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Assessing The Impacts of Agricultural Intensification and Land Management Practices On Maize Productivity Among Farmers in Oyo State, Nigeria

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Abstract
Sustainable agricultural intensification with the adoption of efficient land management practices can increase productivity of farmers. This paper assessed the impacts of agricultural intensification and land management practices on maize productivity among famers in Oyo State, Nigeria. Multi-stage sampling procedure was used to select 291 respondents and structured questionnaire was used to collect information. Data were analyzed using descriptive statistics, Ruthenberg index, Labour Use Intensity Index, Fertilizer Use Intensity Index, Tobit regression, and Total Factor Productivity. Based on the results, the mean year of continuous cropping was 4.41years (±1.78), implying that the farmers were engaged in continuous cropping for approximately 4 years. The average labour use intensity was 249.96 manday/ha and the average fertilizer use-intensity was 205.60kg/ha, while less than half (41%) used improved maize varieties (IMV) across the zones. The most used land management practices were tractor usage (80.76%) and crop rotation (78.35%), bush burning (67.35%), and intercropping (60.82%). Also, the mean total factor productivity in the zones was found to be 0.123, indicating that maize productivity in the zones was low. At p<0.01, fertilizer use intensity, and IMV were significant and positively related to productivity. It is therefore concluded that use of IMV and fertilizer use intensity are the major drivers of agricultural intensification and maize productivity in the study area. Efforts should be made to make intense use of improved maize varieties and encourage optimum fertilizer usage by maize farmers to increase productivity.

Keywords: Land use intensity, Labour use intensity, Fertilizer use intensity, Improved Maize variety, Total factor productivity.

Introduction

Maize is a very important staple crop. According to PricewaterhouseCoopers Nigeria (PwC), maize is the second most important staple food consumed globally, after rice (PricewaterhouseCoopers [PwC], 2021). It holds a significant socioeconomic importance in sub-Saharan Africa and it is widely regarded as one of the most cultivated food crops with high nutritional value (Elham et al., 2023). Nigeria is the second largest producer of maize with an average production volume of 11 million metric tons, after South Africa, which produces about 16 million metric tons on the average (PricewaterhouseCoopers, [PwC], 2021). Adeola et al. (2023) pointed out that maize production is widespread in Nigeria, a number of farmers are involved in its production and it is of high economic value. Also, Adegbite et al. (2023) emphasized that maize production has great potential to mitigate food insecurity problem as it serves as a source of food for humans and livestock, as well as a means of generating income and foreign exchange overtime.

The demand for maize is increasing on daily basis in Nigeria which is due largely to the fact that the grain is an active ingredient in the production of livestock feed and it serves as the main survival means for several households. The utilization of maize for different home purposes reveals that the domestic requirement of 3.5 million metric tons exceeds the production supply of two million metric tons (Pingali & Pandey, 2021). Thus, there is an anticipation of a rise in maize crop production among farmers to meet its worldwide demand as it often exceeds the supply due to the diverse utilization (Pingali & Pandey, 2021). There is a need for strategic efforts to increase maize production to meet the ever increasing demand, and purposely for its great potential to mitigate the food insecurity issue.

Most Nigerian farmers are subsistence in nature, providing food mainly for their families. Over the past few decades, the farm size has decreased because inheritance and transfer (Ado, 2016). Farm holdings in Nigeria are categorized as: small scale which ranges from 0.10 to 5.99 ha, medium scale which ranges from 6.0 to 9.99 ha and large scale when it is greater than 10 ha (Ado, 2016). According to the National Bureau of Statistics, these classes constituted 84.49%, 11.28% and 4.23% respectively (National Bureau of Statistics [NBS], 2006). However, following the international standards where all farms that are less than 10 ha are classified as small, the values depict that 95.77% of holdings in Nigeria (a total of 46.08million holdings) are small scale farms, while the remaining 4.23% of the holdings (2.033 million farm holdings) are large scale (Ado, 2016). Considering maize production from small or large scale perspective, sustainable maize production and resource use efficiency are required to feed the rising populations while considering environmental impacts (Oyewole & Oyewole, 2023).

Most of the increase achieved in maize production was through the expansion of agricultural land area which is currently competing with increasing population because agricultural land has reached its geographical limits hence resulting in soil degradation and poor fertility (Oyewole & Oyewole, 2023). Furthermore, managing agricultural systems to ensure continuous supply of staple foods to feed the teeming population without irreversibly degrading the natural and agro ecosystems is a huge challenge. This therefore calls for the need to intensify the adoption of agricultural practices that would address ecological problems, enable the long-term sustainability of their activities, and incorporate such practices as an adaptation strategy for coping with climate change. Agricultural intensification and concentration that have occurred over the last century as part of the green revolution to feed growing populations, have resulted in ecological damage with negative environmental effects (Lakew et al., 2024).

Recently, there is adequate provision of some specific factors of production through synthetic chemicals and irrigation, and the noticeable increase observed in crop yield is associated with a huge increase in nitrogen and phosphorus fertilization, hectares of irrigated farmland and the total cultivated land, which affect biological diversity, water quality, water availability, and climate change (Tofa et al., 2022). Irrespective of interventions initiated at boosting agricultural productivity, over-exploitation and degradation of land will lead to reduced fertility and availability of natural resources (Okoroh & Irebuisi, 2024). Thus, it is essential to combat land degradation and encourage commercial farming in order to reduce food insecurity, and ensure the resilience and viability of farm and food systems. Since maize is the most valuable among cereal grains and one of the essential commodities for food aid in Nigeria, increase in its production and availability is a salient issue of concern (Adeola et al., 2023). Increased productivity and improved resource use depend on a sustainable environment. For instance, if the quality of the soil is improved, the resilience of such land to environmental shocks such as erosion and flooding would increase. Land productivity must be ascertained and enhanced for maize farmers to remain in the business of food production. Therefore, the environmental impacts of agricultural production can be reduced through the efficient utilization of productive resources and reduced production loss can be achieved (Alem, 2021).

