International Journal of Agricultural Economics
2026, Vol. 11, No. 5, pp. 153–168
https://doi.org/10.11648/j.ijae.20261105.11

Research Article

Determinants of Smallholder Farmers' Participation and Income Effects of Home-Grown School Feeding Programme in Kenya

Modou Musa Sowe*, Benjamin Mutai, Hilary Bett

Department of Agricultural Economics and Agribusiness, Egerton University, Nakuru City, Kenya

Abstract

The Home-Grown School Feeding Programme (HGSFP) provides a link between smallholder farmers and institutional markets, possibly for enhancing household productivity and income. However, empirical evidence on farmers' engagement decisions and the programme's effect on income remains unknown. This study evaluates the determinants of HGSFP participation and its impact on smallholder farmers' household income. Survey data were collected from 384 households (200 participants and 184 non-participants in HGSFP) in the 2025 cropping production year. An Endogenous Switching Regression model was used to account for non-randomness in programme engagement and to evaluate counterfactual treatment effects. Participation was positively and statistically significantly influenced by awareness of school tendering procedures, farmer-group membership, land size owned, radio ownership, distance to extension services, and children currently attending public primary schools, but had a negative effect with herd ownership and off-farm income. The evaluated Average Treatment effect on Treated (ATE) was [ATE=2.1519, $p<0.01$], while the Average Treatment Effect on the Untreated (ATU) was [ATU=2.7762, $p<0.01$], showing significant probable income gains amongst currently excluded from HGSFP. The findings illustrate that HGSFP can work not only as a school-feeding intervention but also as an institutional market system for enhancing smallholder farmers' welfare. The policy framework should combine programme expansion with enhanced access to farmer organizations, credit, extension services, and procurement information. The ATU estimates offer a basis for targeted programme expansion in terms of socioeconomic, institutional, and agroecological criteria, mainly for eligible non-participant households with higher potential income gains.

Keywords

Institutional Food Procurement, Homegrown School Feeding, Livelihood Outcome, Household Income, Smallholder Farmers

1. Introduction

Agriculture plays a significant role in economic growth, rural development, food security, nutrition, employment, and rural livelihoods in developing countries Most participants in rural agriculture are smallholder farmers who produce food to feed the ever-growing populations in rural and urban areas, thereby contributing greatly to food security, nutrition, and rural livelihoods [1]. Smallholder farmers contribute a greater share of domestically consumed food but are constrained by

*Correspondence: Modou Musa Sowe (smodoumusa@gmail.com)

Received: 30 July 2026; **Accepted:** 13 August 2026; **Published:** 22 September 2026

Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

numerous obstacles that diminish their productivity and income [2, 3]. The main limitations affecting smallholder farmers are poor access to profitable markets, poor infrastructure, price volatility of produce, and weak institutional support services, which undermine their contribution to the national food system [4-7]. Government, non-governmental organizations, and development agencies have collaborated to reduce these challenges by encouraging institutional procurement programs that create stable markets for smallholder farmers while simultaneously addressing food insecurity and malnutrition among schoolchildren [8, 9].

The Homegrown School Feeding Programme (HGSFP) was introduced as an innovative strategy to connect agricultural production with social security by sourcing food locally from smallholder farmers to supply schools. The institutional procurement system was aimed at improving local agricultural markets, enhancing food security and dietary diversity, and improving the quality of education amongst school children [8, 9]. Previously, conventional school feeding programme schools relied on procurement of food from external producers. At the same time, HGSFP creates structural demand for locally produced food, thus providing smallholder farmers with consistent markets, lowering transaction costs and improving local agricultural commercialization [2, 8]. The HGSFP enhances dietary diversity among schoolchildren while promoting local economic development by increasing agricultural trade (Desalegn et al., 2022) [2].

Globally, the introduction of the Homegrown School Feeding Programme is highlighted for its potential to improve agricultural development, education, food security, nutrition, and rural transformation [3]. The institutional procurement programme creates economic benefits that extend beyond the engagement of smallholder farmers by promoting local value chains and opening opportunities for local traders, input suppliers, transport service providers, and rural labor markets. HGSFP stimulates demand for locally produced food [8, 10]. Recent studies evaluated the effect of HGSFP using a local economy-wide Impact Evaluation Model. They reported that for every Kenya Shilling invested in Kenya's Home-Grown School Feeding Programme, there is an overall income multiplier of approximately 2.26 [2]. They concluded that the school feeding programme improves local economic growth and education quality.

