Istanbul Gelisim Univ J Soc Sci 2025:12(3)Special Issue;1505-1523
DOI: 10.17336/igusbd.1709565

ÖZGÜN ARAŞTIRMA / ORIGINAL ARTICLE

Labour Diversification and Efficiency Trade-offs in Cassava Production: Evidence from Smallholder Farmers in Nigeria

Manyok Üretiminde İşgücü Çeşitlendirmesi ve Verimlilik Arasındaki Değiş-Tokuş: Nijerya'daki Küçük Ölçekli Çiftçilerden Elde Edilen Bulgular

Adewale Isaac OLUTUMISE

Dr., Department of Agricultural Economics, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria ; Department of Economic and Business Sciences, Walter Sisulu University, Mathatha, 5117, South Africa
✉ adewale.olutumise@aaua.edu.ng; firstwalefat@yahoo.com

Geliş/Received: 30.05.2025
Kabul/Accepted: 09.01.2026

Abstract

Aim: This study examines the relationship between off-farm work participation and the technical efficiency of smallholder cassava farmers in Nigeria, addressing the trade-offs between labour diversification and on-farm efficiency.

Method: Primary data were collected from 150 smallholder cassava farmers in Nigeria using a multi-stage sampling procedure and structured questionnaires. Data analysis employed stochastic frontier analysis (SFA) to estimate technical efficiency and logistic regression to identify determinants of off-farm work participation.

Results: Off-farm work participation is associated with lower technical efficiency in cassava production. Farmers engaged in off-farm work achieved an average efficiency of 41.28%, compared to 51.42% among non-participants, suggesting that off-farm labour commitments may hinder timely farm management. Logistic regression analysis revealed that sex, household size, farming experience, and access to credit significantly influence participation in off-farm work.

Conclusion: Findings emphasize policy imperatives for rural development that reconcile off-farm livelihood opportunities with sustainable cassava productivity. The need for policy efforts to promote labour-saving technologies, enhance access to rural credit, and develop flexible labour systems holds promise for enabling smallholder farmers to integrate livelihood diversification with efficient cassava production.

Keywords

Cassava production, technical efficiency, labour diversification, stochastic frontier, rural employment

Adewale Isaac OLUTUMISE, "Labour Diversification and Efficiency Trade-offs in Cassava Production: Evidence from Smallholder Farmers in Nigeria", Istanbul Gelisim University Journal of Social Sciences, 12 (3), Special Issue on Sustainability, 2025, pp. 1505-1523.

Öz

Amaç: Bu çalışma, Nijerya'daki küçük ölçekli manyok çiftçilerinin tarım dışı işlere katılımı ile teknik etkinlikleri arasındaki ilişkiyi incelemekte; iş gücü çeşitlendirmesi ile çiftlik içi verimlilik arasındaki değiş-tokuşu ele almaktadır.

Yöntem: Birincil veriler, çok aşamalı örnekleme prosedürü ve yapılandırılmış anketler kullanılarak Nijerya'daki 150 küçük ölçekli manyok çiftçisinden veri toplanmıştır. Veri analizinde, teknik etkinliği tahmin etmek için (SFA) analizi ve tarım dışı işlere katılımın belirleyicilerini tanımlamak için lojistik regresyon kullanılmıştır.

Bulgular: Tarım dışı işlere katılım, manyok üretiminde daha düşük teknik etkinlik ile ilişkilendirilmiştir. Tarım dışı işlerde çalışan çiftçiler ortalama %41,28 verimlilik düzeyine ulaşırken, bu oran katılımcı olmayanlarda %51,42 olarak belirlenmiştir. Bu durum, tarım dışı iş taahhütlerinin, işletme yönetiminin aksamasına yol açabileceğini göstermektedir. Lojistik regresyon analizi; cinsiyet, ev halkı sayısı, çiftçilik deneyimi ve krediye erişimin tarım dışı işlere katılımı önemli ölçüde etkilediğini ortaya koymuştur.

Sonuç: Bulgular, tarım dışı geçim kaynakları ile sürdürülebilir manyok üretkenliğini bağdaştıran kırsal kalkınma politikalarının önemini vurgulamaktadır. İş gücü tasarrufu sağlayan teknolojilerin teşvik edilmesi, tarım krediye erişimin artırılması ve esnek iş gücü sistemlerinin geliştirilmesine yönelik politika çabaları; küçük ölçekli çiftçilerin geçim kaynaklarını çeşitlendirirken aynı zamanda verimli manyok üretimi yapabilmelerine olanak tanıma potansiyeli taşımaktadır.

Anahtar Kelimeler

Manyok üretimi, teknik verimlilik, iş gücü çeşitlendirmesi, stokastik analiz, kırsal istihdam

Introduction

Cassava (*Manihot esculenta Crantz*) remains a main crop in Nigeria and sub-Saharan Africa (SSA), where it is used for both subsistence and industrial purposes. Nigeria is the world's largest producer of cassava, accounting for more than 20% of global production, underscoring the crop's importance to national food security and rural livelihoods (FAO, 2020). In addition to its nutritional value, cassava also serves as a raw material for various industries, including food processing, livestock feed, and bioethanol production. Despite this potential, cassava-based system productivity remains sub-optimal, whereby technical inefficiencies restrict smallholder farmers (Borku et al., 2025). Once more, small farmers control Nigeria's agricultural landscape, often managing less than 2 hectares of farmland in resource-scarce environments (MGBenka et al., 2016). Producers frequently face limited market access, restricted expansion, and insufficient credit facilities (Ajayi and Olutumise, 2018). In response, households diversify their labour through off-farm activities, such as commerce, transport services, or contingent jobs, to stabilize income (Reardon et al., 2020). Although it reduces financial pressures, this can create trade-offs, notably in labour availability and managerial attention to key farm operations (Babtunde and Kam, 2010).

Technical efficiency is defined as the ability to make the highest output from a specified set of inputs (Olutumise et al., 2023). As such, it is a central measure in evaluating agricultural performance (Farrell, 1957). Research indicates that cassava farmers' efficiency rates vary widely, typically ranging from 30% to 80% (Ogunniyi et al., 2013). This variability indicates opportunities to boost productivity and the effect of household decision-making on labour allocation. Since off-farm income increases farm input use, it can also reduce the time devoted to essential activities such as pest control or appropriate harvesting, thereby hindering technical efficiency (Ellis and Freeman, 2004). The empirical literature reveals mixed evidence regarding the effect of off-farm employment on farm performance. Some scholars maintain that non-farm employment increases efficiency by alleviating liquidity constraints and by enabling investment in better inputs (Benjamin and Kimhi, 2006; Kehinde and Ogundeji, 2023). Others, however, advise that time poverty caused by off-farm activities weakens efficient farm management (Oyetunde-Usman and Olagunju, 2019; Issahaku et al., 2021). This ambiguity indicates that an investigation of labour allocation practices and their impact on farm productivity needs to be re-examined, especially for cassava, which requires intensive labour for management.

Many socio-economic indices dictate how off-farm employment intersects with on-farm efficiency. Access to land, schooling, extension assistance, and credits all contribute (Adetomiwa et al., 2021). Moreover, demographic attributes such as gender, age, and household size moderate off-farm activity engagement and on-farm efficiency (Reardon and Barrett, 2000). For example, male farmers and young households are often involved in informal employment and migrant employment, which can reduce their involvement in day-to-day farm practices. The literature also suggests that off-farm income promotes the adoption of knowledge-based technologies, such as improved stem cuttings or mechanical weeding (Omonona et al., 2006; Mekonnen, 2022). However, opportunity cost from redeployed labour must be carefully taken into account. Farmers who are absent from their farms during peak planting and harvesting seasons may yield less or produce lower-quality output (Fang et al., 2022). Hence, understanding these trade-offs guides the design of labour-aware, technology-inclusive rural development policy.

This study identifies an urgent research need by examining the efficiency effects of labour diversification in cassava agricultural systems. Using stochastic frontier analysis (SFA), it measures the technical efficiency of cassava producers and explores how off-farm work affects these outcomes. In addition, logit regression identifies the socio-economic causes of labour diversification. Analyzing these interactions provides policy-relevant insights into the balancing act between off-farm income generation and sustainable cassava production. Given the strategic importance of cassava in Nigeria's food system and its integration into regional value chains, improving technical efficiency is essential to achieving national development goals, reducing poverty, and advancing Sustainable Development Goal 2 (Zero Hunger). This research is timely and relevant, especially in the context of Nigeria's post-pandemic agricultural recovery strategy and labour mobility transitions. Ultimately, the findings aim to inform policies that harmonize livelihood diversification with agricultural efficiency for inclusive rural transformation.