In Nigeria, maize is largely produced in the Northern region, particularly in Kaduna, Borno, Niger, and Taraba, and in the South-Western States including Ogun, Ondo and Oyo. The country has comparative advantage in the production and export of maize in Africa for it has large cultivable land area for production and conducive climatic condition. However, one of the most pronounced problems constraining the production of maize in Nigeria farming community is limited access to high-quality seeds and fertilizers as well as outdated farming techniques (Tofa et al., 2022). Also, despite the significance of maize production in Southwest farming community, especially in Oyo state, a major maize producing area in the zone (Saka et al., 2011), there is possibility of increased frequency of cultivation that can lead to loss of fertility and decline in productivity if the increased land use is without commensurate use of modern inputs because Oyo state is also known to be one of the most populous state thereby indicative of attendant pressure on arable land.

Maize is a crop that is highly intensive and sensitive to depletion in soil nutrients (especially, soil Nitrogen). It is therefore pertinent to know the relationship between intensification and maize productivity as an indicator of the existing potential for productivity increase. Most previous studies were mainly on production constraints, sustainable agricultural practices and the like, there exists a few empirical research on agricultural intensification and land management practices. This gave the motivation to conduct this study on agricultural intensification, land management practices and maize productivity. Therefore, this paper examined the relationship between agricultural intensification, land management practices and maize productivity in the study area.

Statement of Research Questions

This paper aimed to find answers to the following research questions:

- What is the extent of agricultural intensification among maize farmers in Nigeria?
- What are the land management practices employed?
- What are the impacts of agricultural intensification and land management practices employed on maize productivity of farmers?

Objectives of the Study

The main objective of this study is to assess the impact of agricultural intensification and land management practices on maize productivity among famers in Oyo State, Nigeria. The specific objectives are to

- investigate the extent of agricultural intensification among maize farmers in Nigeria
- examine the land management practices employed
- assess the impact of agricultural intensification and land management practices employed on maize productivity of farmers.

Literature Review

Theoretical Review

The appropriate theories underpinning this study are Boserup's theory of agricultural development, theory of induced innovation and Von Thunnen model of land use.

Boserup's Theory of Agricultural Development

Boserup's theory was propounded by Ester Boserup in 1965. The theory posited that the main driver of agricultural production intensification is continuous increase in population. Based on this theory, increase in population density curtails bush fallowing and shifting cultivation to the use of bush burning, and yearly and/or continuous cultivation, with high input requirements. As population increases, the pressure on the available land forces farmers to shift gradually from extensive farming methods to intensive farming techniques such as the use of improved planting materials, more efficient land management strategies, weed control, and irrigation. These changes sometimes induce agricultural innovation, but with an increase in the marginal labour cost to be incurred by farmers. This process of increasing production at the cost of more work is what Boserup referred to as agricultural intensification. In the context of this paper, maize farmers should find a way to produce in large quantity through adaptation and innovation.

Theory of Induced Innovation

Induced innovation theory was proposed by Yujiro Hayami and Vernon Ruttan in 1971. According to this theory, change in the relative cost of production factors leads to the intervention of more economic technologies. For instance, scarcity of labour or capital as an important factor of production will gradually birth the new technologies purposely designed to economize on the relatively more expensive factor, inducing innovation directed towards substituting scarce resources with cheap factors. It suggests that technological change is driven by economic conditions and resource scarcity. Because of limited sizes of land holding, farmers will use intensification technologies such as fertilizers and improved maize varieties to increase yield.

Von Thunnen Model of Land Use

Von thunnen model of land use was developed in 1826 by Johann Heinrich von Thunnen. The ancient economist proposed that agricultural land use patterns depend on the interaction of transportation costs and the market value of the product. According to the theory, farmers will prefer to produce crops that yield the highest return very close to market place, bearing in mind the transportation costs to the market. Von Thünen's model opines a centralized market town surrounded by a uniform, featureless plain. For instance, dairy farming and intensive crops will be found near the market, while extensive crops like grains and livestock will be found farther away. This theory provides a fundamental framework for understanding the spatial distribution of agricultural activities based on distance from the market and transportation cost.

Empirical Review

Adegbite et al. (2023) investigated the factors influencing the profitability of maize farmers in Osun State, Nigeria. A structured questionnaire was used to obtain data from 120 farmers that were randomly selected from two of the three Agricultural Development Program (ADP) zones in Osun State. Data obtained were analysed using benefit-costs ratio and ordinary least square regression analyses. Based on the results, majority of the farmers were female with an estimated average age of 45 years. Also, the average household size was 5 persons and the average farming experience was estimated to be 13 years. The revenue to cost ratio result depicted that maize farming is profitable in the study area and that age, marital status, level of education, and farm-size were significant determinants of maize farmer's income in the study area.