Furthermore, participation in HGSFP enhances smallholder farmers' access to structural markets by creating anticipated institutional demand for locally produced agricultural products. Integration of smallholder farmers into supplying school meals strengthens market linkages, reduces market uncertainties, and improves engagement in higher-value agricultural markets [2, 9]. A study conducted found unequal access to the HGSFP market, attributed to procurement procedures, farmers' ability, and low utilization of digital marketing platforms, while the programme presents critical opportunities for enhancing smallholder farmers' engagement in formal markets [2]. Another study reported a significant positive effect of HGSFP on food security among smallholder farmers who engaged in the programme, indicating a broader livelihood effect associated with institutional food procurement [11].

Existing literature on the Home-Grown School Feeding Programme mainly focused on market participation, food security, children's nutrition, quality of education, project implementation and local spillover effects. There is limited research on rigorous estimates of the causal effect of HGSFP engagement on smallholder farmers' household income, using robust effect analysis models that control for self-selection bias arising from observable and unobservable characteristics of the farmers' households [3, 8, 9]. Moreover, the effect of the programme differs across countries and regions due to variations in procurement systems, institutional capacities, payment methods, and farmers' ability to meet procurement requirements [9].

Therefore, this study determines the effects of participation in the Home-Grown School Feeding Programme on the household income of smallholder farmers in Bomet County. The study exclusively examines whether engagement in the programme significantly affects household income after accounting for selection bias arising from observable and unobservable farm and household characteristics. Using an endogenous switching regression model, the study evaluates the causal effect of HGSFP participation while accounting for potential selection bias and endogeneity that influence the decision to participate in the programme and the outcome, which is household income [12, 13].

This study contributes to the emerging stock of knowledge on institutional procurement systems and rural agricultural development in various ways. The study provides empirical evidence on the effect of participation in HGSFP on the income of smallholder farmers. The study used an impact evaluation framework to estimate the effect of HGSFP, while concurrently addressing selection bias and endogeneity. Findings from this study provide relevant policy evidence to support government and NGOs in designing a procurement system that maximizes the welfare benefits of HGSFP by strengthening local food systems and enhancing sustainable rural development.

2. Literature Review

The Home-Grown School Feeding Programme (HGSFP) has been widely used as a food system initiative that connects school nutrition with local agricultural development, rural economic activities and social protection. The HGSFP creates a forecastable institutional market for locally produced food, reduces market uncertainty, creates employment and income generation, and enhances agricultural commercialization [14]. Currently, empirical evidence from Kenya reaffirms this broader economic impact: the national Home-Grown School Meal Programme produced an income multiplier effect of approximately 2.226, with the greatest gains accruing to businesses and farmer households engaging in school meals [15].

However, the distribution of the gains relies primarily on smallholder farmers' access to information and adequate competition within the institutional procurement procedure.

In Kenya, the decentralized procurement system has not consistently translated into significant smallholder farmer participation in the programme. Recent studies from Kitui, Kilifi, and Tharaka Nithi counties reported that only 37.5% of farmer-based organizations and 22.8% of smallholder farmers have access to institutional markets through HGSFP. Schools depend mainly on traders and brokers, with the majority of the schools applying a manual tendering system. Farmers and farmer-based organizations face constraints such as low prices, poor transport infrastructure, and inadequate market surplus, which limit their participation in HGSFP. Food deliveries usually take more than 10 days after tendering publication, exposing weak procurement coordination and supply-chain responsiveness [1]. Even though mobile phone procurement platforms are viewed as transparent and faster than the manual tendering procedure, their utilization remains low, suggesting that digitalization alone cannot solve underlying supply and capacity constraints.

This limitation occurs within a wider institutional environment characterized by unequal programme distribution, scarce resources, and imperfect integration of local producers into school meal supply chains. Kenya's 2023 to 2030 School Meal Programme scale-up aims to evolve to universal coverage. Still, current policy evidence identifies exclusion, regional marginalization, dependence on local inputs, and the lack of involvement of local farmers as regular barriers for achieving the maximum agricultural development potential of HGSF [16]. The evolution of the 2025 STEP -School Feeding Programme further illustrates the policy concern that the procurement system needs high inclusivity, equity, and sustainability, especially in connecting youths, women, people with disabilities, and smallholder farmers to HGSFP [4]. Therefore, the effectiveness of HGSFP depends on existing institutional demand and farmers' capability to meet procurement requirements in terms of logistics, finance aggregation, and quality and quantity requirements.