Specifically, the study aims to:

(i) measure the technical efficiency of cassava farmers in the study area;

(ii) examine the effect of off-farm labour participation on technical efficiency; and

(iii) identify the socio-economic factors influencing farmers' decision to engage in off-farm work."

Literature Review

The decision-making behaviour of smallholder farmers, particularly regarding labour allocation between farm and non-farm activities, can be effectively explained by synthesising two key theoretical constructs: the Agricultural Household Model (AHM) and the theory of production efficiency. These frameworks jointly provide insights into how off-farm work participation interacts with technical efficiency in agricultural production. The Agricultural Household Model (AHM), as developed by Singh, Squire, and Strauss (1986), recognizes that in rural settings with imperfect markets, especially for credit and labour, households make joint production and consumption decisions. Labour diversification, particularly through off-farm employment, emerges as a strategy for managing income risks and coping with economic shocks. For many Nigerian smallholder farmers, engagement in non-agricultural labour activities is a response to constrained access to production credit, land insecurity, and volatile agricultural markets. While such off-farm participation provides supplemental income that can be reinvested into farming, it also competes with farm labour demands, potentially leading to suboptimal resource use and reduced technical efficiency. This dynamic is further understood through the lens of production efficiency theory, particularly the framework introduced by Farrell (1957), which defines technical efficiency as the ability of a producer to maximize output given a set of inputs. Any deviation from the efficient frontier signifies either resource misallocation or management inefficiencies. In smallholder agriculture, stochastic frontier analysis (SFA) has been widely used to quantify inefficiencies, accounting for both random errors and inefficiency effects. In contexts where labour allocation decisions are fluid and influenced by off-farm incentives, the SFA approach offers a valuable tool to isolate the specific impact of off-farm participation on farm-level productivity.

The incorporation of each explanatory variable in the empirical models is grounded in the theories. Under the AHM, age is associated with a farmer's physical capacity and accumulated production experience. Older farmers are likely to have better knowledge of input use and crop management, which may enhance efficiency (Awotona, 2020). However, their physical limitations may offset these gains in labour-intensive activities like cassava production. Education is linked to human capital development in the AHM. It enhances a farmer's ability to understand and adopt improved technologies, interpret extension messages, and make informed production choices (Olutumise et al., 2020). These abilities contribute to more efficient use of inputs and to better farm decision-making. The AHM emphasizes credit constraints in rural settings. Access to credit reduces reliance on off-farm income and enables timely investment in inputs, mechanization, and farm expansion (Kehinde & Ogundeji, 2023). This directly affects technical efficiency by addressing liquidity bottlenecks. Household size represents both an available labour force and a consumption burden. Larger households have more family labour to allocate to farming (a production-side benefit), but also require higher income to meet consumption needs, which may push households toward off-farm work (Neglo et al., 2021a). This trade-off is a key concern in the AHM framework. Participation in off-farm work is a core concept in the AHM. Households diversify into off-farm labour to stabilize income, especially under imperfect market conditions. While off-farm work may bring financial benefits, it also imposes opportunity costs in the form of reduced time, attention, and labour for on-farm operations (Babtunde & Qaim, 2010). Gender roles influence labour allocation, access to resources, and decision-making authority. The AHM recognizes that men and women face different constraints in rural economies. Male farmers often have greater mobility and access to labour markets, increasing the likelihood of off-farm participation (Reardon & Barrett, 2000), whereas female farmers may be constrained by domestic responsibilities, which can affect farm productivity differently. Marital status affects household labour structure, responsibilities, and access to support networks. Married farmers may benefit from greater family labour availability but may also face increased household obligations, which can influence labour allocation and income diversification strategies, consistent with AHM assumptions on intra-household labour and consumption dynamics. In both theoretical frameworks, farm size plays a crucial role. Larger landholdings enable access to economies of scale, mechanization, and better land management, which can improve technical efficiency (Akpaeti & Frank, 2021). In the AHM, land is also a key production asset influencing household livelihood strategies. Cooperative membership reflects both institutional and social capital. Through cooperatives, farmers gain better access to credit, inputs, extension services, and market information, key components that lower transaction costs and improve resource allocation, consistent with household models emphasizing the role of institutions in shaping production behaviour.

Empirical research on the interaction between off-farm labour participation and agricultural efficiency has yielded mixed outcomes, reflecting differences in crop systems, institutional environments, and methodological approaches. Broadly, the literature can be categorized into three strands: studies reporting adverse effects of off-farm work on technical efficiency, those identifying positive or neutral impacts, and those exploring the determinants of technical efficiency in cassava-based systems. Several studies argue that off-farm labour compromises farm efficiency by reducing the availability of time and labour for essential agricultural tasks. Seidu (2008), using stochastic frontier analysis (SFA) in Ghana, found that farmers who engaged in part-time employment experienced delays in weeding and pest control, resulting in reduced productivity. Similarly, Kehinde and Ogundeji (2023) employed econometric techniques in Southwestern Nigeria to analyze cassava farmers' income patterns. Their findings revealed that involvement in off-farm employment significantly reduced cassava yields and profitability, mainly due to labour shortages during peak agricultural periods. Supporting this view, Oyetunde-Usman and Olagunju (2019) argued, based on household-level survey data from Nigeria, that time constraints imposed by non-farm jobs led to suboptimal farm supervision, thereby negatively affecting decision-making and efficiency.

In contrast, other empirical contributions suggest that off-farm income can enhance technical efficiency, particularly when the additional earnings are reinvested into agriculture. Adepoju, Olaleye, and Olagunju (2023) examined the role of non-farm income among maize farmers in Nigeria using regression analysis. They found that off-farm earnings facilitated access to improved seeds, fertilizers, and extension services, thereby boosting farm productivity. Benjamin and Kimhi (2006), in a discrete-choice modelling study of French farm households, reported that non-agricultural labour supported

capital accumulation and enabled the adoption of modern technologies, thereby improving technical efficiency. Similarly, Li and Jiang (2022), using threshold regression models in rice-producing regions of China, concluded that moderate levels of off-farm employment had no detrimental effects on farm productivity. Instead, they found that when off-farm income was strategically reinvested in mechanization, farm efficiency improved.

In the context of cassava farming, a growing body of research has focused on identifying the socio-economic and institutional determinants of technical efficiency. Ogunniyi, Ajetomobi, and Ajetomobi (2013) applied a stochastic frontier model to cassava-based farms in Oyo State, Nigeria, and reported that education, access to credit, and cooperative membership significantly increased efficiency scores. Likewise, Ajayi and Olutumise (2018), conducting an SFA analysis in Ondo State, observed that input use intensity, land tenure status, and household demographics were essential predictors of efficiency levels. Akpaeti and Frank (2021) compared cassava cooperative members with non-members in South-South Nigeria and found that cooperative affiliation led to improved efficiency, primarily due to shared access to inputs and extension support services. Further insights were provided by Olutumise et al. (2023), who examined gender-based differences in efficiency among oil palm processors in Southwest Nigeria. Their findings revealed that women faced institutional constraints that limited their access to credit and extension services, resulting in lower technical efficiency than their male counterparts.

While the literature provides valuable insights into the implications of off-farm labour and the determinants of agricultural production efficiency, significant gaps remain. Most notably, few studies have integrated the dual role of off-farm work, as both a potential income source and a source of managerial constraint, within a unified analytical framework. In particular, the cassava subsector remains underexplored, despite its national importance in Nigeria's food system and rural economy. This study addresses this research gap by employing a combination of stochastic frontier analysis to measure technical efficiency and logistic regression to identify the socio-economic drivers of off-farm labour participation among cassava farmers. In doing so, it contributes to a more comprehensive understanding of the trade-offs and synergies inherent in rural labour diversification strategies.

