmers had difficulty of gaining feat on returns on investments from agricultural food production. Hence, the Nigerian famers has failed to achieve sustainable economic gains from investment on experimental mechanization practices aimed to transform the sector into its commercial phase. Until favourable government policies and rightful environments are created for farmers to embrace commercial production, it will remain difficult to increase food production through mechanization practices by bringing more expands of arable land under cultivation.

The main objective of this study is to assess farmers' productivity as a function of mechanization practices within ten (10) prominent farming communities in Ibaji area of Kogi State, Nigeria. The study farming communities include: Echeno, Ejule, Obale, Odeke, Onyedega, Uje, Unale, Ogwulugwu, Omabo, and Ochuchu, respectively. Crops such as yam, rice vegetable and sweet potatoes are majorly produced by farmers within these communities.

2. Material and methods

Online publications and questionnaires were adopted to collate primary data while, previous research works and relevant academic and print media publications were adopted as secondary data for this study purpose. Inquiries from farming areas covered, land preparation/clearing, tillage operation aspects and type of machinery were utilized. Secondary data was collated from of published academic research articles, relevant government agricultural agencies documented works, seminar, conference and workshop papers. Farm mechanization operations were randomly sampled within the communities [5, 9]. Within existing ten (10) agrarian communities, seven (7) farmers were selected from each community, making a total of seventy (70) respondents for this research study. Data collated were statistically analyzed using descriptive method such as percentages and frequencies to describe respondents' characteristics, extent of mechanized technology adopted and associated limitations. The extent of utilized machines in farm operations was defined by comparing it with that of human power input. Where, overall work done by farm machinery, human power input expressed in percentage as given in Equation 2 below. The index presents outcomes of assessments and of the different stages of mechanization being practiced in relation to the various power sources utilized as shown in equations [3-4]:

$$\mathbf{MI}=\frac{E_M}{E_{H+}E_M}\times\mathbf{100} \quad (1)$$

Where

EM = Power inputby mechanical operation (kWhr/ha)

EH = Power input by human operation (kWhr/ha)

Where E_H was determined on the basis of feedback from farmers within the studied communities.

The effectiveness of both machinery and manual labour input by human were determined based on highest amount of output from any given input per work schedule. These were mathematically expressed by [1] below:

$$A_M=\frac{1}{E_M} \quad (2)$$

$$A_H=\frac{1}{E_H} \quad (3)$$

$$A_T=\frac{1}{E_M}+\frac{1}{E_H} \quad (4)$$

Where:

A_M = Productivity of machines, defined as the work carried out as a function of the machinery employed

A_H = Productivity of labour, defined as the work carried out as a function of labour employed

A_T = Total productivity and all other terms as defined previously.

The level of labour productivity for each farm settlement was determined as an inverse of the work outlay of the explicit factors involved in production function (capital or machine and labour).

