Journal of Integrated Sciences
Volume 2, Issue 4, September 2022
ISSN: 2806-4801

ASSESSMENT OF AGRICULTURAL LAND-USE INTENSIFICATION PRACTICE AND ITS DETERMINANTS AMONG FOOD CROP FARMERS IN SOUTH-WESTERN NIGERIA

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ABSTRACT

The agricultural land-use intensification process is the continual cultivation of a farmland area that is characterized with low fallow period and improved methods of farming system. Such practices were considered as a means to enhance food crop production in order to keep pace with food demand. In view of this, there is a need to assess the extent and determining factors of agricultural land-use intensification among food crop farmers in south-western part of Nigeria. A sum of 346 respondents were sampled through multi-stage sampling technique. Data was collected using a structured questionnaire and analyzed with descriptive statistics, Ruthenberg (R) index and Fractional Logit Regression Model. The findings showed that the percentages of farmers with low (R<33%), medium (R≤66%) and high R>66%) land-use intensities were 3.18%, 19.65% and 77.17% respectively while the mean value of intensity of land-use is approximately 80% based on Ruthenberg index. This study further identified that agricultural land-use

intensification in south-west, Nigeria hinges on the gender of the farmer, credit access, inorganic fertilizer use, farm size and extension services. It has to be concluded that the agricultural land system is associated with high land-use intensity in the study area. Policy efforts on agricultural land-use intensification strategy should be ready at all courses to support the farmers by providing inorganic fertilizers, unconditional credit, and also facilitate easy access to farmland parcels as well as extension trainings in order to ensure a sustainable agricultural intensification.

Keywords: Agricultural land-use intensification, food crop farmers, Ruthenberg (R) index, fractional logit regression model, south-west, Nigeria.

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1. INTRODUCTION

Agriculture is a land-based production system and its intensification – especially under food crop production – requires that farmlands should be ideally managed in order to raise farm productivity. This automatically calls for sustainable agriculture in all developing countries including Nigeria. In line with the framework of Boserup (1965) and Ruthenberg (1980) on the intensification of the farming system, agricultural intensification takes any one of these forms in smallholder farming practices, that is: an increased proportion of cropped land at the rate of a reduced fallow length and fallow area (Becker and Johnson, 2001; Garnett and Godfray (2012); cropping for longer periods during the year including the off-season cropping (FAO, 1997); more crops per unit land area by intercropping and multiple cropping (Andrews and Kassam, 1976; Dawson, et al., 2019); increased input use per unit area (Tiffen et al., 1994; Yusuf et al., 2011); and increased factor productivity (Cassman and Pingali, 2005).

The most economic indices of agricultural land performance are outputs or yields per hectare among others, and so by interpretation, land-use intensification refers to any practice (system of land-use) that increases output per unit area of land. Also, according to Cook et al., (2015) agricultural intensification, as a sustainable concept refers to a rise in the outputs without adverse environmental impacts and without the cultivation of more land. Literatures had made it known to farmers that the potential of this practice relies on the availability and effective management of farm production inputs. For instance, it has been reported that agricultural intensification depends on efficient land-use and proper reallocation of farm resources (Awoyinka et al., 2009; Raufu, 2010; Saka et al., 2011).

In respect to the gradual reduction in cropland due to urban development among others, agricultural intensification practice, as cherished by smallholder farmers serves as an effort to boost farm production and survival.

Consistently, in many of the rural communities the assessment of agricultural land-use intensification is necessary for planning agricultural development, because of the role of agricultural land system in supporting food security and Sustainable Development Goals (Shrestha et al., 2021). In other words, the intensification of agricultural production has been, and continues to be one of the most common policy strategies for promoting human development and improving food security. It is worthwhile to note that sustainable intensification can be a great advantage to guide agriculture in the period of increasing food demand and limiting resources (Cook et al., 2015).

Moreover, agricultural intensification geared up towards the promotion of modern farm inputs such as seeds or fertilizers, commonly subsidized to promote production of different crops, often with reduced fallow periods, and in effects supported national markets and international export (Dawson et al., 2019). Sanctus (2011) believed that by growing a certain number of crops, farmers can benefit from an optimum land-use in terms of improving farm output and increasing on-farm income offered to landless households. In view of all these, this article is motivated and assessed the extent and determining factors of agricultural land-use intensification among food crop farmers in south-western part of Nigeria.

Meyfroidt et al., (2018) pointed out that agricultural intensification is often seen as a key tool for sustainability, to lessen competition for productive land and mitigate associated trades-offs, but the dynamics and spill-over effects of intensification remain insufficiently understood. However, agricultural intensification of the peasant farmers especially in Nigeria has some challenges which cannot be overlooked. The major problems are inadequate land-use methods, land ownership and poor farm resources distribution among the farmers in Nigeria. For instance, prior studies observed that fallow areas have disappeared, but cropping intensities remain very low. The use of organic and chemical fertilizers is too low to maintain soil fertility while investments in irrigation are inadequate (Binswanger-Mkhize and Savastano

2017). These in consequences, shows bad implication on the threshold of food production because our domestic turnout has never been enough to meet demand. As evidence based on the research work by Shrestha et al., (2021), the current demand for food has continued to rise due to the world's rapidly increasing population.

Thus, the need to execute this study is inevitable firstly because of the need for food production as the human population grows or reduction in cropland, and secondly because the sustainable agricultural intensification strategy is one of the important policy concerns to ensure food supply and security in the year 2030. As a result, the study aimed at analyzing the following specific objectives: describe socio-economic characteristics of food crop farmers in south-western part of Nigeria; measure the extent of agricultural land-use intensification among food crop farmers and determine the factors that influence agricultural land-use intensification practice among food crop farmers. Conjunctively, this study is hypothesized that agricultural land-use intensification practice among food crop farmers has no significant economic-drivers that determine it. This paper has magnificently contributed to literature by filling the gap in research because studies on assessment of the extent and determining factors of agricultural land-use intensification among food crop farmers in south-western part of Nigeria is dearth in the study area. Also, it strengthens the ability of food crop farmers to organize their farm resources for agricultural intensification just to enhance farm returns.