Material and Methods

Study Area

The research took place in Nigeria, acknowledged as the world's largest cassava producer, with an emphasis on small-scale cassava farmers. Although the crop is cultivated nationwide, this study focused on Ondo State due to its substantial cassava output and the common engagement of farmers in off-farm work. The state's mix of agroecological conditions, active rural labour markets, and evolving policy landscape offers a fitting setting to examine how labour diversification, particularly off-farm employment, affects the technical efficiency of cassava farming. The State's importance in both national food security efforts and rural income diversification makes it an ideal case for evaluating trade-offs between off-farm earnings and farm productivity.

Research Design

This research employed a cross-sectional survey to investigate how labour diversification (off-farm work) relates to the technical efficiency of smallholder cassava producers. Primary data were gathered using structured questionnaires and direct interviews to ensure precision and context. A quantitative approach was applied, allowing for the calculation of efficiency scores and the statistical testing of the effects of off-farm work on cassava farm productivity. The design was chosen because it effectively captures variation in labour allocation strategies and their impact within a single farming season.

Sampling Technique and Sample Size

A multi-stage sampling strategy was used. First, Ondo State was intentionally selected due to its significance in cassava farming and the high rate of off-farm labour among rural households. In the second stage, three Local Government Areas (LGAs) with active cassava farming were randomly chosen. Third, five farming communities were randomly selected from each LGA. Finally, systematic random sampling was applied to select 150 cassava farmers, ensuring balanced representation

between those with off-farm work and those who farm exclusively. The sample size was determined using Yamane's (1967) formula to ensure statistical representativeness with a 7% margin of error:

$$n = \frac{N}{1 + N(e^2)} \quad (1)$$

where: n = sample size, N = total population of cassava farmers in the selected LGAs, e = margin of error (set at 7%).

Data Collection

The study used primary data collected through a well-structured questionnaire and in-person interviews conducted by trained enumerators to ensure clarity and consistency in responses. The survey gathered information in several variables: socio-economic attributes of respondents (age, education level, household size, access to credit, and cooperative membership), farm characteristics (land area, input usage, labour), labour diversification measures (type, frequency, and duration of off-farm activities, income earned, and motivation for participation), and cassava production data (yield levels, production costs, revenue, and main constraints).

Analytical Techniques

The dataset was analyzed using descriptive statistics, stochastic frontier analysis (SFA), and binary logistic regression to assess both the technical efficiency of cassava producers and the determinants of off-farm work participation.

Descriptive Statistics

Measures such as means, percentages, and frequency distributions were used to summarize socio-economic and farm-related variables of the sampled farmers.

Stochastic Frontier Analysis (SFA)

A Cobb–Douglas stochastic frontier production model was applied to compute technical efficiency (TE) scores, following the approach of Olutumise et al. (2023) and Ijigbade et al. (2023). As noted by Coelli et al. (2005). This model accommodates both random shocks and production inefficiencies, making it appropriate for analyzing the effect of off-farm work on cassava output. The model is specified as in equation (2):

$$Y_i = \int (X_i; \beta)\, \varepsilon^{(V_i - U_i)} \quad (2)$$

The explicit function of the stochastic frontier production function model for the cassava farmers is specified by the Cobb-Douglas production function, as specified in equation (3):

$$ln\, Y_i = \gamma_0 + \gamma_1 FET_{i1} + \gamma_2 PET_{2i} + \gamma_3 LAB_{3i} + \gamma_4 FAS_{4i} + \gamma_5 SCT_{5i} - (V_i + U_i) \quad (3)$$

where: Yi = output of cassava (kg), Xi = vector of production inputs (*FET* = fertilizer used (kg), *PET* = pesticide used (litres), *LAB* = labour used (man-day), *FAS* = farm size (ha), and *SCT* = stem cuttings used (kg), β = vector of parameters to be estimated, Vi = random error (assumed to be normally distributed), Ui = non-negative inefficiency term.

The inefficiency effects model was specified as equation (4):

$$U_i = \delta_0 + \sum_{j=1}^{n} \delta_j Z_{ij} \quad (4)$$

The explicit function of the inefficient component is stated as equation (5):

$$Ui = \sigma_0 + \sigma_1 Z_1 + \sigma_2 Z_2 + \sigma_3 Z_3 + \sigma_4 Z_4 + \sigma_5 Z_5 + \sigma_6 Z_6 + \sigma_7 Z_7 + \sigma_8 Z_8 + \sigma_9 Z_9 + \sigma_{10} Z_{10} \quad (5)$$

where: Z_{ij} = socio-economic variables (Z_1 = age (years), Z_2 = education (years), Z_3 = access to credit (yes =1), Z_4 = cooperative membership (yes=1), Z_5 = farm size (ha), Z_6 = household size (numbers), Z_7 = off-farm work participation (yes =1), Z_8 = sex (male =1), Z_9 = farming experience (years) and Z_{10} = marital status (married =1), δ_0, δ_j = parameters to be estimated. The efficiency score for each farmer was derived from the SFA model, ranging from 0 (least efficient) to 1 (fully efficient).

Logistic Regression Model

To identify factors influencing farmers' participation in off-farm work, a binary logistic regression model was applied. The dependent variable equals one if a farmer engages in off-farm work and zero otherwise. The probability function in equation (6) is shown as:

$$P(Y_i) = \frac{e^{(\theta_o + \sum \theta_j X_{ij})}}{1 + e^{(\theta_o + \sum \theta_j X_{ij})}} \quad (6)$$

The explicit function (log-odds transformation) of the model is stated in equation (7) as:

$$\ln\left[\frac{Y_i}{1 - Y_i}\right] = \beta_0 + \beta_1 \text{Age}_1 + \beta_2 \text{Education}_2 + \beta_3 \textit{Marital status}_3 + \beta_4 \text{Credit access}_4 + \beta_5 \text{Farm size}_5 + \beta_6 \text{Experience}_6 + \beta_7 \text{Extension services}_7 + \beta_8 \text{cooperatives}_8 + \beta_9 \text{Sex}_9 + \beta_{10} \text{Household size}_{10} + \varepsilon_i \quad (7)$$

where: Y_i = 1 if the farmer participates in off-farm work, 0 otherwise. The explanatory variables are age, sex, education, marital status, access to credit, household size, farm size, farming experience, access to extension services, and cooperative membership. β0 and βj are the regression coefficients. ε_i = the error term.

Hypotheses

The study tested the following hypotheses:

H_{o_1}: Off-farm work has no significant impact on cassava farmers' technical efficiency.

H_{o_2}: Socio-economic variables do not significantly influence farmers' engagement in off-farm work.

Results and Discussion

Socioeconomic Characteristics of Cassava Farmers in the Area

The demographic profile of cassava farmers, as shown in Table 1, reveals that 54% are aged 41-60 years, with an average age of 45 years. This suggests that most participants are in their productive working years, a key advantage in cultivating labour-intensive crops such as cassava. Similar patterns have been reported in previous research, where younger farmers (under 40) often exhibit greater openness to adopting innovative farming techniques and technologies (Liu et al., 2018; Szabo et al., 2021), while older farmers tend to draw on their accumulated knowledge and experience to improve production efficiency (Awotona, 2020). The gender distribution reveals a male dominance in cassava production, with 60% male and 40% female respondents. This aligns with previous studies in Nigeria (Kehinde and Ogundeji, 2023; Oparinde et al., 2023), which report higher male participation in staple crop production. The gender imbalance may reflect broader disparities in access to land, credit, and labour, which in turn influence both productivity and the decision to engage in off-farm employment. Regarding marital status, 80% of farmers were married, 13.3% were single, and 6.7% were widowed. Married individuals' dominance implies greater access to family labour, which can reduce reliance on hired labour and enhance technical efficiency (Ajayi and Olutumise, 2018). However, domestic duties can also lead farmers to take on off-farm employment as households seek to diversify their income. Educational level was relatively high, with 90.7% of respondents having attained at least primary education. Education enhances absorptive capacity and mastery of new technologies, interpretation of market signals, and use of extension facilities (Olutumise et al., 2020). High literacy implies that awareness of better cassava production practices and resource optimization can be enhanced. Household size was moderate, averaging seven persons per family, and 88% of farmers reported fewer than 10 family members. Larger households can be a source of family labour, reducing production costs, but can also put additional financial pressure on the family, prompting off-farm engagement (Johnston and Roux, 2007). This dynamic highlights the dual role of household size as both an asset and a liability in smallholder agriculture.