Kolapo et al. (2022) examined the determinants of choice of sustainable land management practices and the factors influencing the adoption of multiple sustainable land management practices on maize productivity in Nigeria using endogenous switching regression model (ESRM). Based on multivariate probit results, gender, household size, marital status, farming experience, farm size, years of formal education, access to extension contacts, access to credit and owning a land, influenced the maize farmers' decision to choose between the different sustainable land management practices. Ordered probit results indicated that gender, marital status, farming experience, access to extension contacts, access to credit and owning a land, influenced farmers' decision to adopt multiple sustainable land management practices. Furthermore, age, gender, marital status, farming experience, farm size, membership in association and access to extension services translates into increased maize productivity for the maize farmers who adopted sustainable land management practices. The adoption of sustainable land management practice improves the productivity of the maize farmers.

Onuwa et al. (2023) assessed the socioeconomic determinants of the adoption of maize production technologies among smallholders in Bauchi state. The study used primary data obtained through multi-stage sampling from 101 smallholders. Data were analysed using descriptive statistics and Logit regression. Results showed the most adopted production technologies include; adjustment in sowing period and planting method, and seed varieties, plant spacing and seed rate as agreed by 74.3%, 70.3% and 60.4% of the respondents respectively. The regression results established that household size (0.54 unit), education (0.33 unit), farm experience (0.62 unit), farm size (0.45 unit) and extension contact (0.46 unit) statistically influenced the adoption of maize production technology at $p<0.05$. Further, high cost of production technologies (81.2), complexity of the technology (80.2%), poor access to technology (72.3%), agricultural credit (65.3%), inadequate extension contact (64.4%), high cost of labour (60.4%) and fragmented land (45.5%) were considered major constraints to the adoption of maize production technologies by the respondents.

Okoroh and Irebuisi (2024) analyzed the perceived effects of soil erosion on maize production in Imo State, Nigeria. A sample of 180 respondents were selected using multistage sampling techniques. Data were obtained using structured questionnaire and were analyzed using descriptive statistical tools and Ordinary Least Square (OLS) regression analysis. The perceived causes of soil erosion were flooding ($\bar{x}$ = 3.107), overgrazing (($\bar{x}$ = 2.96), deforestation/ destruction of vegetation (x̄ = 2.80), blocked or poor drainage system (x̄ = 2.77), among others. Maize farmers perceived the effects of soil erosion as decline in maize yield (x̄ = 3.46); food insecurity and poverty (x̄ = 3.22); scarcity of agricultural land (x̄ = 3.32), among others. The identified erosion control measures were land filling with farm residue (86.67%), making ridges (76.11%), unobstructed water ways (68.33%), cover cropping and mulching (61.67%). Also, the perceived constraint to the use of soil control measures are inadequate funding (78.89%), high cost of erosion control measures (73.33%), lack of incentive from governments (70.00%), difficulty in acquiring land for forest establishments (68.89%). OLS results show that age, marital status, education, household size, monthly farm income and extension contacts influenced the perceived effects of soil erosion on maize production by farmers at 1% probability level.

Tofa et al. (2022) evaluated the interactive effect of nitrogen (N) and phosphorus (P) fertilizers on maize growth, grain yield, nitrogen uptake and nitrogen use efficiency in southern and northern Guinea savanna zones of Nigeria. Field experiments were conducted during two cropping seasons and the treatments consisted of three levels of N (0, 60, and 120 kg/ha of N) and three levels of P (0, 13, and 26 kg/ha of P). The experimental design consisted of three replications in a split-plot design, with N as the main plot and P as the subplot. Results showed that the response of maize to N depends on the application of P. Higher yields were obtained with the combined application of 120 kg/ha of N and 26 kg/ha of P in both locations. With no P applied, plant N uptake was greater at N rate of 120 kg/ha at Iburu while in Zaria, it rises with increase in N from 0 to 60 kg/ha. When P was applied at 13 kg/ha, the Phosphorous and Nitrogen uptake (PNU) increased by 52% and 66% at Iburu while in Zaria the increases were 51% and 57% each, with N application of 60 and 120 kg/ha, respectively, compared with zero N rate. The values for N recovery efficiency and agronomic efficiency were lower for N rate of 120kg/ha than for 60kg/ha irrespective of P application rate at both locations. The N utilization efficiency however was higher at 120 kg/ha of N under 26 kg/ha of P across locations. Thus, in low fertile soils environments like the Nigeria savannas, N should be applied along with P for optimum grain yield and nitrogen use efficiency of maize.

Methodology

Study Area

The study area is Oyo state. The state has a large amount of arable land of about 28,545 km2 and is bordered in the south by Ogun state, in the north by Kwara state, in the west partly by Ogun state and the republic of Benin, and in the east by Osun state. The state has an equatorial climate with wet and dry season and the average daily temperature ranges from 250C to 350C which makes it favorable for growing crops like maize, yam, cassava, millet, rice, plantains, cocoa, palm produce, and cashew. The state is divided into four agricultural zones which are Ibadan/Ibarapa, Oyo, Saki/Iseyin, and Ogbomoso. There are many government farm settlements in Oyo State, including Ipapo, Ilora, Sepeteri, Eruwa, Ogbomoso, Iresa-adu, Ijaiye, Akufo, and Lalupon. Maize is the mostly cultivated crop by the people of the state and it is the leading maize-producing state in southern part of Nigeria. (https://en.m.wikipedia.org/wiki/Oyo_State). Figure 1 is the map of Oyo state showing the four agricultural zones.