2. REVIEW OF LITERATURE

2.1 Concept of Agricultural Land Intensification

Agricultural intensification, as proposed by some theorists, is a way to reduce forest clearing for increasing the outputs in farmed plots or increasing efficiency instead of cutting more forest (Boserup 1965). It involves permanent cropping on a fixed plot with the aims of getting optimum output while good soil conditions and environment are sustainably maintained. In

such cases, the term agricultural land-use intensification will go hand in hand with sustainable concept to meet the goal of surplus production in order to feed the burgeoning population. In many regions across the world, agricultural land-use intensification may be usual farming practice because the purpose of agricultural land is primarily changing in response to population growth rate and urban development. Sequel to these, the available farmland needs to conserve for food production and subject to intensification system. Lerner and Lopez-Carr (2010) stipulated that land-use intensification is often measured by actual agricultural methods, such as using fertilizer or number of years successively cropped on a given hectare of land. This approach of agricultural practices has been in existence for centuries and probably pronounced in several areas where cropland is scarce due to several reasons. The evidence of agricultural land intensification as identified by Carswell, (1997) cited in the work of Yusuf et al., (2011) were increased use of organic or inorganic fertilizer, labor, improved seeds, animal traction, mechanization, multi-cropping, or series/relay-cropping and changes to the land reclamation such as irrigation, or soil conservation measures.

The perception about whether land-use intensification strategy causes depletion of economic and environmental resources may not be completely reckoned with, as long as the land cultivators incorporate the use of soil amendments into farming especially the modern conservation practices, in addition to agronomic measures. The resulting intensification in land-use has occurred mostly in the absence of conservation measures and has been identified as the main cause of land degradation and nutrient depletion According to Tsue (2015), land use, coupled with management practices is the key instrument for achieving increased crop yield and productivity as well as agricultural produce sustainability.

Land-use intensification is one of the most significant forms of land resource utilization targeting increased agricultural production outputs from farms. The processes associated with agricultural intensification include an

increased (per fixed unit of land) frequency of cultivation, an increase in labor inputs, or a change in technologies. Agricultural intensification is beneficial to farm growers apart from raising agricultural yields, it can as well support the regional sustainable development and national food security strategies (Xie et al., 2012).

According to Yusuf et al., (2011), the traditional practice of being unable to meet the increasing demand for food as induced by demographic pressures and rising demand for agricultural produce led to agricultural land intensification – a new practice in agriculture, involving change in land use. In other words, intensification of agricultural land productivity is mandatory in more densely populated areas because of the rapidly growing population as well as food demand. Therefore, increased agricultural production in sub-Saharan Africa may be attributed to cropland intensification and area expansion (Vanlauwe et al., 2014).

2.2 Theoretical Framework

Both theories of Boserup (1965) and Ruthenberg (1980) conjunctively agreed that agricultural intensification as a farming system began since the period when farmland was said to be under human pressure. Prior evidence in Africa is consistent with the framework. Over the past two decades, rapid population growth has put farming systems under stress, while rapid urbanization and economic growth have provided new market opportunities (Binswanger-Mkhize and Savastano, 2017).

Since independence in the 1960s, Sub-Saharan African countries (SSA) have undergone exceptionally fast population growth. They also have faced rapid urbanization and some economic growth, which has tended to increase the demand for agricultural products. In more densely populated areas, the rising population has resulted in farm sizes now close to East and Southeast Asian levels (Headey and Jayne, 2014; Otsuka and Place, 2014). This means that farmers now have to fend for their livelihood in a much-reduced area, which

requires rapid intensification and productivity growth. At the same time, the rising demand for agricultural commodities should be beneficial for them in terms of better market opportunities and higher prices for non-traded commodities. Both forces are leading to higher farming intensities, and possibly to higher investments and input use. Under the theory of intensification of farming systems of Ester Boserup (1965) and Hans Ruthenberg (1980a, b), the BR model of intensification, both population growth and market access can lead to a virtuous cycle of intensification of agriculture: These forces lead to a reduction in fallow, higher use of organic manure and fertilizers to offset declining soil fertility, and investments in mechanization, land and irrigation. All of these have the potential to offset the negative impact of population growth on farm sizes, maintaining or increasing per capita food production, and even increase a farmer's income, which we call the BR predictions. Thus, in most case studies across locations intensification has progressed along the lines predicted by Boserup and Ruthenberg.

In addition, agricultural land-use intensification practice is also based on Von Thunen (1850) model of land-use which is prior to the BR predictions. It predetermined that the farming system steadily became intensified as the agrarian sites and cities converged, which in turn resulted in an increase in the price of land. These two theories (Ricardian and Von Thünen) are the basis for most economic models of land-use change. Combining the two theories by integrating the inherent features of plots (Ricardo) with distance measures (von Thünen) and relaxing some additional assumptions provides a consistent economic theory to explain land-use changes in a spatially explicit manner. Previous studies on land use made references to the Ricardian notion of land rent and demonstrated how land use varies across a landscape at a given location and depends on the cost-of-access to market, road, and population centers (Deininger and Minten, 2002).

2.3 Empirical Literature Reviews

In this paper, the relevant past studies reviewed include the following:

Okike *et al*., (2001) worked on agricultural intensification and efficiency in the West African savannahs: Evidence from northern Nigeria. Frontier production function to measure farm-specific efficiency, parameter estimates for factors of production and inefficiency effects were obtained and the farms were characterized according to their economic efficiency ratings. The results show that a positive relationship exists between agricultural intensification and economic efficiency and that food production in West Africa could be significantly boosted through improving the economic efficiency of farms by utilizing existing resources as well as introducing improved technology.

Lerner and Carr (2010) based their discussion on the fact that tropical deforestation is one of the world's most pressing environmental issues. Some theorists, building on agricultural economist Esther Boserup's work, proposed that agricultural intensification through population growth curbs deforestation through limiting extensive forest cutting for agricultural purposes. Although various scholars have studied the drivers of tropical deforestation, few have examined the determinants of agricultural intensification, which plays a key role in forest conservation. This paper uses household data collected in the Maya Biosphere reserve, Guatemala, to uncover predictor variables associated with intensification in farmed plots. Maize productivity is statistically and positively related with several key variables including smaller farms, and a small percentage of overall land area in crops; the latter households dedicate more of their output to market sales instead of subsistence.

Udoh *et al*., (2011) in their study investigated the agricultural land allocation pattern and the level of land-use intensification among farming household heads in urban local government area of Akwa Ibom state in the southern

Nigeria. A two-stage random sampling technique was used to select 240 farming household heads. A structured questionnaire was used to collect primary data from sample farming household heads in the study area. Combination of analytical tools including descriptive Statistics, Herfindahl index, Crop Diversification index, and Ordinary Least Squares technique were used to analyze the specific objectives. From the results an average Herfindal index of 0.641 and land intensification index of 0.8654 were obtained among respondents. Also, a negative relationship was discovered between land intensification index and farm size in the study area. The study therefore suggests provisions of improved seed varieties and other inputs to farming household heads by the Akwa Ibom state government. Also, state government should intensify effort to reclaimed less productive land and developed Fadama projects in the state to reduce the menace of land use intensification among farming household heads in the area.