3. Results

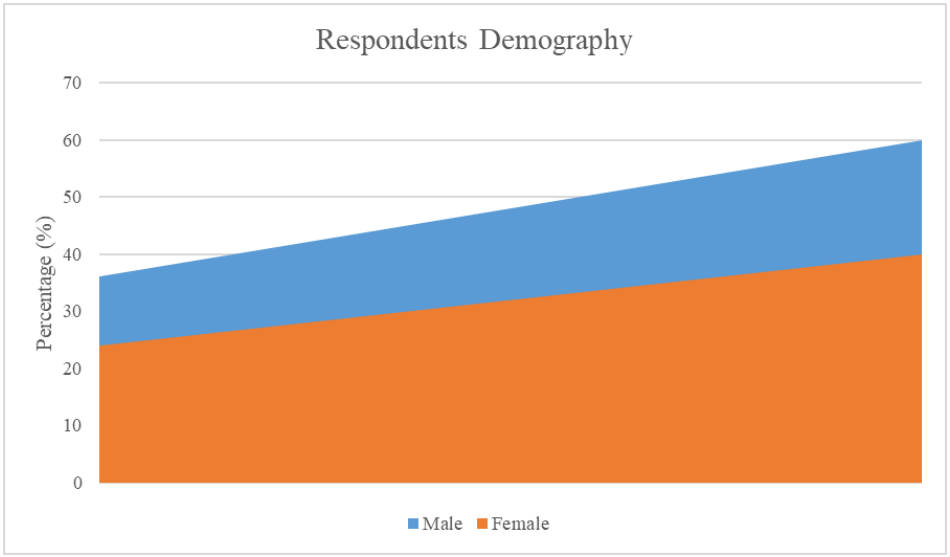

Fig. 1. Respondent farmers' demography by gender

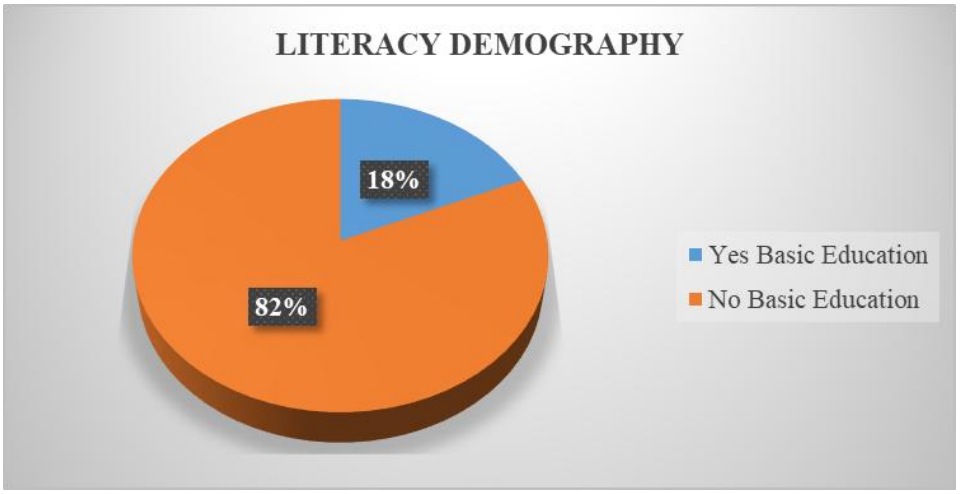

Fig. 2. Non-gender based respondent farmers' literacy demography across the communities