Only 32.7% of respondents owned their land, while 67.3% farmed on leased or rented farmland. Land tenure security significantly influences long-term investments in soil fertility, irrigation, and mechanization (Adetomiwa et al., 2021). Limited ownership may discourage farmers from undertaking long-term efficiency-enhancing practices, particularly when capital is also constrained. The farm size distribution indicates that 86.4% of cassava farmers operated on less than 1 hectare,

with a mean farm size of 0.90 hectares. This affirms the dominance of smallholder farming in Nigeria and underscores challenges related to economies of scale, mechanization, and technology adoption (FAO, 2019). Small landholdings may hinder full-time reliance on cassava farming and encourage income supplementation through off-farm labour. Regarding farming experience, 58% of respondents had 11–20 years, 43% had fewer than 10, and only 2% had more than 30. Experience is a critical determinant of farm management skills and input optimization (Awotona, 2020). Meanwhile, the presence of newer entrants into cassava farming may reflect the crop's growing market relevance and the appeal of cassava value chains.

About 63.3% of farmers reported access to credit, while 36.7% lacked it. Credit availability facilitates the purchase of improved inputs and supports timely farm operations, both of which are essential for efficiency (Kehinde and Ogundeji, 2023). The moderate rate of credit access suggests that while some farmers have the financial means to scale production, others may be constrained and more likely to diversify into off-farm work. Membership in cooperatives or farmer groups was relatively low, with only 38% reporting participation. Farmer organizations provide collective bargaining power, access to extension services, and training on improved technologies, all of which enhance technical efficiency (Tadele, 2021). The low participation rate suggests an opportunity to strengthen farmer networks to boost productivity outcomes. Access to extension services was reported by 61.3% of respondents. Extension plays a vital role in disseminating knowledge and promoting best practices (Norton and Alwang, 2020). Farmers with regular extension contact are more likely to implement productivity-enhancing techniques, which could mitigate the negative effects of off-farm labour time constraints.

Table 1. Socioeconomic characteristics of the cassava farmers

Variable	**Frequency**	**Percent**	**Mean (SD)**
Age (years)			**45.0 (34.9)**
21 – 40	58	38.7	
41 – 60	81	54.0	
61 – 80	11	7.3	
Sex			
Male	90	60.0	
Female	60	40.0	
Marital status			
Single	20	13.3	
Married	120	80.0	
Widowed	10	6.7	
Educational status			
No formal education	14	9.3	
Primary school education	31	20.7	
Secondary school education	79	52.7	
Tertiary education	26	17.3	
Household size			**7.0 (3.1)**
<10	132	88.0	
11 – 20	18	12.0	
Farm ownership			
Yes	52	32.7	
No	98	67.3	

Table 1. Devamı

Variable	Frequency	Percent	Mean (SD)
Farm size (ha)			**0.90 (0.54)**
< 1	132	86.4	
2	15	11.8	
3	3	1.8	
Experience (years)			
< 10	43	28.7	
11 – 20	98	65.3	
21 – 30	7	4.7	
> 30	2	1.3	
Credit access			
Yes	55	63.3	
No	95	36.7	
Membership			
Yes	57	38.0	
No	93	62.0	
Extension services			
Yes	92	61.3	
No	58	38.7	
Total	150	100.0	

Identification, Motivation, and Impact of Labour Diversification (Off-Farm Work Activities) in the Area

The results reveal that a significant proportion (83.8%) of cassava farmers engage in off-farm work activities (Table 2). This high participation rate is consistent with earlier findings by Reardon et al. (1998) and Neglo et al. (2021b), who observed that smallholder farmers in developing economies increasingly turn to non-farm employment to supplement household income. This trend underscores the economic vulnerability of smallholder systems and the role of labour diversification as a risk-coping strategy. It also depicts the inefficiencies of relying solely on cassava production to meet household income needs. Farmers surveyed are engaged in several off-farm livelihood activities, of which transport service provision (34.6%) and commerce/marketing (28.4%) prove to be the most frequent ones. Such activities probably appeal because of their simple startup requirements and relatively stable cash inflow. More specifically, participation in informal transport activities, such as Okada (motorcycle taxis) and Keke (tricycles), generates daily income that can be used to sustain family consumption needs or to fund farm activities (Ogunniyi et al., 2021).

Public employment jobs (10%) include off-farm wage workers, who are part-time teachers, medical attendants, and government employees who run cassava farms on stable monthly salaries. Even though stable income increases investment in agriculture, it may reduce the time available for on-farm monitoring and labour control, thereby decreasing technical efficiency (Kehinde and Ogundeji, 2023). Other notable categories include artisanal work (6.6%), such as tailoring, hairdressing, and blacksmithing. These activities are often performed locally and offer flexible hours, especially for women balancing domestic and farm duties. Meanwhile, agricultural labour (8%) reflects seasonal work by cassava farmers on other farms, typically in exchange for cash or in-kind payments. The widespread adoption of off-farm work indicates that labour reallocation plays a central role in smallholder livelihood strategies. However, the nature and intensity of these activities vary, and their implications for on-farm productivity depend on factors such as time management, income reinvestment, and gender dynamics. The following sections examine how these engagements affect technical efficiency among cassava producers.

Motivations for Engaging in Off-Farm Work: Supplementary Income (67.8%) was reported as the highest motivation. The dominant reason for off-farm employment is financial necessity. Many farmers lack access to credit (only 36.7% have formal credit access), making off-farm income essential for purchasing fertilizers, pesticides, and labour (Ajayi and Olutumise, 2018). Financial Security (19.8%) was also reported. Some farmers see off-farm work as a way to hedge against agricultural risks such as low yields, price fluctuations, and climate variability (Adebayo et al., 2020). Income Diversification (12.6%) was also given as motivation for off-farm income. A few farmers intentionally balance farm and off-farm activities to spread risk and stabilize household income.

Impacts of Off-Farm Work on Cassava Production: Many farmers reported that off-farm work positively affected (60.7%) their cassava production by providing additional income to buy improved seeds, fertilizers, herbicides, and farm equipment. Reducing reliance on formal credit, which is often inaccessible due to collateral requirements and high interest rates (Awotona, 2020). Helping farmers cope with market fluctuations, allowing them to store produce and sell at better prices. These findings support Neglo et al. (2021b), who argued that non-farm income is a crucial determinant of smallholder investment in agriculture. However, about 18.3% reported negative impacts. According to Kehinde and Ogundeji (2023) and Oparinde et al. (2023), off-farm work reduces the time available for farm supervision, leading to suboptimal input use. Again, farmers engaged in transport services or construction often find it challenging to meet peak farming activities, such as weeding and harvesting. Thus, periodic absences from farm activities result in poor monitoring of pest infestations and delayed harvesting (Ogunniyi et al., 2021; Omotayo et al., 2021). Again, a few (21.0%) farmers reported that off-farm work had no significant effect on cassava production. These farmers likely balance farm and non-farm activities efficiently, or their off-farm jobs are seasonal and do not interfere with peak farming periods.

Table 2. Participation in Off-farm Activities by Cassava Farmers

Off-farm Activities	Frequency	Percentage (%)
Engagement in off-farm work	126	83.80
Types of off-farm work		
Transport workers	52	34.6
Trading (retail, wholesale)	43	28.4
Building contractor (masonry, carpentry, welding)	29	19.5
Public servants (teaching, health workers, civil service)	15	10.0
Artisanal work (tailoring, hairdressing, blacksmithing)	10	6.6
Agricultural labour (working on other farms)	12	8.0
Commercial motorcycle/tricycle operator	22	14.7
Others (remittances, rental business, food processing)	26	17.5
Sources of Motivation		
Means of getting supplementary income	102	67.80
Enhance financial security	30	19.8
Means of income diversification	18	12.6
Perceived Impacts on Cassava Production		
Positive impacts	91	60.70
Negative impacts	27	18.3
No impacts	32	21.0
Total	**150**	**100.0**

Estimating the Technical Efficiency of Cassava Farmers

The technical efficiency of cassava producers in the study area was assessed using the Maximum Likelihood Estimation (MLE) method within the Cobb–Douglas stochastic frontier production framework. This approach separates variations in output into two components (random noise

and inefficiency), making it particularly suitable for examining production settings influenced by shifting resource allocation, such as those shaped by labour diversification. As shown in Table 3, the stochastic frontier specification proved appropriate for the analysis. The estimated sigma-squared (σ^2) value of 0.762 was significant at the 1% level, indicating that inefficiency plays a significant role in explaining differences in cassava yields among farmers. The model's log-likelihood score of –383.53 further confirms the suitability of the Cobb–Douglas form for representing the region's production structure. One of the most important results is the gamma (γ) estimate of 0.82, meaning that 82% of the observed variation in cassava output stems from technical inefficiency rather than from random fluctuations or measurement errors. This sizeable inefficiency component underscores the considerable potential to improve resource use efficiency among cassava farmers, especially given the competing demands of off-farm employment.