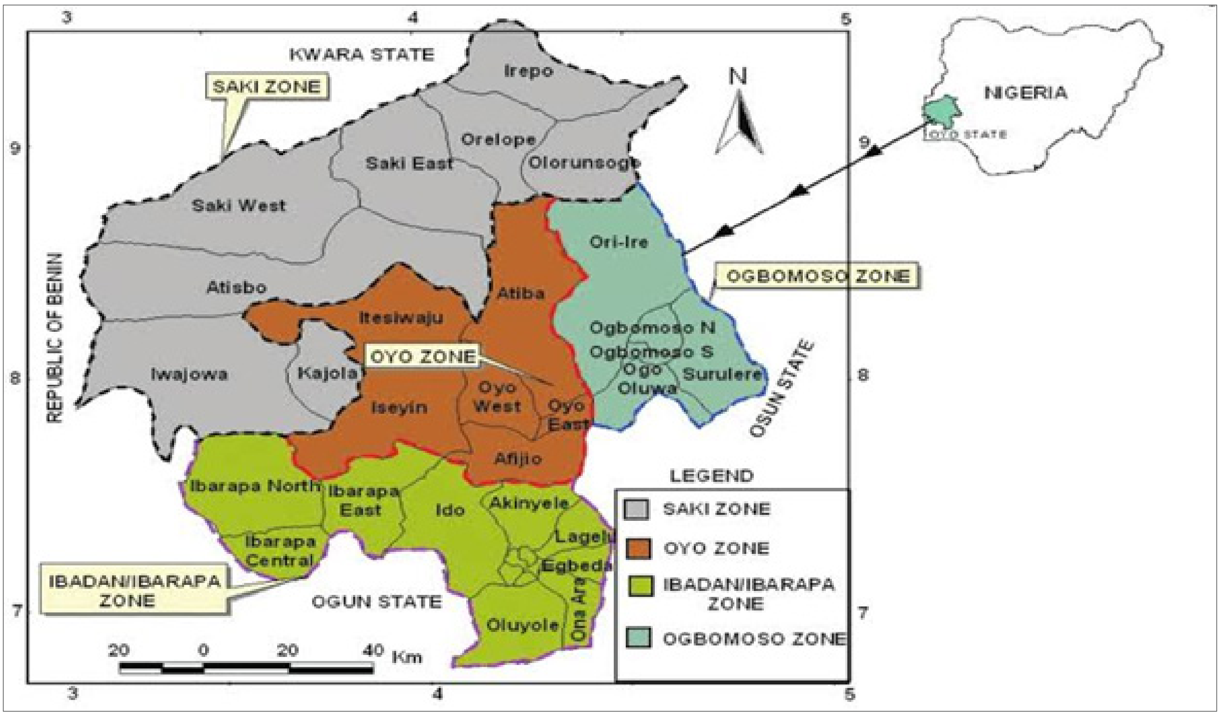

Figure 1: Map of Oyo State Showing the State's Agricultural Zones
Source: Retrieved online: https://www.google.com 25/02/2025

Sampling Procedure

Multistage sampling procedure was used in this study. Stage one involves the selection of one local government area each from the four agricultural development zones in the state (Ibarapa East, Surulere, Atisbo and Afijio). In the second stage, 5 farming communities were randomly selected from each of the four local government areas. In the final stage, fifteen households were randomly selected from each community giving a total of 300 households. Structured questionnaire was administered to the 300 households. However, 291 were recovered and used for the final analysis.

Types and Source of Data

Primary data were obtained with the aid of structured questionnaire on socio demographic characteristics of farmers, farm characteristics, agricultural intensification and land management practices employed by maize farmers, and maize productivity.

Analytical Methods

Descriptive analysis, land use intensity (Ruthenberg index), labour use index, fertilizer use index, Total Factor Productivity estimation, and Tobit regression analyses were used to analyse the data.

Agricultural Intensification Indices

Following Abegunde et al. (2016), four indices were used to evaluate the extent of agricultural intensification; land use intensity index (Ruthenberg index), labour use index and fertilizer use index. The fourth measure is to find out if farmers use improved maize variety.

Ruthenberg Index

Land use intensity model introduced by Ruthenberg in 1980 was used to determine land use intensity of maize crop farmers in the study area. It is stated thus:

$$R = \frac{C}{L}$$

Where R = Ruthenberg index

C = Cropping years

L = Length of cycle of land cultivation (cropping years plus fallow period).

Land use intensity index ranges from 0 to 1. The closer the intensity index is to 1, the higher the land use intensity of maize farmers.

Labour Use Intensity

Labour use intensity was computed to examine the extent of labour use for maize production. The labour use intensity was in mandays per hectare. Higher value of labour use index indicates more intensive labour use. This was computed as:

$$\text{Labour use intensity index} = \frac{\text{Total labour used}}{\text{Number of hectares cultivated}}$$

Fertilizer Use Index

Fertilizer use index was generated to examine the extent of fertilizer use for maize production. It was measured in kilogram per square meter (kg/m^2). Higher value of fertilizer use connotes more use of fertilizers by maize farmers. It can be was expressed as:

$$\text{Fertilizer use intensity index} = \frac{\text{Total fertilizer used}}{\text{Number of hectares cultivated}}$$

1 hectare = $10{,}000m^2$

Total Factor Productivity Estimation

Total Factor Productivity (TFP) can be measured as the inverse of unit variable cost. Total Factor Productivity is the ratio of the output to the total variable cost (TVC):

$$TFP = \frac{Y}{TVC} = \frac{Y}{\Sigma P_i X_i}$$

But since

$$AVC = \frac{TVC}{Y} \text{ then } TFP = \frac{Y}{AVC}$$

Where

Y = Quantity of output (N)