Saka *et al*., (2011), in their study, examined the structure of land-use intensification in food crop production in southwestern Nigeria towards determining its drivers and concordance with condition for sustainable intensification. The results showed that land-use intensification is characterized by high frequency of cultivation (79%) and high cropping intensity estimated as 1.24years/ha. Cropping intensity was however higher in the derived and southern guinea savannah than forest agro-ecology. However, about 48%, 32% and 12% made use of inorganic fertilizer, tractor, and herbicide respectively. Farm and farmer specific attributes significantly influenced the level of land-use intensity of food crop farmers. The structure of land-use intensity portrays challenges for sustainable growth through intensification thus underscoring the need for adequate focus on sustainable land management messages by the extension system.

Garnett and Godfray (2012), predetermined if sustainable intensification is to be a useful aid to thinking about how food production should develop in coming years, the assumptions that underpin these different interpretations

of, and attitudes to, sustainable intensification need to be exposed and explored, so that analysis as to the way forward is founded on a shared understanding of what is actually being discussed. Put simply, differing interpretations of sustainable intensification hinge upon three linked assumptions. The first is that sustainable intensification denotes a particular type of agriculture; the second that it is inherently bound up with arguments about the 'need' to produce more food; and lastly, that the 'intensification' side of the term should be preferred over 'sustainable.' These three criticisms are addressed in turns in this work for perfect understanding of the concept.

Kodiwo (2012) examined the complex nexus between agricultural land-use intensity and the socio-economic milieu in which the farming households operate. The study is based largely on field interviews conducted on 257 homesteads chosen randomly using multistage sampling. Data are analyzed using both simple mathematical calculations and computerized multivariate techniques including stepwise Regression and Factor Analysis. The study reveals that socio-economic factors studied accounted for about 92 per cent of the spatial variations in land use intensity between the farmsteads. The regression of the 17-predictor variables on land use intensity using the stepwise method reveals that dependency ratio, sex ratio. Family size, farm size, crop index, distance to the furthest plot, farmers' income and the number of visits by extension agents accounted for about 91 percent of the total variations in the dependent variable. These are the most significant factors influencing variations in land use intensity levels between the farmsteads. His study suggested that land consolidation should encourage land-use intensification in the district. The study also viewed that farmers should be encouraged to commercialize their farms by cultivating high value crops, such as coffee and farmers with surplus land can be induced to lease out for intensive agricultural production. Also, the findings recognized the need for scholars to determine the ''Optimum Farm Size'' necessary for intensive land-use.

Oladeebo and Adekilekun (2013) empirically experimented with the relationship between land-use intensity and food crops production efficiency in Osun State of Nigeria. Primary data was collected with the aid of structured questionnaires. The data was subjected to various methods of analysis such as descriptive statistics, indices of land use intensity and stochastic frontier production function. Results showed that the majority of the food crop farmers were in their active age, educated and highly experienced in food crop production. Maximum likelihood estimation (MLE) showed that farm size had the highest production coefficient and was statistically significant at 5 percent level of significance. Results of the inefficiency analysis showed that while crop diversification, labor use intensity and age of the food crop farmers contributed positively and significantly to inefficiency, land use intensity contributed negatively to inefficiency of food crops production. Major land management methods used by the farmers were mulching, crop rotation and fertilizer use.

Nuhu and Ahmed (2013) in their paper aimed to highlight the current land-use for agriculture in the area and their specific objectives were to identify different categories of land-uses. GPS (Germin 76csx model) was used for data collection in the field and copies of questionnaires were administered to the respondents in the area. The GIS analysis shows that the total area (sub-urban Lafia) covers 234.43 ㎢ within the 15Km radius. The analysis for the categories of land-use shows:

- Uncultivated area (14.98㎢)
- Built-up area (14.12㎢)
- Natural Vegetation (64.64㎢)
- Agricultural/Cultivated area (140.69㎢. 95)

The result revealed the following distribution for land use:

- 40% for agriculture
- 32.63% for commercial use
- 13.68% for manufacturing
- 10.53% for artisanal activities
- 3.16% for mining

The distribution of different land-uses along the selected roads shows that Jos road's main activity is mining due to the availability of raw material and quarry sites located in the area. Makurdi road's main activities include agriculture (26.7%) and commerce (33%). Doma road also partakes in manufacturing and artisanal activities with 7.1% and 50% of respondents engaged respectively. The respondents' age by their land-use activities shows the following distribution:

- agricultural 66.7%
- commercial 0%
- mining 26.7%
- manufacturing 6.7%
- artisanal services 0%

The respondents aged between 18 and 35 years have more agricultural lands than those aged between 51 and 65. Males have more lands for agriculture than females (42% and 36% respectively); while a larger number of females engaged in commercial activities (45.5 and 25.8% respectively). It also shows the income earned based on land-use activities, agriculture (50%) while mining being the least paid. The paper concludes that agriculture occupies more land followed by undisturbed land/vegetation and there is need for a proper database collection of the lands for feature planning.

Haiguang *et al*., (2015) employed rural households survey data from Taibus Banner, in the Inner Mongolia Autonomous Region, China, this study

separately categorizes agricultural land use intensity into labor intensity, capital intensity, the intensity of labor-saving inputs, and the intensity of yield-increasing inputs, and then analyzes their determinants at the household level. The findings reveal that within the study area:

(1) Labor intensity is higher and capital intensity is lower than in the major grain-producing and economically developed areas of eastern and central China

(2) The most widely planted crops are those with the lowest labor intensity (oats) and capital intensity (benne)

(3) There are marked differences in agricultural land use intensity among households

A major factor affecting land use decision-making is the reduced need for labor intensity for those households with high opportunity costs, such as those with income earned from non-farming activities which alleviates financial constraints and allows for increased capital intensity. As a result, these households invest more in labor-saving inputs.

(4) Households with a larger number of workers will allocate adequate time to manage their land and thus they will not necessarily invest more in labor-saving inputs. Those households with more land to manage tend to adopt an extensive cultivation strategy. Total income has a positive impact on capital intensity and a negative impact on labor intensity. Households that derive a higher proportion of their total income through farming are more reliant upon agriculture, which necessitates significant labor and yield-increasing inputs. Finally, the authors contend that policy makers should clearly recognize the impacts of non-farming employment on agricultural land use intensity. In order to ensure long-term food security and sustainable agricultural development in China, income streams from both farming and non-farming employment should be balanced.