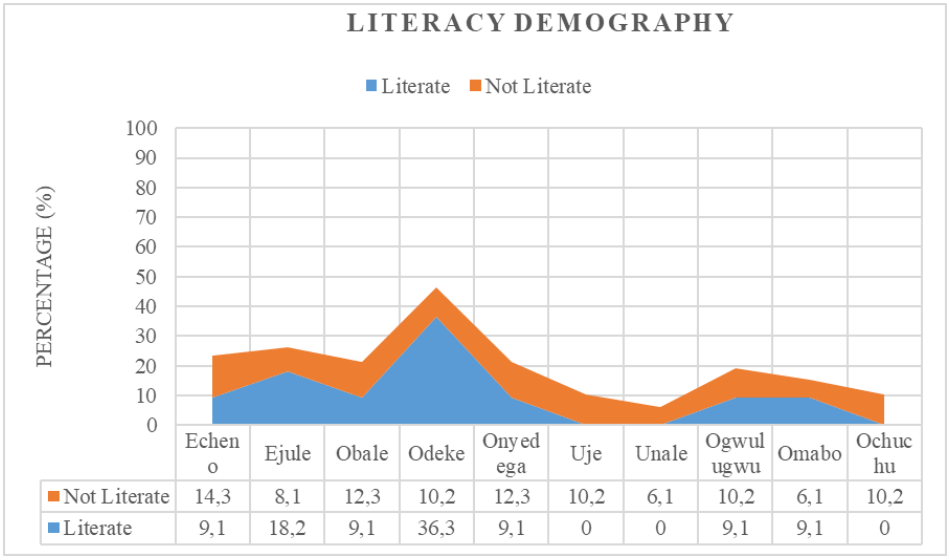

Fig. 3. Communities farmers' literacy level compared

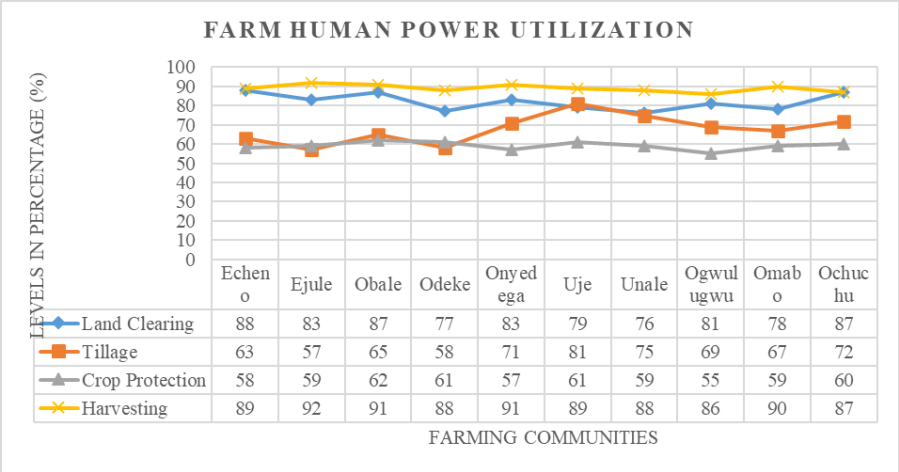

Fig. 4. Human power (non mechanization) utilization in specific operations by farmers in percentages

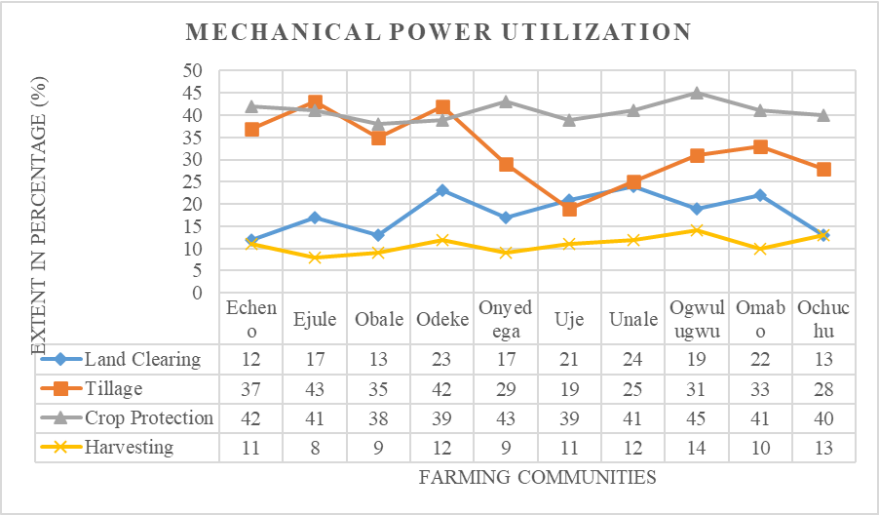

Fig. 5. Mechanization technology applications in specific farm operations in percentage by farmers

Table 1. Mechanization level index

Community	Ta (ha)	T_{tp} (kW/ha)	T_{hp} (kW/ha)	ΣMa (kWhr/ha)	ΣHa (kWhr/ha)	ΣE_T (kWhr/ha)	LOM (%)	MI
Echeno	120	88.25	1.8	5295	108	5403.0	55.31	0.9822
Ejule	98	88.25	1.8	5295	108	5403.0	45.02	0.9800
Obale	150	94.2	1.8	5652	108	5760.0	47.10	0.9813
Odeke	186	88.25	1.9	5295	114.0	5409	23.73	0.9789
Onyedega	148	88.25	2.0	5295	120.0	5415.0	29.82	0.9789
Uje	134	88.25	1.7	5295	102.0	5397.0	32.93	0.9811
Unale	167	88.25	1.6	5295	96.0	5391.0	26.43	0.9821
Ogwulugwu	147	75.00	1.8	4500	108	5403.0	38.27	0.8329
Omabo	110	88.25	1.7	5295	102.0	5397.0	40.12	0.9811
Ochuchu	136	88.25	1.6	5295	96.0	5391.0	32.45	0.9820
Total average	**139.6**	**87.52**	**1.77**	**5251.2**	**106.2**	**5436.9**	**37.118**	**0.9659**