Among the production inputs, farm size had a positive and highly significant coefficient at the 1% level. A 1% increase in harvested area (farm size) for cassava was associated with a 0.657% increase in output. This finding continues to establish land access and land tenure security as important drivers of productivity and technical efficiency. Programs that seek to improve land access through reform or institutional strengthening may help farmers expand operations and adopt more efficient practices. Fertilizer use was associated with a positive, statistically significant coefficient (0.706) with cassava output, indicating that an additional unit of use increased yield by 0.706%. This finding strengthens the imperative for a reliable supply of inputs to achieve optimal performance in outputs. In like manner, pesticide use was associated with a positive and significant coefficient (0.874), which verifies its effectiveness in pest and disease control to sustain high-level productivity. These findings align with earlier studies (e.g., Bankole et al., 2018; Ajayi & Olutumise, 2018; Oparinde et al., 2019; Olutumise et al., 2023), which underscore the imperative of enhancing farmers' access to and efficient use of yield-inducing inputs.

Notably, labour input showed a statistically insignificant but negative coefficient (-0.624), suggesting that additional labour does not always result in increased cassava production. This may reflect labour inefficiencies, poor supervision, or time constraints imposed by off-farm commitments, which reduce the quality or timing of labour-intensive operations (Oseni and Winters, 2009; Obe et al., 2024). The result aligns with the broader argument that it is not merely the quantity of labour but the quality, timing, and supervision that determine productive efficiency.

Table 3. Maximum Likelihood Estimates of the Stochastic Frontier Production Function

Variables	Coefficient	Standard Error	t-value
Constant	7.305	1.668	4.38
Fertilizer	0.706***	0.176	4.02
Pesticide	0.874***	0.241	3.63
Labour	-0.624	0.606	-1.03
Farm Size	0.657***	0.165	3.98
Stem Cutting	0.061	0.052	1.18
Sigma Squared (σ^2)	0.762	0.161	4.72
Gamma (γ)	0.820	0.181	4.54
Log-Likelihood Function	-383.53		
LR Test	4.2		

Note: ***Significant at 1%, **Significant at 5%, *Significant at 10%.

Determinants of Technical Efficiency of Cassava Farmers

The determinants of technical efficiency for cassava producers were examined using the inefficiency effects model incorporated within the stochastic frontier framework. Ten socio-economic factors were assessed to identify those most influential in shaping farm-level efficiency. The results in Table 4 show that farming experience, age, credit access, cultivated area, education, and cooperative membership were all positively and significantly associated with higher efficiency levels. In contrast, involvement in off-farm employment had a negative and statistically significant effect, lending support to the main hypothesis that labour diversification can reduce on-farm performance.

Among the positive factors, farming experience emerged as an important contributor, with a coefficient of 0.7160 ($p < 0.10$). This suggests that each additional year of farming experience improves efficiency by 71.6%. Experienced farmers often possess better agronomic skills, improved input management, and stronger risk mitigation strategies, all of which boost productivity. Similarly, age was positively related to efficiency (coefficient = 0.2271, $p < 0.10$), indicating that each additional year of age increases efficiency by 22.71%. This result highlights the benefits of accumulated farming knowledge, although physical constraints among older farmers may limit their capacity for labour-intensive activities, underscoring the need for extension programs that balance generational expertise and physical capability.

Credit access proved to be another key driver of efficiency, with a coefficient of 0.6243 ($p < 0.01$), indicating that farmers with credit are 62.43% more efficient than those without. Credit facilitates the timely purchase of inputs, investment in machinery, and adoption of yield-enhancing technologies. These findings emphasize the importance of strengthening rural finance systems and expanding agricultural credit schemes to improve productivity.

Farm size had a strong positive effect (coefficient = 0.5417, $p < 0.01$), indicating that an additional hectare cultivated is associated with a 54.17% increase in efficiency. This supports the view that larger farms often benefit from economies of scale, mechanization, and better labour organization (Akpaeti & Frank, 2021; Bankole et al., 2018; Olutumise et al., 2023). However, the widespread problem of land fragmentation in Nigeria calls for land tenure reforms and consolidation policies.

Education also had a significant positive impact on efficiency (coefficient = 0.2410, $p < 0.01$). Each extra year of schooling improved efficiency by 24.10%, suggesting that educated farmers are more likely to adopt improved practices, interpret technical advice effectively, and make sound production decisions. This underscores the value of integrating functional literacy into rural development strategies.

Membership in cooperatives showed a significant effect (coefficient = 0.6501, $p < 0.05$), with members being 65.01% more efficient than non-members. This finding illustrates the benefits of social networks and collective action in improving access to credit, inputs, technical knowledge, and market opportunities.

On the other hand, off-farm employment participation had a significant negative effect on efficiency (coefficient = –0.4901, $p < 0.01$), with participants recording 49.01% lower efficiency than farmers fully engaged in cassava production. This efficiency loss likely results from reduced time, labour, and management attention devoted to farming when balancing multiple income sources. The results highlight trade-offs in labour allocation in rural livelihoods and underscore the need for policy interventions that create off-farm income opportunities without undermining agricultural productivity.

Table 4. Determinants of Technical Efficiency of Cassava Farmers

Variable	Parameter	Coefficient	Standard Error	z-value	p-value
Constant	Z_0	9.0320	0.7731	11.68	0.000
Farming Experience	Z_1	0.7160***	0.0318	22.52	0.000
Age	Z_2	0.2271***	0.0270	8.41	0.000
Sex	Z_3	0.1228	0.3040	0.40	0.636
Marital Status	Z_4	0.1160	0.4380	0.26	0.582
Education Level	Z_5	0.2410***	0.0108	22.31	0.000
Access to Credit	Z_6	0.6243***	0.0312	20.01	0.000
Farm Size	Z_7	0.5417***	0.0081	66.88	0.000
Household Size	Z_8	0.3421	0.3321	1.03	0.3220
Cooperative Membership	Z_9	0.6501**	0.2305	2.82	0.0117
Off-Farm Work Participation	Z_{10}	-0.4901***	0.0445	-11.02	0.000

Note: ***Significant at 1%, *Significant at 5%, Significant at 10%.

Comparison of Technical Efficiency Between Off-Farm Participants and Non-Participants

Examining the technical efficiency of cassava farmers who combine farming with off-farm work against those engaged exclusively in on-farm activities provides important insights into how labour allocation affects productivity and resource use. As shown in Table 5, the results highlight apparent differences in efficiency scores between the two groups, supporting the notion that labour diversification may involve trade-offs in agricultural performance.

Across the full sample, the mean technical efficiency was 42.65%, indicating that, on average, farmers are operating about 58% below the potential production frontier. This considerable shortfall points to significant opportunities for improving productivity, particularly if challenges related to input access, labour organization, and time allocation are effectively addressed. Efficiency scores ranged from 4.73% to 81.62%, reflecting wide variability in farmers' socio-economic backgrounds, managerial capacity, and the impact of external commitments, such as off-farm employment.

A notable finding is the difference in mean efficiency between the two groups: farmers engaged in off-farm activities averaged 41.28%, while those working solely on-farm achieved a higher mean of 51.42%. The 10.14 percentage-point gap is statistically significant at the 1% level, suggesting that farmers who dedicate all their labour and management to cassava production tend to use resources more effectively. Off-farm work may reduce efficiency by imposing time constraints, delaying decision-making, limiting input application, and reducing field supervision, all of which are crucial for optimal farm performance.

These results align with earlier studies showing that farmers who focus entirely on their agricultural enterprises often benefit from closer crop monitoring, better resource coordination, and more timely decision-making (Akerele et al., 2019; Adebayo et al., 2020; Kehinde & Ogundeji, 2023; Oparinde et al., 2023). While income from off-farm work can strengthen household finances, it may also introduce managerial inefficiencies that ultimately lower farm productivity.