Alawode *et al*., (2020) researched on Land Use Intensity, Crop Diversification and Productivity of Farmers in Akinyele Local Government Area of Oyo State, Nigeria. Data were analyzed using Descriptive Statistics, Ruthenberg index, Herfindahl index, Total Factor productivity and Tobit regression analysis. The results of land-use intensity by farmers, calculated using Ruthenberg index, show that majority (70.0%) of the farmers had an index of 1 which means complete land intensification (continuous cropping on the same piece of land every year). The mean index of 0.9 (± 0.2) showed that land is intensively used in the area. This may be as a result of farmers trying to increase their output with the only asset (land) they have as their family size increases. Also, Okoruwa *et al*., (2011) also found that 79.0% of farmers used land intensively.

Shrestha *et al*., (2021) observed that sustainable intensification of agriculture is a good approach for reducing the yield gap without exacerbating the current condition of the environmental components, which is a big challenge for agriculture in the modern world. This review provides a summary of the role and approaches of sustainable intensification in agriculture which offer ways to increase crop production and create long-term sustainability in agriculture production. The current demand for food has continued to rise as a result of the world's rapidly increasing population. In order to increase crop/food production, agricultural systems should be intensified by more sustainable practices, as well as by reforming existing production systems/techniques and diversifying them into newer and more profitable enterprises. Despite the heavy use of inputs, farmers have recently been unable to achieve optimal crop yields. The judicious use of agricultural inputs, combined with improved management techniques, is important for advancing sustainable intensification. New scientific techniques in agronomic practices, as well as improved farm mechanization, are helping to boost resource use efficiency in sustainable crop production. Sustainable agricultural intensification is necessary to increase the agricultural productivity under the

changing and adverse climatic conditions while maintaining healthy production practices.

3.RESEARCH METHODOLOGY

3.1 Study Area

The study was conducted in south-western parts of Nigeria. The south-western zone covers an area spreading between Latitudes 6oN and 4oS and Longitudes 4oW and 6oE (Balogun and Akinyemi, 2017). It has a total land area of 114,271㎢ representing 12% of the country's land mass and comprises six states which include Oyo, Osun, Ogun, Lagos, Ondo and Ekiti states (Balogun and Akinyemi, 2017). This region is bounded in the east by Edo and Delta states, in the west by the Republic of Benin, in the north by Kwara and Kogi states, and in the south by the Gulf of Guinea.

The peculiar climatic condition of south-western regions is mainly tropical and it is characterized by wet and dry seasons. The wet season is associated with the southwestern monsoon wind from the Atlantic Ocean while the dry season is associated with the northeast trade wind from the Sahara Desert. Average rainfall is 1480mm with a mean monthly temperature range of 18o-24oC during the raining season and 30o-35oC during the dry season. The vegetation type in south-west comprises freshwater swamp and mangrove forest at the belt, the lowland in forest stretches inland to Ogun and part of Ondo state, while secondary forest is towards the northern boundary where derived and southern savannah exist (Faleyimu et al., 2010).

The south-western part of Nigeria is dominated by the Yoruba ethnic groups although some people have local dialects which they speak such as Ijesha, Egba, Sagamu and so on. Economic activities commonly in the area include trading, handicraft or artisanal activities, public and private service employment, and agricultural production (Balogun and Akinyemi, 2017). The land cover endowed in this zone is conducive for agricultural and non-

agricultural practices. This area serves as a food basket/major center of food crops production in Nigeria especially Oyo and Osun states. The predominant arable crops cultivated are cassava, maize, yam, guinea corn, rice, sweet potato, vegetables (such as okra, garden-egg, cucumber, tomatoes, pepper; tree/cash crops like oil palm, mango, orange, cashew, cocoa, and kola-nut among others. Its agro-ecological condition also supports grazing land and raising livestock such as sheep, goat, cattle and poultry. In addition, the south-west region is highly populous, with a mixed farming population comprising adults, youth and children. The farming households, though smallholders, substantially feed the millions of inhabitants in Nigeria at large. Small-scale farmers make up to 80% of farmers in Nigeria and produce a substantial percentage of the food consumed by Nigerians (Mgbenka, Mbah and Ezeano 2016).

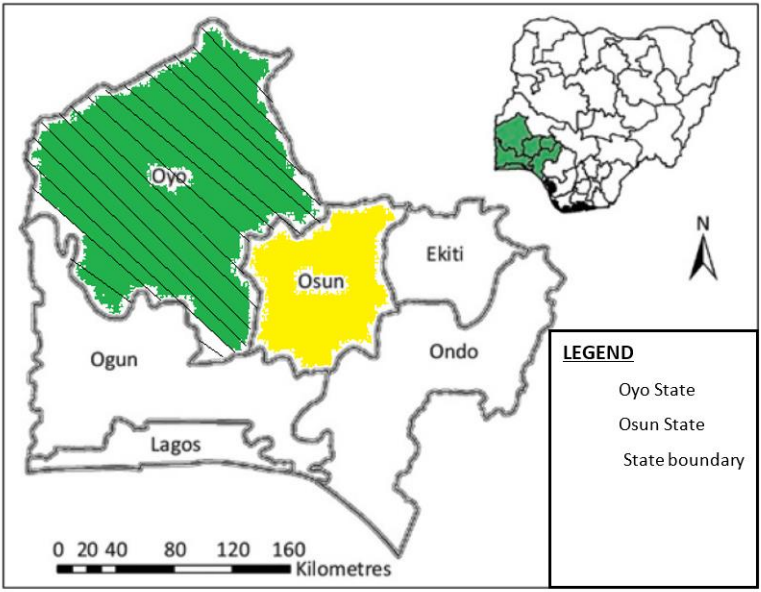

Figure 1. Map Showing the Study Area in the Context of South-Western Nigeria.
Source: Adapted from Nigeria Map.