Where Ta = Total land in area under cultivation (ha)
Ttp = Total tractor power (kW/ha)
Thp = Total human power (kW/ha)
ΣMa = Average sum of mechanical operation (kWhr/ha)
ΣHa = Average sum of human operation (kWhr/ha)
ΣE_T = Sum of all human + mechanical operations (kWhr/ha)
LOM = Level of mechanization (%)
MI = Mechanization Index

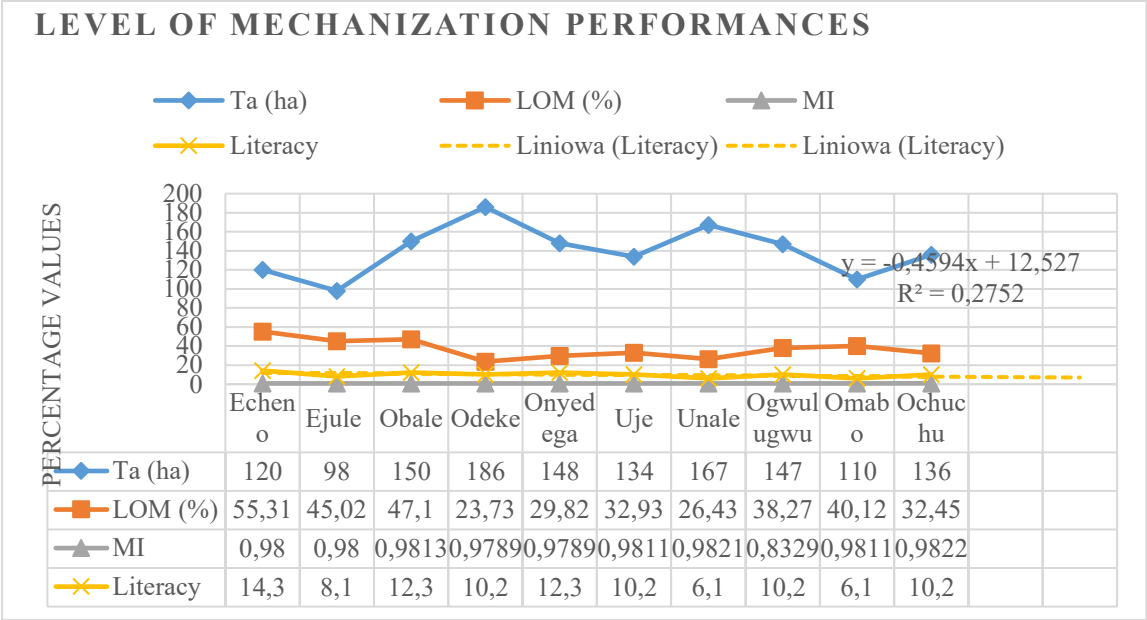

Fig. 6. Mechanization performance determinants within communities compared

Table 2. Productivity levels for each farm settlement

Community	ΣA_m (Ha/kWhr)	ΣA_H (Ha/kWh)	ΣA_T (ha/ kWhr)
Echeno	0.00020	0.0092	0.00949
Ejule	0.00018	0.0094	0.00949
Obale	0.00019	0.0092	0.00948
Odeke	0.00018	0.0051	0.00519
Onyedega	0.00020	0.0082	0.00849
Uje	0.00019	0.0011	0.00119
Unale	0.00021	0.0103	0.01059
Ogwulugwu	0.00022	0.0092	0.00952
Omabo	0.00018	0.0011	0.00119
Ochuchu	0.00017	0.0141	0.01419
Total average	**0.0002**	**0.0077**	**0.0079**