Pi = Unit price of the ith variable input (N)

Xi = Quantity of the ith variable input

AVC = Average variable cost

TVC = Total variable cost

Tobit Regression Model

In order to assess the impacts of agricultural intensification and land management practices on maize productivity, Tobit regression model was used. The model is therefore written thus:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_{10} X_{10} + U_i$$

Y = Dependent variable, that is the total factor productivity (value of TFP)

X_s = Explanatory variables

U_i = Error term

Where,

X_1 = Age (year)

X_2 = Household size (number)

X_3 = Farm size (ha)

X_4 = Farm income(₦)

X_5 = Tractor usage (yes=1, otherwise=0)

X_6 = Crop rotation (yes=1, otherwise=0)

X_7 = Use of Improve Maize Variety (yes=1, otherwise=0)

X_8 = Land use intensity (ranges from 0 to 1)

X_9 = Labour use intensity (mandays/ha)

X_{10} = Fertilizer use intensity (kg/m^2)

Results and Discussion

Assessment of the Extent of Agricultural Intensification among Maize Farmers

Land use Intensity across ADP zones

Table 1 shows the indices of land use intensity across zones. On the average, maize farmers engaged in continuous cropping for approximately 4 years across the zones. It shows a mean of 5.5 years (±1.69) in Ibadan/Ibarapa zone, and 3.69 years (±1.80) in Ogbomoso zone. The results were significant across the zones. Also, the average fallow was 3 years. Farmland were allowed to fallow for approximately 4 years both in Oyo and Saki zones, approximately 3 years in Ibadan/Ibarapa and 2 years in Ogbomoso zone. The mean cropping cycle across the zones was 0.63 (±0.22) year and was significant across the ADP zones. Results show a mean cropping cycle of 0.71 (±0.21) in Saki zone and the least cropping cycle in Ogbomoso zone (0.50±0.20), indicating that farmers in the zones engaged their farmland in continuous cropping. The mean land use intensity across the zones was 0.6±0.14. The highest mean land use intensity was obtained in Ibadan/Ibarapa zone (0.70/ha±0.10) and lowest in Oyo (0.52/ha ±0.11) zone. These imply that farmers in the zones had to engage more in continuous cropping in other to increase production. This result can be backed with the fact that the demand for food is persistently increasing and the majority of Nigerian food producing farmers are smallholders who cultivate fragmented lands (Kolapo et al., 2022). Thus, there is a need to produce on yearly basis to meet the market demand, and encourages intensive land utilization.

Table 1: Indices of Land Use Intensity and Fallow Rotation Period across ADP zones.

Land use variables	Ibadan/lbarapa	Ogbomosho	Oyo	Saki	Pooled	F-stat
Continuous cropping	5.50	3.69	3.82	4.73	4.41	19.05***
	(1.69)	(1.80)	(1.39)	(1.63)	(1.78)	
Fallow Year	2.51	2.38	3.84	3.78	3.15	14.82***
	(0.71)	(1.36)	(2.18)	(2.17)	(1.87)	
Cropping Cycle	0.66	0.50	0.64	0.71	0.63	12.21***
	(0.19)	(0.20)	(0.26)	(0.21)	(0.22)	
Land use Intensity (Ruthemberg Index)	0.70	0.62	0.52	0.57	0.60	26.24***
	(0.10)	(0.12)	(0.11)	(0.16)	(0.14)	

Source: Computed from Field Data, 2024.
Values in parenthesis are percentages
*** Significant at 1%

Distribution of Farmers by Fallow Rotation Period:

Results in Table 2 present the distribution of farmers based on rotation period. Pooled results show that 52.58% of the farmers practiced bush fallow while 45.21% and 2.06% were into continuous cultivation and shifting cultivation across the zones, respectively. Shifting cultivation was not commonly practiced and none was found in Ibadan/Ibarapa zone. A higher proportion (75%) of farmers in Oyo zone practiced bush fallow with the least in Ibadan/Ibarapa (14.71%) zone. The lower number of farmers engaged in bush fallow may be as a result of higher number of farmers practicing continuous cultivation in Ibadan/lbarapa zone. Continuous cultivation was common in Ibadan/lbarapa (85.29%) and the least (23.68%) was in Oyo zone.

Table 2: Distribution of Farmers by Fallow Rotation Period.

Fallow Rotation	Ibadan/Ibarapa	Ogbomosho	Oyo	Saki	Pooled
Shifting Cultivation	0	1	1	4	6
	(0.00)	(1.35)	(1.32)	(5.48)	(2.06)
Bush fallow	10	50	57	36	153
	(14.71)	(67.57)	(75.00)	(49.32)	(52.58)
Continuous cropping	58	23	18	33	132
	(85.29)	(31.08)	(23.68)	(45.21)	(45.21)

Source: Computed from Field Data, 2024.
Values in parenthesis are percentages

Labour Use by Farmer and Labour Use Intensity across ADP Zones

Labour use serves as one of the engines for driving agricultural production in any society. From Table 3, the farmers adopted both hired and family labour on the farm and the average total labour was 253.84 manday/ha. The highest labour use intensity was obtained in Ogbomoso (362.79 manday/ha), and the least in lbadan/lbarapa (134.72 manday/ha) zones. Also, an average of 166.64 manday/ha of hired labour were used as compared to family labour which was 87.20 manday/ha. Similarly, the highest family labour use was 142.49 manday/ha in Ogbomoso zone, followed by 221.63 manday/ha used in Oyo zone as compared to Ibadan/lbarapa zone (50.39 manday/ha). The higher number of hired labour maybe as a results of the fact that the zones are semi-urban and dominated by different ethnic groups from different rural settings and well known for crop farming. Further, the average labour use intensity across the zone was 249.96 manday/ha and Ogbomoso had the highest labour use intensity (309.80 manday/ha) while Saki zone had the least (187.63 manday/ha ± 209.68). This is in consonance with the findings of Ling et al. (2022) who reported an increase in labour productivity in the U.S. farm sector from 1948 to 2017 as it grew faster by 17% and consequently resulted in about 187% increase in the US agricultural output.