Journal of Integrated Sciences
Volume 2, Issue 4, September 2022
ISSN: 2806-4801

Population, Sampling Technique and Data Collection

The population for this study comprises all food crop farmers in sout western parts of Nigeria. The south-western zone of Nigeria has six stat (Oyo, Osun, Ogun, Lagos, Ondo and Ekiti). The first stage involved a purposi selection of two states (Oyo and Osun) representing one-third of the states in the south-western region. Meanwhile, the choice of these two states was prompted by the dominance of arable crops production in the areas. For illustration, a growing body of evidence reports that Oyo and Osun states are agriculture-based economies, wherein production of food crops provides employment and income for more than 75% of the population (Adepoju and Salman 2013). Precisely there are four Agricultural Development Project (ADP) zones with thirty-three (33) Local Government Areas (LGAs) in Oyo state and, three ADP zones with thirty (30) LGAs in Osun state. At the second stage, random sampling was used to select two-third of the zones in each of the selected states that is, Ibadan/Ibarapa, Ogbomoso and Saki zones from Oyo state while Iwo and Ife/Ijesha zones from Osun state were selected. The third stage also involved a simple random selection of one-third of the Local Government Areas (LGAs) out of the LGAs found in each zone. Thereafter, with the known population of the food crop farmers in all Local Government Areas selected for the study as in Table 3.1, the required sample size was determined using the population proportionate factor stated as:

$$S = \frac{X^2 NP\ (1-P)}{d^2(N-1) + X^2 P\ (1-P)}$$

Where S = required sample size, N = the population size, X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (95%), normally (1.96 x 1.96 =3.841), P = the population proportion (assumed to be 0.50), d = the degree of accuracy expressed as a proportion (0.05). As we have in Table 3.1 below, the study drawn population size (N) equal to 60348 and assumed a population proportion (P) of 0.50, chi-square (X^2) for 1 degree of

freedom at 95% confidence level, normally (1.96 x 1.96 =3.841) and degree of accuracy (d) of 5%. This method of obtaining sample size is based on probability assumption which permits every individual farmer to be a good representative of the entire population in the study area. Therefore, following this procedure the sample size is as given below:

$$S = \frac{3.841\ x\ 60348\ x\ 0.5\ (1-0.5)}{0.5^2(60348-1) + 3.841\ x\ 0.5\ (1-0.5)} = 382\ farmers$$

Hence, a total of 382 questionnaire copies were administered to farmers during the field exercise. However, the study confidently made use of 346 questionnaires for analysis at the end. The left-over questionnaires were not found useful due to inconsistent information and poor responses from the target farmers.

Table 1. Population of Respondents in Southwestern Nigeria

States	ADP Zones	Selected-ADP Zones	LGAs in Zone	Selected LGAs	Registered Farmers consisted in LGAS
Oyo	5	Ibadan/Ibarapa	14	Ido	3104
				Egbeda	4319
				Akinyele	4403
				Ibarapa central	4906
		Ogbomoso	5	Surulere	5829
				Oriire	7541
		Saki	9	Kajola	3054
				Iseyin	3513
				Iwajowa	4022

Osun	3	Iwo	7	Iwo	4685
				Irewole	3880
		Ife/Ijesa	10	Atakumosa	4302
				Oriade	2976
				Ife-east	3914
Total	**8**	**5**	**45**	**14**	**60348**

Source: ADP Office, Oyo and Osun States

3.2 **Data Analytical Tools**

We employed both descriptive and inferential statistics for data analysis. Descriptive analysis (frequency tables, percentage, mean, and standard deviation), Ruthenberg index, and Fractional logit regression model were estimated according to each of the specific objectives.

3.2.1 **Ruthenberg index**

Ruthenberg index was computed by dividing the number of years for which cropland is consecutively cultivated before being allowed to fallow (Ti) with the length of cropping cycle Ci, (addition of years of consecutive cultivation and period of fallow) (Rothenberg 1980), thus, Land-use intensity, (Li) of each farmer measured by the R value, ($0<R\leq 1$) is specified as:

$$\text{Land-use intensity, (Li)} = Ti/Ci \times 100 \quad \ldots\ldots 1$$

3.2.2 **Fractional logit regression model**

The fractional logit model initially proposed by Papke and Wooldridge (1996, 2011) is chosen for observing the determinants of agricultural land-use intensity within farming households. It is capable of taking into account the fractional nature of the explained variable, works for discrete and continuous

variables (Papke and Wooldridge, 1996), and is capable of handling the extreme values of 0 and 1 without having to manipulate the data (Baum, 2008; Mullahy, 2010).

In the fractional logit model applied in the present paper, the dependent variable (agricultural land-use intensity) is operationalized as a fraction bound between zero and one, $0 \leq Yi \geq 1$, and specified as follows:

$$P\left(y = \frac{j}{x}\right) = \frac{\exp\left(x\beta j\right)}{\left[1 + \sum_{h=1}^{j} \exp(x\beta h), j = 12, \ldots j\right]} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

The equation (2) here changes to a linear model of the form

$$Yi = \beta_0 + \beta_i Xi + \mu_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where, Yi= dependent variable for ith farmer, β_0 = constant term, β_i = vector of parameter estimates, X_i = vector of independent variables and μ_i = disturbance term.

As regards this analysis, variables entered into fractional logit as Y_i =Agricultural land-use intensity for each farmer, X_1= sex of farmer, X_2 = year of education, X_3 = credit access, X_4 = inorganic fertilizer use, X_5 = manure use, X_6 = farm size, X_7 = cropping intensity, X_8 = farm distance and X_9 = extension services.

4 RESULTS AND DISCUSSION

4.1 Result of Socio-economic Characteristics of the Food Crop Farmers

Table 2 showed that 89.88% of the respondents were males while the rest (10.12%) of them were females. This indicated that male respondents are more relative to their female counterparts, which is possibly due to the tedious nature of farm works. Similarly, Alawode et al., (2020) observed that 93.0% were male farmers. The age distribution indicated that 41.62% of the

farmers were within the age of 41-50 years, 26.59% of them fell between the age of 51-60 years, 17.92% were within the age of 31-40 years, 12.43% reached 60 years and more, while the remaining (1.45%) of them were between the age of 30 years or less. The mean age of farmers was 49.38 years, which implied that the farmers are still within the middle age group. According to Alawode et al., (2020) youths should be encouraged to actively participate in farming rather than only ageing farmers.

The result revealed that 86.13% of the respondents were married while the rest (13.87%) were single. It means that the number of married farmers was higher relative to single ones. In the work of Alawode et al., (2020) 88.0% were married among the sample farming households. The study also found that 50.87% of the respondents have a household size of between 6 and 10 members, 43.64% of them had household size of 5 members or less while the rest (5.49%) of them had household size of 10 or more members. The average household size is about 6 persons which implies a relatively large family size. It was viewed that these family members will supply additional farm labor. It agreed with the study of Alawode et al., (2020) who observed that the farmers have an average of 6 persons per household. In addition, about 44% of the sampled farmers spent 6 years or less in school, 32.66% of them spent between 7 and 12 years in school and 23.12% of the farmers spent more than twelve years (>12). However, the average duration of education was 9.02 years, this finding signified that the farmers are able to read and write since most of them have acquired post primary education. This finding is consistent with Ehirim et al., (2013) who observed that the mean formal education attainment is 9.5 years.