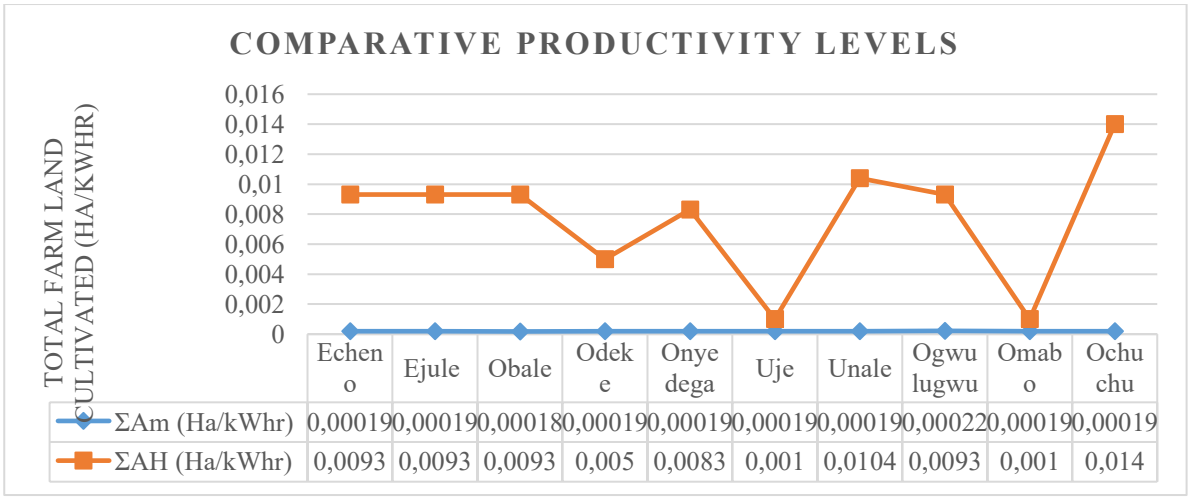

Fig. 7. Comparing farm productivity output based on source of farm power utilized

4. Discussion

This study was carried out in Ibaji Local Government Area of Kogi state with its headquarters at Onyedega; located within latitude 6°53'N 6°41'E and 6.867°N 6.800°E of equator and longitude of the Greenwich meridian. It's a 87% humid climatic zone with a mean annual rainfall of (1524 mm - 1,626 mm) per annum, temperature range of 20°C. It has a topographic height between 305 m to 49 m above the sea level [9].

Seventy (70) questionnaires were administered, only sixty (60) were returned with relevant information for data collation. According to Figure 1, the male gender dominated the respondents by 60%, while the female gender were 40% among the demography of farmers. These are farmers who own and practiced agricultural farming as an occupation individually across the farming communities in Ibaji local government area.

It was also observed according to Figure 2 that, 82% of these farmers had no form of basic formal education. Data from figure 5 revealed that, only 45, 43, 24, and 14% of farmers in Ogwulugwu, Ejule, Unale, and Ogwulugwu communities' respectively, mechanized crop protection, tillage, land clearing and harvesting operations most. While an average of 40.9, 32.2, 18.1, and 10.9% utilization levels were attained across all farming communities operations respectively.

From Figure 6, R2 value of 0.2752 revealed a poor fit of literacy among farmers on levels of mechanization practiced, irrespective of the total area of land being cultivated. Farmers lack adequate relevant knowledge on high productivity from mechanization practices on their various farms; stating high cost of purchase and rental services as reasons.

This study revealed low productivity levels as a function of low mechanization practices. Figure 7 compared sources of farm power utilized. Predominant higher human power utilization across farming communities resulted in small total area of farm land in hectares (ha) cultivated and its corresponding yield across these farming communities was revealed.

Mathematical equations according to [3-4, 13], as presented in equations 1, 2, 3, 4 and Table 1 respectively, were used to determine levels and mechanization index for each community. From the results, increase in MI indicated greater human power input required than machine power per land area in hectare. This implies, for any given area of land under cultivation, more time utilization by human is required for work capacity than machine.

Table 2 shows the opposite correlation of the work schedule as indicator of production functions in the areas under study. The average productivity level of mechanical power (ΣAm) utilization was significantly as low as 0.0002 ha/kWhr compare to human labour (ΣAH) productivity of 0.0077 ha/kWhr. This means, the application of human power was more than machine power utilization.

5. Conclusion

The study revealed existence of low agricultural mechanization productivity across all active farming communities under this study. This was attributed to underutilization of mechanical power and drudgery arising from excessive human power utilization on large expanse of cultivated farmland. This undermined the benefits of owned available large farmlands to crop production across the ten (10) communities in Ibaji LGA of Kogi state.

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