Table 3: Labour Use Pattern and Labour Use Intensity across the ADP Zones.

Labour Use (ha)	Ibadan/Ibarapa	Ogbomosho	Oyo	Saki	Pooled	F-stat
Total manday	134.72	362.79	255.22	252.94	253.84	22.54***
	(±73.50)	(±112.41)	(±131.23)	(±269.97)		
Family labour	84.33	142.49	33.58	89.64	87.20	17.35***
	(±62.64)	(±81.17)	(±48.78)	(±146.01)		
Hired labour	50.39	220.29	221.63	163.30	166.64	34.59***
	(±31.22)	(±79.38)	(±138.02)	(±158.76)		
Labour-use Intensity	256.85	309.80	245.14	187.63	249.96	4.86***
	(±258.77)	(±146.47)	(±146.19)	(±209.68)		

Source: Computed from Field Data, 2024.
Values in parenthesis are standard deviation
*** Significant at 1%

Fertilizer Usage and Fertilizer Use Intensity across the ADP zones

Results in Table 4 show fertilizer usage across the ADP zones. All farmers (100%) in Ogbomoso zone used fertilizer and that the zone had the highest fertilizer use intensity (274.99kg/ha). About, 75% of Ibadan/Ibarapa farmers used fertilizer and had the lowest fertilizer use intensity. However, this estimate is less than 50% of the recommended fertilizer application rate of 600kg/ha for maize production in the zones (Salau et al., 2011). Agricultural intensification requires increased utilization of agricultural chemicals like fertilizers and pesticides, as opined by Ling et al. (2022), as it can be substituted for labour use in the production process in some cases. There is a low fertilizer use intensity, which could be due to poor access to fertilizer and high cost.

Table 4: Fertilizer Usage across the ADP Zones.

ADP Zone	Usage of Fertilizer+	Fertilizer Use Intensity (Kg/ha)++
Ibadan/Ibarapa	51 (75.0)	144.30 (±122.90)
Ogbomosho	74 (100.0)	274.99 (±196.08)
Oyo	63 (82.89)	216.69 (±136.33)
Saki	53 (72.60)	180.82 (±136.75)
Total	241 (82.82)	205.60 (±158.84)
F-statistics		9.71***

Source: Computed from Field Data, 2024.
+ values in parentheses are percentages
++ values in parentheses are standard deviation
***** Significant at 1%*

Fertilizer Usage and Fertilizer Use Intensity Across Land Use Pattern

Results in Table 5 show that fertilizer is commonly used by virtually all farmers across land use pattern. It shows that all (100%) farmers practicing shifting cultivation used fertilizer and had the highest fertilizer used intensity (269.44kg/ha). Also, 80.39% of those practicing bush fallow used fertilizer with 200.01kg/ha of fertilizer use intensity. It implies that farmers practicing shifting cultivation used fertilizer without considering the numbers of years the farmland have been abandoned in other to revert (or regenerate) the natural vegetation, as compared to those practicing continuous cultivation. Hence, there exists no significant difference (F=0.62) in the fertilize use intensity and this suggests that fertilizer is used by farmers without specific consideration to the level of land use intensity. This may be influenced by the size of land available for farmers for cultivation.

Table 5: Fertilizer Usage and Fertilizer Intensity Group across Land Use Pattern.

ADP Zone	Usage of Fertilizer+	Fertilizer Use Intensity (Kg/ha)++
Shifting Cultivation	06 (100.0)	269.44 (±70.05)
Bush fallow	123 (80.39)	200.02 (±179.51)
Continuous cropping	112 (84.85)	209.18 (±131.68)
F-statistics		0.62

Source: Computed from Field Data, 2024.
Note: *+ values in parentheses are percentages*
++ values in parentheses are standard deviation

Use of Improved Maize Varieties

Presented in Table 6 are the results of the use of improved seeds as a form of agricultural intensification. The pooled result shows that more than half (58.85%) of the maize farmers in the zones used local maize, especially solo maize, while 41.15% used improved maize varieties. Also, 50% of saki farrmers and 34.33% in Ogbomoso zone used improved maize varieties. Pooled results depict that about one-quarter (27.43%) of the farmers sourced maize seeds from ADP. Moreover, 47.89% and 10.64% in Ogbomoso and Oyo, respectively, sourced their maize seeds from ADP. About 27.00% sourced from input dealers across the zones with the highest (44.68%) in Oyo zone and the least (18.31%) in Ogbomoso zone. Results also show that 42.48% of farmers sourced from local market, with 57.69% in Ibadan/Ibarapa zone and the least (25.35%) in Ogbomoso zone. About 3.10% of farmers sourced their maize from research institutes with a drastic lower percentage (8.45%) in Ogbomoso zone and none in Ibadan/Ibarapa and Oyo zones respectively. The variation in the use of improved maize varieties may be due to availability, cost of purchase, nearness to the source of purchase, and farmers inability to keep for the next planting season before getting another one to plant.