The experience level distribution in Table 2 showed that 46.53% had between 6 to 15 years of farming experience, 34.11% of them had 16 to 25 years of experience, 8.38% had 5 or less years of experience and 7.80% had 26 to 35 years of farming experience while the remaining 3.18% had above 35 years of farming experience. The mean farming experience was 17.39 years which

suggests that farmers have spent several years in the course of producing food crops. This is comparable to the findings by Lawal et al, (2013) wherein the mean Fadama farming experience was about 17.5 years and Idumah et al., (2015). Result in Table 2 showed that 45.95% had 5 hectares or less as their farm size, 31.50% had between 6 and 10 hectares while 22.54% had 10 hectares or more as farm size. The average farm size is 7.67 hectares.

The majority (91.62%) of the respondents solely engaged in farming activities, it is supported by Alawode et al., (2020) who reported that majority (86.5%) of the respondents were primarily involved in farming activities. Therefore, the study suggested that most of the rural dwellers still relied on farming activities in order to live and it is further evident that agriculture remains the backbone for livelihood security (Yamba et al., 2017). Furthermore, the majority (91.04%) of the farmers were members of farmers' association. This indicated that most farmers have a sense of belonging and social relationship amongst other people in the villages which may strengthen their collective participatory roles especially during farming activities. The study further exhibited that over half (54.34%) of the farmers used both hired and family labor, 38.73% of them used only hired labor, 3.67% used only family labor while 3.08% sourced farm labor from other means like casual or exchange labor. This implied that the majority of farmers employed both family and hired labor for their farming activities contrarily, evidence revealed that majority (79.5%) used hired labor on their farms (Alawode et al., 2020). About 78% of the farmers have access to extension services while 21.68% did not have access to extension services.

Table 2. Distribution of Socio-economic Factors of the Food Crop Farmers

Socio-economic	Frequency	Percentage	Mean
Sex			
Male	311	89.88	
Female	35	10.12	

Age Group			49.38
≤30	5	1.45	
31-40	62	17.92	
41-50	144	41.62	
51-60	92	26.59	
> 60	43	12.43	
Marital Status			
Single	48	13.87	
Married	298	86.13	
Household Size			6
≤5	151	43.64	
6-10	176	50.87	
>10	19	5.49	
Years of education			9.02
≤6	153	44.22	
7-12	118	32.66	
>12	80	23.12	
Years of Experience			17.39
≤5	29	8.38	
6-15	161	46.53	
16-25	118	34.11	
26-35	27	7.80	
Above 35	11	3.18	
Farm Size			7.67
≤5	159	45.95	

6-10	109	31.50
>10	78	22.54
Primary Occupation		
Non-full-time farmers	29	8.38
Full- time farmers	317	91.62
Farmers' Association		
No	31	8.96
Yes	315	91.04
Labor Source		
Family Labor	13	3.76
Hired Labor	134	38.73
Both hired &family	188	54.34
Others	11	3.08
Extension Services		
No	75	21.68
Yes	271	78.32
Total	**346**	**100**

Source: Field Survey, 2020

4.2 Variable Inputs Used by Food Crop Farmers

Table 3 showed the distribution of variable inputs within food crop farmers in order to know their rate of application. It was found that all (100%) of the farmers made use of fertilizers, pesticides and herbicides for food crops production respectively, 88.15% used improved planting materials, while 6.65% used organic manure in their farms. This finding asserts that inorganic fertilizers are being widely used and also many of them used improved

planting materials. It suggests that proper management of these farm resources is needed to promote agricultural land-use intensification practices in the study area.

Table 3. Distribution of the Food Crop Farmers by Variable Inputs used

Variable inputs used	Frequency *	Percentage
Improved planting materials	305	88.15
Chemical fertilizers	346	100
Pesticides	346	100
Herbicides	346	100
Organic manure	23	6.65

Source: Field Survey, 2020 Reported in multiple responses*

4.3 Measurement of Land-Use Intensity based on Ruthenberg Index

Ruthenberg index was estimated to measure the land-use intensity of individual farm plots as developed by Ruthenberg (1980). It was revealed that the farmers practiced agricultural land-use intensification with an average value of intensity of land-use approximately R= 80%. Also, the percentages of crop farmers with low (R<33%), medium (33≤ R≤66%) and high (R>66%) land-use intensities were 3.18%, 19.65% and 77.17% respectively (Table 4). This result is just an indication to show that most food crop farmers intensively cultivated their farmland in the study area. The result is line with the finding by Alawode, et al., (2020) who found that majority (70.0%) of the farmers had index of 1 which means complete land intensification (continuous cropping on the same piece of land every year). According to Lawal, et al. (2013) the land-use intensity for the sampled households was estimated as 0.983 during the survey. This implies that land cultivation is nearly on a continuous basis in the Fadama regions in Niger State of Nigerian Southern Guinea Savanna. Based on the finding of Yusuf et al., (2011), the mean land-use intensity was 0.83,

and similarly Saka et al., (2011) arrived at 0.79 as land-use intensity on the average. These reports generally provide evidence that land-use is characterized by high frequency of cultivation in Nigeria.

Table 4. Distribution of Respondents according to Land-Use Intensity

Land-use intensity	Frequency	Percentage
Low land-use intensity	11	3.18
Moderate land-use intensity	68	19.65
High land-use intensity	267	77.17
Total	346	100

Source: Data Analysis, 2020

Mean value = 79.57% Ruthenberg index **: R<33%=low land-use intensity, 33≤R≤66% = moderate land-use intensity, and R>66% =high land-use intensity.

4.4 Fractional Logit Estimation of Factors Determining Agricultural Land-Use Intensification Practice among Food Crop Farmers

Factors that influenced the agricultural land-use intensification of the food crop farmers are presented in Table 4.4. Using fractional logit analysis, the value of pseudo R2 was found to be 0.056 with a p-value of 0.000 which means that the model as a whole is statistically significant. The result of fractional logit showed that sex of farmers, credit access, quantity of fertilizer used, farm size cultivated and access to extension are statistically significant variables.

Sex of crop farmers is significant at 10% and positively affected land-use intensification which implied that with the increase in population of male

farmers, there is likelihood of increasing agricultural land-use intensification among the respondents. This is because farming activities is energy demanding and men are more powerful to perform farm operations than their female counterparts. Yusuf et al., (2011) had also found that sex/gender influenced agricultural intensification, but the direction of effect differed. Credit access also determined the agricultural land-use intensification since it is statistically significant at 1% level, although inversely related with agricultural land-use intensification practice. This result suggested that more access to credit by the farmers will probably limit the extent of agricultural land-use intensification in the study area.