Table 5. Distribution of Technical Efficiency Scores Among Cassava Farmers

Efficiency Range	Full Sample (%)	Off-Farm Participants (%)	Non-Participants (%)
Low Efficiency (0 - 0.25)	39.3	46.0	4.2
Moderately Low (0.25 - 0.50)	24.7	24.6	25.0
Moderately High (0.50 - 0.75)	18.7	17.5	25.0
High Efficiency (0.75 - 1.00)	17.3	11.9	45.8
Mean Technical Efficiency	42.7	41.3	51.4
Minimum Efficiency	4.7	3.82	7.5
Maximum Efficiency	81.6	75.1	83.2
Standard Deviation	35.6	31.1	21.0

Factors Influencing Labour Diversification (Off-Farm Participation) in the Area

The determinants of cassava farmers' involvement in off-farm economic activities were assessed using a binary logistic regression model. As shown in Table 6, the model demonstrated a strong fit to the data. The log-likelihood value of 189.52 was significant at the 1% level, and the likelihood ratio (LR) statistic of 351.27 exceeded the 5% critical chi-square value of 17.823, confirming the model's robustness in identifying the main drivers of off-farm participation.

Among the variables examined, household size had a positive and highly significant effect (coefficient = 0.0624, $p < 0.01$). This indicates that households with more members are more likely to seek supplementary income outside farming to meet rising living costs. The marginal effect suggests that each additional household member increases the probability of engaging in off-farm activities by 0.0623 units, all else equal. This outcome is consistent with the findings of Neglo et al. (2021a), who observed that in rural economies, larger household sizes often drive diversification into non-farm income sources.

Farming experience showed a negative and significant association with off-farm work participation (coefficient = –0.0169, $p < 0.05$), implying that experienced cassava farmers are less inclined to engage

in non-farm employment. Greater agricultural expertise enables such farmers to generate sufficient income from their primary enterprise, reducing the need for alternative livelihoods. This observation supports Boncinelli et al. (2018), who reported that highly skilled farmers often remain committed to full-time agriculture due to confidence in their abilities and higher returns.

Access to credit also emerged as a significant negative factor (coefficient = –0.2336, $p < 0.05$). Farmers with access to credit are less dependent on off-farm work because it enables timely input purchases, the adoption of improved technology, and farm expansion. This aligns with Oparinde et al. (2023), who emphasized that financial inclusion strengthens the viability of smallholder farming and reduces the push toward off-farm income generation.

Gender (sex) was positively associated with off-farm participation (coefficient = 0.1585, $p = 0.057$), significant at the 10% level, indicating that male farmers are more likely than females to take up off-farm jobs. This pattern reflects men's relatively greater mobility and access to non-farm labour markets, particularly in transport, construction, and informal trade sectors (Awotona, 2020). Women, in contrast, are more often constrained by domestic duties, limiting their participation in such opportunities.

Other factors, including marital status, cultivated land size, and education level, were included in the analysis but were not statistically significant. Their lack of influence suggests that, while these characteristics may shape broader livelihood strategies, they do not directly determine farmers' engagement in off-farm work in this context.

Table 6: Logit Regression Analysis of Factors Influencing Off-Farm Participation

Variable	Coefficient	Standard Error	z-value	p-value
Constant	0.1958	0.0417	4.70	0.000
Age	-0.0072	0.0054	-1.32	0.190
Sex	0.1585*	0.0824	1.92	0.057
Education Level	0.0129	0.0377	0.34	0.733
Marital Status	0.0103	0.1089	0.09	0.925
Household Size	0.0624***	0.0123	5.07	0.000
Farm Size	-0.0145	0.0127	-1.14	0.256
Farming Experience	-0.0169**	0.0069	-2.46	0.015
Credit Access	-0.2336**	0.1007	-2.32	0.022
Extension Access	0.1046	0.0909	1.15	0.252
Cooperative membership	0.0539	0.0927	0.58	0.562

Model Summary: Log Likelihood = 189.52*, Likelihood Ratio (LR) = 351.27*
Note: ***Significance at 1%, **Significance at 5%, *Significance at 10%.

Conclusion

This study provides empirical insights into the labour diversification-efficiency nexus among smallholder cassava farmers in Nigeria, emphasizing the trade-offs associated with off-farm employment. While off-farm income can act as a financial buffer that supports farm investment, its implications for technical efficiency are notably adverse. Farmers involved in off-farm employment exhibited notably lower technical efficiency scores than those dedicating all their labour to on-farm activities. This finding underscores the inherent trade-off between diversifying household income sources and optimizing resource use in primary agricultural production. Remarkably, this shows how important credit provision was in reducing reliance on non-farm employment. Farm households with access to funds were better off purchasing higher-quality inputs, adopting more advanced technologies, and remaining in farming as their main livelihood, thereby achieving higher levels of efficiency. Household size and gender were also crucial in determining off-farm participation

behaviour. Larger households were diversifying further into non-agricultural income-generating activities to offset rising living costs, and male farmers were more likely to be engaged in off-farm employment, an indication of greater mobility and access to non-farm labour markets. These findings suggest that balancing labour allocation between farm and non-farm activities remains a central challenge to improving agricultural efficiency in Nigeria's cassava sector. Therefore, policy interventions should prioritize expanding access to affordable agricultural credit to enable farmers to reduce their reliance on supplemental income sources, and promote mechanization and labour-saving technologies, such as irrigation systems and innovative tools, to address labour constraints linked to off-farm commitments. Also, encouraging time-efficient farming practices through targeted extension programs that support productivity even among partially absent farmers. Strengthening agricultural cooperatives to enhance financial access, input procurement, and peer learning, and promoting gender-inclusive support systems, particularly by enhancing female farmers' access to productive assets, training, and commercial agriculture opportunities. Ultimately, optimizing cassava production in Nigeria requires labour-smart and equity-driven strategies that support smallholder farmers in managing the dual demands of income diversification and on-farm productivity. Addressing the institutional and structural constraints that underlie these trade-offs will be essential for improving technical efficiency, rural livelihoods, and the broader transformation of the cassava value chain.

Conflict of interest: Regarding the publication of this manuscript, the author declares that there are no conflicts of interest.

Acknowledgement: Gratitude goes to the staff members of the Department of Agricultural Economics, Faculty of Agriculture, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria, for their valuable contributions, one way or the other, towards the success of this paper.

References

ADEBAYO, O., OPEYEMI, O., JACOB, A., MAYOKUN, O., MISTURA, R., OMOTAYO, A. O., & OLUSEYI, O. K. (2020). Resource-use efficiency and production constraints among cassava farmers in Nigeria: Insight, linkage, and pathway. The Journal of Developing Areas, 54(4). https://doi.org/10.1353/jda.2020.0045

ADEPOJU, A. A., OLALEYE, R. S., & OLAGUNJU, K. O. (2023). Does off-farm income enhance food productivity? Evidence from smallholder maize farmers in Nigeria. African Journal of Economic Policy, 30(2), 127–142.