Table 6: Use of Improved Maize Varieties:

Maize varieties	Ibadan/Ibarapa	Ogbomosho	Oyo	Saki	Pooled
Use of IMV'S	14 (35.00)	23 (34.33)	21 (45.65)	28 (50.00)	86 (41.15)
Local maize Sources of Seed	26 (65.00)	44 (65.67)	25 (54.35)	28 (50.00)	123 (58.85)
ADP	06 (11.54)	34 (47.89)	05 (10.64)	17 (30.36)	62 (27.43)
Input dealer	16 (30.77)	13 (18.31)	21 (44.68)	11 (19.64)	61 (27.00)
Local market	30 (57.69)	18 (25.35)	21 (44.68)	27 (48.21)	96 (42.48)
Research Institutes	0 (0.00)	06 (8.45)	0 (0.00)	01 (1.79)	07 (3.10)

Source: Computed from Field Data, 2024.
Values in parenthesis are percentages

Land Management Practices among Maize Farmers across the ADP zones

The distribution of the farmers by their use of land management practices are presented in Table 7. The pooled results show that 80.76% of the farmers used tractor for land preparation. However, the highest proportion of farmers who used tractor was in Ogbomoso (98.65%) than farmers in Oyo (86.84%), Saki (76.71%) and Ibadan/lbarapa (58.82%) zones, respectively. Ibadan/Ibarapa zone has spread of rain forest with topography and vegetation that are less amenable to use of tractors compared to Ogbomoso, Saki and Oyo that are predominantly savannah agro ecology.

Results also show that 29.21% of the farmers engaged in minimum/zero tillage which is considered mutually exclusive to tractor usage. Minimum/zero tillage involves the use of hoes to condition the soil for planting, usually through construction of mounds and heaps which was found to be common among farmers with small farm size. Also, the highest percentage of farmers (64.71%) who used cover crop was found in Ogbomoso zone than in other zones. This is in line with Tsado et al. (2021) who found that planting of cover crop is one of the major conservation practices adopted by small-scale yam farmers in Osun state. Contrary to cover cropping, crop rotation was very prominent across zones with Ibadan/Ibarapa zone (85.29%) and the least in Ogbomoso zone (63.51%). The result is in agreement with the findings of Turyahabw et al. (2022) that crop rotation is prominent and practiced by half of the farmers in Eastern Uganda.

The low use of organic fertilizer is attributable to its bulkiness and the potential high cost of labour for its application. Intercropping and bush burning were generally common across the zones whereas land management practices such as use of organic manure, alley cropping; afforestation and irrigation were not common among maize farmers across the zones. However, maize farmers in Ibadan/Ibarapa were more into mulching (73.53%), crop residue management (60.29%), and terracing (54.41%) than the farmers in other zones. This result corroborates that of Kehinde et al. (2022) that mulching is the most adopted land management practice by smallholders in Oyo state. Also, Akinnagbe and John (2023) found that allowing crop residue to decay on farmland is a common practice among arable farmers in Oyo state.

The need to create security against potential risks of monoculture system of cropping has been seen as one of the forces behind mixed cropping/intercropping as a form of diversification among smallholder farmers. Intercropping allows for flexibility and better utilization of land, labour and capital. It also results in less variability in annual returns compared with mono-cropping (Salau et al., 2011). The low level of irrigation use underscores the age-long challenges regarding the use of abundant water resources for agricultural purposes.

Table 7: Land Management Practices Adopted across the ADP Zones:

Land Management Practices	ADP Zones				
	Ibadan/Ibarapa	Ogbomosho	Oyo	Saki	Pooled
Tractor usage	40 (58.82)	73 (98.65)	66 (86.84)	56 (76.71)	235 (80.76)
Minimum/Zero tillage	17 (25.00)	30 (40.54)	12 (15.79)	26 (35.62)	85 (29.21)
Cover cropping	44 (67.41)	20 (27.03)	30 (39.47)	27 (36.99)	121 (41.58)
Crop rotation	58 (85.29)	47 (63.51)	61 (80.26)	62 (84.93)	228 (78.35)
Organic fertilization	5 (7.35)	19 (25.68)	14 (18.42)	21 (28.77)	59 (20.27)
Intercropping	45 (66.18)	47 (63.51)	43 (56.58)	42 (57.53)	177 (60.82)
Mulching	50 (73.53)	34 (45.95)	39 (51.32)	23 (31.51)	146 (50.17)
Bush burning	53 (77.94)	49 (66.22)	47 (61.84)	47 (64.38)	196 (67.35)
Organic manure	5 (7.35)	14 (18.92)	7 (9.21)	12 (16.44)	38 (13.06)
Alley cropping	20 (29.41)	15 (20.27)	22 (28.95)	28 (38.36)	85 (29.21)
Crop residue	41 (60.29)	26 (35.14)	36 (47.37)	46 (63.01)	149 (51.20)
Terracing	37 (54.41)	15 (20.27)	21 (27.63)	18 (24.66)	91 (31.27)
Afforestation	31 (45.59)	22 (29.73)	10 (13.16)	22 (30.04)	85 (29.21)
Irrigation	18 (26.47)	11 (14.86)	9 (11.84)	3 (4.11)	41 (14.09)

Source: Computed from Field Data, 2024.
Values in parenthesis are percentages

Impacts of Agricultural Intensification and Land Management Practices on Productivity of Maize Farmers

Total Factor Productivity of Maize Farmers

Results in Table 8 shows the frequency distribution of maize farmers by their level of productivity. The total factor productivity estimates were computed based on the five variable inputs that are common to maize farmers and the total yield of farmers. The results show that higher percentage (69.42%) of maize farmers had total factor productivity estimates of less than 0.833, 28.87% had total factor productivity ranging from 0.834 - 1.677 and the least (0.34%) had total factor productivity from 3.334-4.167. Also, the mean estimate of maize farmers' total factor productivity in the zones was found to be 0.123, indicating that maize productivity in the zones was low.