According to the result, the agricultural land-use intensification seems to improve with the application of inorganic fertilizers on food crops land. It indicates that fertilizer use is positively related to agricultural land-use intensification and also significant at 1% level. It shows further that increased use of fertilizer would increase the probability of agricultural land-use intensification system. This finding is in line with the a priori expectation. The coefficient of size of farm was found to be significant at 10% and indirectly associated with agricultural land-use intensification. This finding means that a unit increase in hectare of farm size is likely to cause a reduction in intensity of land-use in the study area. It is suggesting that abundant farmland areas will enable farmers to put land on fallow in order to improve its natural fertility, thereby preventing over cultivation. Yusuf et al., (2011) reported that hectare of farm size determined agricultural intensification. Lastly, the extension services have a positive relationship with the agricultural land-use intensification and significant at 1%. This result indicated that as the farmers have more access to extension training, they are more likely to engage in agricultural land-use intensification strategy. So, this finding argued that access to extension services also determined the agricultural land-use intensification practices in the study area. Therefore, the overall findings from this analysis provide partial evidence that access to input/output

markets, population pressure, the socio-economic characteristics of the households, biophysical features and government policy and institutions are the main drivers of agricultural intensification in the small holder farming systems according to des Grades et al., (2007).

Table 5. Factors Determining Agricultural Land-Use Intensification Practice among Food Crop Farmers based on Fractional Logistic Regression

Explanatory Variables	Coefficients	Robust Std. Errors	Z-values	P>/Z/-values
Constant	0.8089388	0.2674761	3.02	0.002
Sex of farmer	0 .2808749	0 .1675085	1.68*	0.094
Years of education	-0.0035388	0.0118181	-0.30	0.765
Access to credit	-0.5689989	0.1559328	-3.65***	0.000
Inorganic fertilizer	0.8427547	0.1553885	5.42***	0.000
Manure use	0.1039631	0.1194141	0.87	0.384
Farm size	-0.0316142	0.0165552	-1.91*	0.056
Cropping intensity	0.0100061	0.0143047	0.70	0.484
Distance to farm	0.0135147	0.0102625	1.32	0.188
Extension services	0.4458558	0.1304433	3.42***	0.001

Source: Data Analysis, 2020

5 CONCLUSION

This study assessed the extent and determining factors of agricultural land-use intensification among food crop farmers in south-western part of Nigeria. The index of land-use intensity computed signifies that agricultural land-use

intensification substantially dominates the farming systems with the average land-use intensification approximately 80% in south-western, Nigeria. Thus, this study uncovered that agricultural land-use intensification is being practiced by most of the food crop farmers in the study area. It is therefore advisable for farmers to take note of depleting soil and plan sustainable land-use measures. Also, in determining the factors affecting agricultural land-use intensification, the finding shows that sex of farmer, credit access, quantity of fertilizers, hectare of farmland and access to extension are statistically significant variables and followed a priori expectations.

Policies that will make youth among men to be actively participated in agriculture will go a long way in promoting agricultural land-use intensification and food production, while the cropland is easily accessible. Supporting agricultural land-use intensification practices will also involve the provision of farm credit sources, chemical fertilizers, and extension trainings in the study area.

5.1 Contributions to Knowledge and Policy Implication

As part of useful contributions, the study has empirically showed that access to credit, application of inorganic fertilizers, shrinking farm size and access to extension facilities were driven agricultural land-use intensification practices in southwestern Nigeria. Assessment of extent of agricultural land-use intensification becomes a relevant study nowadays since agricultural intensification strategy is one of the important mechanisms to achieve Sustainable Development Goal (SDG) by year 2030 in Nigeria. The study has also contributed its own quota based on the view that agricultural land-use intensification management may be an alternative in the process of food production, if well planned.

REFERENCES

Adepoju, A. A. and Salman, K. K. (2013). Increasing Agricultural Productivity through Rural Infrastructure: Evidence from Oyo and Osun States, Nigeria *International Journal of Applied Agricultural and Apicultural Research IJAAAR* © Faculty of Agricultural Sciences, LAUTECH, Ogbomoso, Nigeria 9 (1and 2): 1-10.

Alawode, O. O., Kabiru, B.A. and Akanbi, O. A. (2020). Land-Use Intensity, Crop Diversification and Productivity of Farmers in Akinyele Local Government Area of Oyo State, Nigeria. *International Journal of Innovative Environmental Studies Research* 8(3):20-32.

Andrews, D.J, and Kassam, A.H. (1976). The Importance of Multiple Cropping in Increasing World Food Supplies. In: Papendick A, Sanchez GB, Triplett, editors. Multiple Cropping Madison, W.I. USA: *ASA Special Publication* 27:1-11.

Awoyinka, Y.A., Akinwumi, J.A., Okoruwa, V.O. and Oni, O.A. (2009). Effects of Livelihood Strategies and Sustainable Land Management Practices on Food Crop Production Efficiency in South-West Nigeria. *Agricultural Journal*, 4(3): 135-143.

Balogun, O.L and Akinyemi B.E., (2017). Land Fragmentation Effects on Technical Efficiency of Cassava Farmers in South-West Geopolitical Zone, Nigeria *Cogent Social Sciences* 3 (1387983):1-10

Becker, M., and Johnson, D.E. (2001). Cropping Intensity Effects on Upland Rice Yield and Sustainability in West Africa. Nutrient Cycling in Agro-ecosystems 59:119-127.

Binswanger-Mkhize, H.P and Savastano, S. (2017). Agricultural Intensification: Status in six African Countries, Food Policy 67 (2017) 26–40

Boserup, E. (1965). The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure in Chicago, Aldine Publishing and Co.

Carswell G. 1997. Agricultural intensification and rural sustainable livelihoods—A think piece. Working Paper 64. Institute of Development Studies, University of Sussex, Brighton, UK. 27 pp.

Cassman, K.G and Pingali., P.L. (2005). Intensification of Irrigated Rice Systems: Learning from the Past to Meet Future Challenges. *Geo Journal* 35(3):299-305.

Chen Y Q, Li X B, Tian Y J, Tan M H (2009). Structural change of agricultural land use intensity and its regional disparity in China. J Georg Sci, 19(5): 545–55.

Cook, S. Silici, L., Adolph B. and Walker, S. (2015). Sustainable intensification revisited. IIED Issue Paper. IIED, London.