ADETOMIWA, K., ISEOLUWA, A. E., & BABATUNDE, O. S. (2021). Land tenure, land property rights and adoption of bio-fortified cassava in Nigeria: Policy implications. Journal of Land and Rural Studies, 9(2), 223–240. https://doi.org/10.1177/23210249211001988

AHITUV, A., & KIMHI, A. (2002). Off-farm work and capital accumulation decisions of farmers over the life-cycle: The role of heterogeneity and state dependence. Journal of Development Economics, 68, 329–353. https://doi.org/10.1016/S0304-3878(02)00016-0

AJAYI, C., & OLUTUMISE, A. (2018). Determinants of food security and technical efficiency of cassava farmers in Ondo State, Nigeria. International Food and Agribusiness Management Review, 21(7), 915–928. https://doi.org/10.22434/IFAMR2016.0151

AKERELE, E. O., ODOJUKAN, D. M., YANGOMODOU, O. D., OLUGBEMI, M. T., SOLANA, O. I., ILORI, A. R., & FADIPE, M. O. (2019). Productivity and technical efficiency of cassava production in Ogun State, Nigeria. Journal of Agriculture and Veterinary Science, 12(11), 33–40. https://doi.org/10.9790/2380-1211013340

AKPAETI, A. J., & FRANK, N. N. (2021). Technical efficiency of cassava cooperative farmers in South-South, Nigeria: A comparative analysis. Nigeria Agricultural Journal, 52(2), 8–14. https://www.ajol.info/index.php/naj/article/view/214032

AWOTONA, T. O. (2020). Technical efficiency in cassava production among farmers in Oyo State, Nigeria: A gender situation analysis. Nigeria Agricultural Journal, 51(3), 28–35. http://www.ajol.info/index.php/naj

BABATUNDE, R. O., & QAIM, M. (2010). Impact of off-farm income on food security and nutrition in Nigeria. Food Policy, 35(4), 303–311. https://doi.org/10.1016/j.foodpol.2010.01.006

BANKOLE, A. S., OJO, S. O., OLUTUMISE, A. I., GARBA, I. D., & ABDULQADIR, M. I. (2018). Efficiency evaluation of smallholders palm oil production in Edo State, Nigeria. Asian Journal of Agricultural Extension, Economics & Sociology, 24(4), 1–9. https://www.researchgate.net/profile/Sylvester-Ojo/publication/324990842

BENJAMIN, C., & KIMHI, A. (2006). Farm work, off-farm work, and hired labour: Estimating a discrete-choice model of French farm couples' labour decisions. European Review of Agricultural Economics, 33, 149–171. https://doi.org/10.1093/erae/jbl002

BONCINELLI, F., BARTOLINI, F., & CASINI, L. (2018). Structural factors of labour allocation for farm diversification activities. Land Use Policy, 71, 204–212. https://doi.org/10.1016/j.landusepol.2017.11.058

BORKU, A. W., TORA, T. T., & MASHA, M. (2025). Cassava in focus: A comprehensive literature review, its production, processing landscape, and multi-dimensional benefits to society. Food Chemistry Advances, 100945. https://doi.org/10.1016/j.focha.2025.100945

CHEN, Q., & CAI, L. A. (2025). Self-fulfilling prophecy in livelihood sustainability: Rural tourism in Pingqian Village, China. Tourism Management, 106, 104988. https://doi.org/10.1016/j.tourman.2024.104988

COELLI, T. J., RAO, D. S. P., O'DONNELL, C. J., & BATTESE, G. E. (2005). An introduction to efficiency and productivity analysis (2nd ed.). Springer Science & Business Media.

ELLIS, F., & FREEMAN, H. A. (2004). Rural livelihoods and poverty reduction strategies in four African countries. Journal of Development Studies, 40(4), 1–30. https://doi.org/10.1080/00220380410001673175

FOOD AND AGRICULTURE ORGANIZATION [FAO]. (2019). Cassava: A staple crop with expanding potential. https://www.fao.org/cassava

FOOD AND AGRICULTURE ORGANIZATION [FAO]. (2020). The state of food and agriculture: Agriculture at a crossroads. https://openknowledge.fao.org/server/api/core/bitstreams/6e2d2772-5976-4671-9e2a-0b2ad87cb646/content

FANG, C., XU, Y., & JI, Y. (2022). Part-time farming, diseases and pest control delay and its external influence on pesticide use in China's rice production. Frontiers in Environmental Science, 10, 896385. https://doi.org/10.3389/fenvs.2022.896385

FARRELL, M. J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society Series A: Statistics in Society, 120(3), 253–281. https://doi.org/10.2307/2343100

FERNANDEZ-CORNEJO, J., MISHRA, A. K., NEHRING, R. F., HENDRICKS, C., SOUTHERN, M., & GREGORY, A. (2007). Off-farm income, technology adoption, and farm economic performance. Agricultural Economics Research Reports. http://dx.doi.org/10.22004/ag.econ.7234

IJIGBADE, J. O., OLUTUMISE, A. I., TOLUWASE, S. O. W., AWOSEYILA, F., & ATURAMU, O. A. (2023). Assessing the efficiency and profitability potentials of honey input supply: The case of South West Nigeria. Tropical Agriculture, 100(4), 351–364. https://doi.org/10.37234/

ISSAHAKU, G., ABDUL-RAHAMAN, A., & AMIKUZUNO, J. (2021). Climate change adaptation strategies, farm performance and poverty reduction among smallholder farming households in Ghana. Climate and Development, 13(8), 736–747. https://doi.org/10.1080/17565529.2020.1860884

JOHNSTON, D., & ROUX, H. L. (2007). Leaving the household out of family labour? The implications for the size–efficiency debate. The European Journal of Development Research, 19(3), 355–371. https://doi.org/10.1080/09578810701504412

KEHINDE, A. D., & OGUNDEJI, A. A. (2023). Distributive impacts of non-farm income on output and farm income of cassava farmers in Southwestern Nigeria. Scientific African, 19, e01535. https://doi.org/10.1016/j.sciaf.2022.e01535

LIU, T., BRUINS, R. J., & HEBERLING, M. T. (2018). Factors influencing farmers' adoption of best management practices: A review and synthesis. Sustainability, 10(2), 432. https://doi.org/10.3390/su10020432

MEKONNEN, K. (2022). Africa Research in Sustainable Intensification for the Next Generation Ethiopian Highlands Project, Technical Report, 1 April–30 September 2022. https://cgspace.cgiar.org/server/api/core/bitstreams/9da5cbb4-82ea-4021-90da-f0e32814a34e/content

MGBENKA, R. N., MBAH, E. N., & EZEANO, C. I. (2016). A review of smallholder farming in Nigeria: Need for transformation. International Journal of Agricultural Extension and Rural Development Studies, 3(2), 43–54. https://www.researchgate.net/publication/310628692

MUGUMAARHAHAMA, Y., MONDO, J. M., COKOLA, M. C., NDJADI, S. S., MUTWEDU, V. B., KAZAMWALI, L. M., ... & MUSHAGALUSA, G. N. (2021). Socio-economic drivers of improved sweet potato varieties adoption among smallholder farmers in South-Kivu Province, DR Congo. Scientific African, 12, e00818. https://doi.org/10.1016/j.sciaf.2021.e00818

NEGLO, K. A. W., GEBREKIDAN, T., & LYU, K. (2021a). Determinants of participation in non-farm activities and its effect on household income: An empirical study in Ethiopia. Journal of Development and Agricultural Economics, 13(1), 72–92. https://doi.org/10.5897/JDAE2020.1231

NEGLO, K. A. W., GEBREKIDAN, T., & LYU, K. (2021b). The role of agriculture and non-farm economy in addressing food insecurity in Ethiopia: A review. Sustainability, 13(7), 3874. https://doi.org/10.3390/su13073874

NORTON, G. W., & ALWANG, J. (2020). Changes in agricultural extension and implications for farmer adoption of new practices. Applied Economic Perspectives and Policy, 42(1), 8–20. https://doi.org/10.1002/aepp.13008

NWEKE, F. I. (2004). New challenges in the cassava transformation in Nigeria and Ghana (Vol. 118). International Food Policy Research Institute. https://books.google.com.ng/books?id=csPx4OVcqsUC

OBE, M. E., OLUTUMISE, A. I., AKIRINOLA, O. O., OMOSEHIN, O. O., ATURAMU, O. A., & HOSU, Y. S. (2024). Impacts of capital formation and investment sources on total factor productivity: The example of Nigeria's agriculture. Diyala Agricultural Sciences Journal, 16(1), 106–117. https://dx.doi.org/10.52951/dasj.24160109

OGUNNIYI, L. T., AJETOMOBI, J. O., & AJETOMOBI, Y. L. (2013). Technical efficiency of cassava-based cropping in Oyo State of Nigeria. Agris On-line Papers in Economics and Informatics, 5(1), 51–59. http://dx.doi.org/10.22004/ag.econ.148103

OGUNNIYI, A. I., OMOTOSO, S. O., SALMAN, K. K., OMOTAYO, A. O., OLAGUNJU, K. O., & AREMU, A. O. (2021). Socio-economic drivers of food security among rural households in Nigeria: Evidence from smallholder maize farmers. Social Indicators Research, 155, 583–599. https://doi.org/10.1007/s11205-020-02590-7