Table 8: Total Factor Productivity Estimates of Maize Farmer.

Total Factor Productivity indices	Frequency (n=291)	Percentage
0-0.833	202	69.42
0.834-1.667	84	28.87
1.668-2.500	0	0.00
2.501-3.333	0	0.00
3.334-4.167	1	0.34
4.168-5.000	2	0.69
5.001-5.833	0	0.00
5.834-6.666	1	0.34
6.667-7.500	0	0.00
7.501-8.333	1	0.34
Mean = 0.123(±0.46)		

Source: Computed from Field Data, 2024.

Impacts of Agricultural Intensification and Land Management Practices on Maize Productivity of

Results on the impacts of agricultural intensification and land management practices on maize productivity using Tobit regression analysis are presented in Table 9. McFadden's Pseudo R2 was 0.2580, indicating that the variation in the Total Factor Productivity of the farmers in the study area could be explained by the explanatory variables. Tractor usage, crop rotation, intercropping, fertilizer use intensity and improved maize variety had significant impact on land management practices in the zones.

Tractor Usage

The results show that tractor usage was negatively related to maize productivity and was significance at $p<0.05$. This may be connected to non-availability of tractor and poor suitability of the soil for mechanization due to presence of stumps/trees in the study area. It is associated with 26.89% decrease in the level of maize production.

Crop Rotation

Also, crop rotation was found to be significance at $p<0.10$ and had negative impact on maize productivity. This suggest that an increased use of crop rotation by farmers lowers the Total Factor Productivity in the zone by 22.54%.

Intercropping

Intercropping was found to be negatively related to maize productivity and significant at $p<0.01$. This implies that increase in the practice of intercropping system by the farmers would lead to decrease in Total Factor Productivity by 74.27%. Intercropping is usually found among small scale farmers. The decrease in Total Factor Productivity might be as a result of competition of the maize crop for space, light, sun, moisture, soil nutrients, and air among others.

Fertilizer Use Intensity

Fertilizer use intensity was positively related to maize productivity of farmers at $p<0.01$ level of significance. This suggest that a unit increase in the amount of fertilizer used would replenish the soil, which leads to an increase in the Total Factor Productivity of farmers' in the zone by 0.26%. In the same vein, Mani et al. (2022) found that fertilizer and input use positively influenced production decision by maize farmers in Kaduna state, Nigeria.

Improved Maize Variety

Also, improved maize variety had a positive and significant impact on maize productivity at $p<0.01$. In other words, continuous use of improved maize varieties would increase the Total Factor Productivity of farmers the more in the zone. This result corroborates the findings of Mani et al. (2022) who found that quality and quantity of seeds had a positive relationship with the intensity of maize production in Kaduna state, Nigeria.

Table 9: TFP/Tobit Regression analysis showing the Impacts of Agricultural Intensification and Land Management practices on Maize Productivity.

Variable	Coefficient	Standard error	$P>\|t\|$
Age	-0.002556	0.004741	0.590
Household size	-0.009267	0.018997	0.626
Farm size	0.033535	0.057329	0.559
Farm income	2.00e-07	2.50e-06	0.936
Tractor usage	-0.268993	0.119725	0.026**
Crop rotation	-0.225403	0.126019	0.075*
Intercropping	-0.742735	0.163897	0.000***
Mulching	0.101420	0.106397	0.342
Bush burning	-0.024212	0.104154	0.816
Crop residue	0.031693	0.097362	0.745
Land intensity	0.825789	0.767441	0.283
Fertilizer intensity	0.002666	0.000284	0.000***
Labour use intensity	-0.000090	0.000187	0.632
Improved maize variety	0.004471	0.000493	0.000***

Source: Computed from 2024 Survey Data.
****, **, * Significant at1%, 5% and 10%, respectively.*

Conclusion and Recommendations

Agricultural intensification was relatively high in terms of land use and labour use intensities but was low in terms of fertilizer use and the use of improved maize varieties in Oyo state. Land management practices differ across ADP zones in the State, and the land management practices had significant impacts on maize productivity. Fertilizer use intensity and improved maize varieties increased maize productivity significantly. Land management practices had no or negative significant impact on productivity. It is therefore concluded that use of improved maize varieties and fertilizer use intensity are the major drivers of agricultural intensification and maize productivity in the study area.

Recommendations

On the basis of the findings, the following recommendations are made towards ensuring effective agricultural intensification in other to boost productivity

1. Encouraging maize farmers to engage in proper land management practices such as Tractor usage, mulching, crop rotation, intercropping and the utilization of crop residue. Also, bush burning as a land management practice should be discouraged because of its adverse effect on the ecosystem, ozone layer, human beings and the environment at large.
2. Improved maize varieties had positive and significant impact on productivity. Government at all levels should make sure that it is readily available, near to maize farmers at subsidized rate.
3. In a bid to ensure adequate use of fertilizer, maize farmers should be sensitized about the benefits that accrue to optimum use of fertilizer in replenishing the soil and ensuring high quality/yield of maize. It should be made available and affordable to all maize farmers.

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