Dawson, N., Martin, D and Camfield, L. (2019). Can Agricultural Intensification Help Attain Sustainable Development Goals? Evidence from Africa and Asiahttps://doi.org/10.1080/01436597.2019.1568190

Deininger Klaus and Minten Bart (2002). Determinants of Deforestation and the Economics of Protection: An Application to Mexico American Journal of Agricultural Economics **Vol.** 84, No. 4 (Nov., 2002), pp. 943-960 (18 pages) Published By: Oxford University Press.

Ehirim, N. C.1, Okere, R. A., Onyeagocha, S. U. O. Rahji, M. A. Y Awoyemi, T. T., Oluwatayo., B. I. and Salman, K. K. (2013). Econometric Analysis of Suitability and Marginal Value Productivity of Farmlands for Cassava Production in Imo State, Nigeria, *JDAE Journal of Development and Agricultural Economics*, 5(11): 450-456.

Faleyimu, O. I., Akinyemi, I, O., and Agbeja, B. O. (2010). Incentives for Forestry Development in the South-west Nigeria. *African Journal of General Agriculture* 6 (2) 68. http://www.asopah.org

Food and Agriculture Organization FAO, 1997. Food Outlook: Global Information and Early Warning System. Rome, Italy: FAO, GIEWS. Pp 10-20.

Garnett. T. and Godfray. C (2012). Sustainable intensification in agriculture. Navigating a course through competing food system priorities, A report on a workshop: Food Climate Research Network and the Oxford Martin Programme on the Future of Food, University of Oxford, UK.

Haiguang HAO Xiubin LI Minghong TAN, Jiping ZHANG, Huiyuan ZHANG (2015). Agricultural land use intensity and its determinants: a case study in Taibus Banner, Inner Mongolia, China *Frontier of Earth Sciences.* 2015, 9(2): 308–318 DOI 10.1007/s11707-014-0471-6.

Headey, D., Jayne, T.S., 2014. Adaptation to land constraints: is Africa different? Food Policy 48 (October), 18–33.

Idumah, F.O., Famuyide, O.O, and Owombo, P.T. (2015). Estimating the Production Efficiency of Food Crop Farmers under Agroforestry System in Edo State, Nigeria *World Journal of Agricultural Sciences* 11 (1):1-7.

Lawal, A.F, Omotesho, O.A. and Adewumi, M.O. (2013). Land-Use Pattern and Sustainability of Food Crop Production in the Fadama of Southern Guinea Savanna of Nigeria, *African Journal of Environmental Economics and Management* 1(1):013-021.

Lerner, A.M and Carr, D.L, (2010). Determinants of Agricultural Intensification and Maize Productivity in the Maya Biosphere Reserve, Guatemala, Acta Universitatis Carolinae geographica, 31–40.

Meyfroidt, P., Chowdhury, R. R., de Bremond, A., Ellis, E. C., Erb, K. H., Filatova, T., ... & Verburg, P. H. (2018). Middle-range theories of land system change. *Global environmental change*, *53*, 52-67.

Mgbenka R.N., Mbah E.N. and Ezeano C.I. (2016). A Review of Smallholder Farming in Nigeria: Need for Transformation. *Agricultural Engineering Research Journal* 5(2): 19-26.

Mullahy, J. (2011). Multivariate Fractional Regression Estimation of Econometric Share Models, Department of Population Health Science, University of Wisconsin Madison.

Otsuka, K., Place, F., 2014. Changes in Land Tenure and Agricultural Intensification in Sub-Saharan Africa. WIDER Working Paper 2014/051.

Papke, L.E. and Wooldridge, J.M. (1996). Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates. *Journal of Applied Econometrics*, 11(6):619-632.

Raufu, M.O. (2010). Pattern of Land Use among Selected Crop Farmers in Osun State. Research Journal of Soil and Water Management, 1(1): 1-4.

Ruthenberg, H. (1980). Farming System in the Tropics. Clarendon Press, Oxford.

Saka, J.O., Okoruwa, V.O. and Oyekale, A.S. (2011). The Structure and Determinants of Land-Use Intensity among Food Crop Farmers in Southwestern Nigeria, *Journal of Agricultural Science*, 3(1):194-205.

Sanctus, N., (2011). Optimizing Land Use among Small-Scale Farms through Agricultural Specialization in the North of Burundi. Master's Dissertation submitted in partial fulfilment of the requirements for the

Degree of Master of Science in Nutrition and Rural Development, main subject: Rural Economics and Management Pp. 95.

Shrestha. J, Subedi.S., Timsina. K.P., Subedi. S, Pandey. M., Shrestha. A., Shrestha. S. and Anwar Hossain. M. (2021). Sustainable Intensification in Agriculture: An Approach for Making Agriculture Greener and Productive, *Journal of Nepal Agricultural Research Council*, I7:133-150, https://doi.org/10.3126/jnarc.v7i1.36937

Tiffen, M., Mortimore, M. and Gichuki, F. (1994). More People less Erosion: Environmental Recovery in Kenya. Chichester, UK: Wiley.

Tsue, P. T. (2015). *Effects of arable land tenure and utilisation on environmental degradation among small-scale farmers in north-central Nigeria* (Doctoral dissertation, Doctoral dissertation, University of Nigeria).

Vanlauwe B, Coyne, D Gockowski, J, Hauser, S Huising, J Masso, C Nziguheba, G Schut, M and Van Asten, P (2014). Sustainable Intensification and the African Smallholder Farmers ttp://dx.doi.org/10.1016/j.cosust.2014.06.001 *Current Opinion in Environmental Sustainability* (6) 8:15–22.

Von Thunen model of agricultural land use was created by farmer and amateur economist J.H. Von Thunen (1783-1850) in 1826 (but it wasn't translated into English until 1966).

Xie. H, Zou. J and Peng. X., (2012). Spatial-temporal Difference Analysis of Cultivated Land- Use Intensity based on Energy in Poyang Lake Eco-economic Zone. *Acta Geographica Sinica*, 67(7): 889–902. (In Chinese)

Yamba, S., Appiah D.O., Pokuaa-Siaw L., and Asante F. (2017). Smallholder Farmers' Livelihood Security Options amidst Climate Variability and Change in Rural Ghana. *Hindawi Scientifica.* Article ID 1868290, 1-10.

Yusuf, S.A., Odutuyo, O.E. and Ashagidigbi, W. M. (2011). Agricultural Intensification and Poverty in Oyo State. *Journal of World Rural Observations*, 3(4) 98-106.