OGUNYINKA, E. O., & AJIBEFUN, I. A. (2003). Determinants of technical inefficiency of farm production: Tobit analysis approach to the NDE farmers in Ondo State, Nigeria. International Journal of Agriculture and Biology, 6(2), 355–358. https://d1wqtxts1xzle7.cloudfront.net/79359568/34775_.-libre.pdf

OLUTUMISE, A. I., ADENE, C. I., AJIBEFUN, A. I., & AMOS, T. T. (2020). Adoption of improved technologies and profitability of the catfish processors in Ondo State, Nigeria: A Cragg's double-hurdle model approach. Scientific African, 10, e00576. https://doi.org/10.1016/j.sciaf.2020.e00576

OLUTUMISE, A. I., BANKOLE, A. S., OLUTUMISE, B. O., & ATURAMU, O. A. (2023). Gender differential in allocative efficiency of oil palm processors in Southwest, Nigeria. Kasetsart Journal of Social Sciences, 44(2), 327–336. https://so04.tci-thaijo.org/index.php/kjss/article/view/266245

OMONONA, B. T., ONI, O. A., & UWAGBOE, A. O. (2006). Adoption of improved cassava varieties and its welfare impact on rural farming households in Edo State, Nigeria. Journal of Agricultural & Food Information, 7(1), 39–55. https://doi.org/10.1300/J108v07n01_05

OMOTAYO, A. O., JANGA, M. M., SETH, D. H., RIIKE, A. A., AHMED, U. G., OJONUGWA, O. E., ... & OMOLAYO, A. F. (2021). Elements of rural off-farm economy: Effects of off-farm income on productivity and poverty status of rural maize farming households in Kaduna State, Nigeria. Russian Journal of Agricultural and Socio-Economic Sciences, 114(6), 110–120. https://doi.org/10.18551/rjoas.2021-06.12

OPARINDE, L. O., THOMPSON, O. A., ATURAMU, O. A., & ADETULA, A. I. (2023). Is off-farm work impacting productivity-enhancing inputs? Evidence from arable crop farmers. International Journal of Agricultural Science, Research & Technology (IJASRT) in Extension & Education Systems, 13(3), 165–177. http://ijasrt.iau-shoushtar.ac.ir

OPARINDE, L. O., AMOS, T. T., DARAMOLA, A. G., & OJO, S. O. (2019). Efficiency analysis among maize and cassava farmers in Southwest, Nigeria: Application of log input mean correction strategy. Nigerian Journal of Technological Research, 14(3), 1–9. https://www.ajol.info/index.php/njtr/article/view/191885

OSENI, G., & WINTERS, P. (2009). Rural nonfarm activities and agricultural crop production in Nigeria. Agricultural Economics, 40(2), 189–201. https://doi.org/10.1111/j.1574-0862.2009.00369.x

OYETUNDE-USMAN, Z., & OLAGUNJU, K. O. (2019). Determinants of food security and technical efficiency among agricultural households in Nigeria. Economies, 7(4), 103. https://doi.org/10.3390/economies7040103

PARMAR, A., STURM, B., & HENSEL, O. (2017). Crops that feed the world: Production and improvement of cassava for food, feed, and industrial uses. Food Security, 9, 907–927. https://doi.org/10.1007/s12571-017-0717-8

REARDON, T., STAMOULIS, K., BALISACAN, A., CRUZ, M. E., BERDEGUÉ, J., & BANKS, B. (1998). Rural non-farm income in developing countries. The State of Food and Agriculture, 1998, 283–356. https://www.researchgate.net/publication/247437478

REARDON, T., & BARRETT, C. B. (2000). Agroindustrialization, globalization, and international development: An overview of issues, patterns, and determinants. Agricultural Economics, 23(3), 195–205. https://doi.org/10.1111/j.1574-0862.2000.tb00272.x

REARDON, T., BARRETT, C. B., BERDEGUÉ, J. A., & SWINNEN, J. F. (2009). Agrifood industry transformation and small farmers in developing countries. World Development, 37(11), 1717–1727. https://doi.org/10.1016/j.worlddev.2008.08.023

REARDON, T., BARRETT, C. B., & MINTEN, B. (2020). Structural transformation and smallholders: The role of off-farm income in developing economies. World Development, 132, 104–112. https://doi.org/10.1146/annurev-resource-101623-105713

SEIDU, A. (2008). Off-farm work and technical efficiency of farmers in Ghana: Stochastic frontier analysis. African Journal of Agricultural and Resource Economics, 2(1), 117–135.

SINGH, I., SQUIRE, L., & STRAUSS, J. (1986). Agricultural household models: Extensions, applications, and policy. World Bank and Johns Hopkins University Press.

SZABO, S., APIPOONANON, C., PRAMANIK, M., LEESON, K., & SINGH, D. R. (2021). Perceptions of an ageing agricultural workforce and farmers' productivity strategies: Evidence from Prachinburi Province, Thailand. Outlook on Agriculture, 50(3), 294–304. https://doi.org/10.1177/00307270211025053

TADELE, E. (2021). Land and heterogenous constraints nexus income diversification strategies in Ethiopia: Systematic review. Agriculture & Food Security, 10, 1–14. https://doi.org/10.1186/s40066-021-00338-1

YAMANE, T. (1967). Statistics: An introductory analysis (2nd ed.). Harper and Row.

Özet

Bu çalışma, Nijerya'daki küçük ölçekli manyok üreticilerinin tarım dışı faaliyetlere katılımı ile teknik etkinlik düzeyleri arasındaki ilişkiyi incelemektedir. Kırsal hanehalklarının gelirlerini çeşitlendirme stratejileri, tarım dışı istihdama yönelimi artırırken, bu durum tarımsal üretimde emek ve zaman tahsisi açısından önemli değiş-tokuşlar yaratabilmektedir. Manyok, Nijerya'da gıda güvenliği ve kırsal geçim açısından kritik bir ürün olup, üretim sürecinin büyük ölçüde emeğe dayanması nedeniyle işgücü dağılımındaki değişimlere karşı hassastır. Bu bağlamda çalışma, tarım dışı istihdamın çiftçilerin üretim performansını nasıl etkilediğini analiz ederek, emek çeşitlendirmesi ile tarımsal verimlilik arasındaki dengeye odaklanmaktadır.

Araştırmada kullanılan veriler, Nijerya'da seçilen üretim bölgelerinde çok aşamalı örnekleme yöntemiyle belirlenen 150 küçük ölçekli manyok üreticisinden anket yoluyla toplanmıştır. Teknik

etkinlik düzeyleri stokastik sınır analizi (SFA) kullanılarak tahmin edilmiş, tarım dışı faaliyetlere katılımın belirleyicileri ise lojistik regresyon modeliyle analiz edilmiştir. Bulgular, tarım dışı işlere katılan çiftçilerin teknik etkinlik düzeylerinin, yalnızca tarımsal üretime odaklanan çiftçilere kıyasla daha düşük olduğunu göstermektedir. Bu durum, tarım dışı istihdamın özellikle ekim, bakım ve hasat gibi zaman açısından kritik üretim faaliyetlerini aksatabildiğine işaret etmektedir. Ayrıca cinsiyet, hanehalkı büyüklüğü, tarımsal deneyim ve krediye erişim gibi faktörlerin tarım dışı faaliyetlere katılım üzerinde anlamlı etkiler yarattığı tespit edilmiştir.

Çalışmanın bulguları, tarım dışı gelir faaliyetlerinin kırsal hanehalkları için önemli bir geçim stratejisi olmakla birlikte, uygun politika çerçeveleri oluşturulmadığında tarımsal üretimde etkinlik kayıplarına yol açabileceğini ortaya koymaktadır. Bu nedenle kırsal kalkınma politikalarının, gelir çeşitlendirmesini desteklerken tarımsal verimliliği de gözeten bütüncül bir yaklaşım benimsemesi gerekmektedir. Emek tasarrufu sağlayan teknolojilerin yaygınlaştırılması, kırsal krediye erişimin güçlendirilmesi ve daha esnek işgücü düzenlemelerinin geliştirilmesi, küçük ölçekli çiftçilerin tarım dışı faaliyetleri manyok üretimiyle daha uyumlu biçimde sürdürebilmelerine katkı sağlayabilir. Sonuç olarak bu çalışma, Nijerya bağlamında küçük ölçekli çiftçilerin geçim stratejileri ile tarımsal performans arasındaki ilişkiye dair önemli politika çıkarımları sunmaktadır.