Farmers' engagement is subsequently shaped by household access to productive resources and institutional market access. Currently, empirical evidence from Kenya shows that engagement is related to access to procurement information, productive resources, and membership in farmer-based organizations. Whereas poor infrastructure, lack of awareness of procurement procedures, and inadequate production capacity constrain access to institutional markets [1]. These reports agree with studies showing that extension, credit, farmer groups, and market information decrease transaction costs and enhance engagement in structural agricultural markets [6, 14]. Household income effects are heterogeneous, as farmers vary in terms of access to productive assets, institutional linkages, market access, and ability to meet school procurement requirements.

Despite the increasing empirical evidence on the wider economic gains of school feeding programmes, there is limited research on factors influencing smallholder farmers' participation in the programme and its causal effects on household income in Kenya. Existing research has mainly focused on nutrition, food security, quality of education, school attendance, programme implementation, and market access, with farmer-level income effects remaining less explored [1]. This distinction is useful as smallholder farmers' engagement in the programme varies systematically from non-involvement in observable traits such as land size, access to extension, credit, and membership of farmers' groups to unobservable traits such as risk preferences, motivations, and entrepreneurial abilities.

Furthermore, recent research evidence illustrates that HGSFP enhance smallholder household welfare, useful contextual and methodological gaps exist. Research applying Propensity Score Matching (PSM) and linking treatment-effect methods is limited by bias from unobservable traits affecting decisions to participate and programme outcome effects. At the same time, most descriptive studies conducted on HGSFP do not identify causal effects. Recent research conducted in Kenya captures only aggregate income spillover effects, rather than counterfactual income benefits accruing to beneficiaries and non-beneficiaries of the programme. This study addresses these gaps by using an Endogenous Switching Regression model to evaluate drivers of participation and the counterfactual effects of engagement in HGSFP on smallholder farmers' household income.

3. Research Methodology

3.1. Study Area

The study was conducted in Bomet county, located in the Rift Valley, Kenya, bordering Kericho County to the north, Narok County to the southeast, Nyamira County to the west, and Nakuru County to the northeast. Agriculture is the main source of livelihood for the majority of the population in the county and is dominated by smallholder farmers cultivating beans, maize, vegetables, fruits, bananas, and tea as the main cash crop [17]. Dairy production is also a main source of income for the majority of households in the county. The county experiences suitable agro-ecological conditions, but most smallholder farmers are constrained by limited market access, volatile prices of agricultural produce, limited access to financial resources, and inadequate access to agricultural advisory services. Bomet county was selected as one of the counties promoting the implementation of HGSFP, which offers opportunities to estimate whether engagement in HGSFP contributes significantly to enhancing the household income of smallholder farmers [18].

3.2. Research Design

The study used a cross-sectional research design applying a

quantitative effect evaluation method to compare household income for participants in HGSFP and non-participants. Participation in the program was non-random, as smallholder farmers self-select into the program. Therefore, a suitable estimation method was used to control self-selection bias and to evaluate the program's effect on household income. The study used primary data collected through face-to-face interviews using structured questionnaires. The questionnaire was pre-tested and tested for reliability and validity before actual data collection.

3.3. Sampling Procedure

A multistage sampling technique was used to sample smallholder farmers for the study. In the first stage, Sotik sub-county was purposively selected based on the high number of participants in HGSFP. In the second stage, two wards, Chemagel and Ndanai, were purposively selected, as they had a higher number of farmers in the program than other wards. This raise a limitation to the study that spatial, infrastructural and agroecological variations between Chemagel and Ndanai wards were not measured directly. The residuals confounding from unobservable ward-level variations cannot be ruled out after controlling even observable traits. In the third stage, a list of beneficiaries was obtained from the ward agricultural office, and from this list, farmers were selected using simple random sampling. Proportional-to-size sampling was used to select 200 beneficiaries and 184 non-beneficiaries. Comparison groups for non-beneficiaries were selected from the same wards with similar agro-ecological and market conditions. The inclusion of farmers from similar communities was intended to enhance the contrast between the treatment and control groups.

3.4. Sample Size Determination

The sample size for the study was derived from employing [18] formular for finite population. The formula has been mostly used in various research as it provides simplified approach for computing suitable sample size if the study population is known with certainty and required precision level has been specified. The formula is expressed as shown in equation (1).

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

Where n is the required sample size, N is the target population, e is the level of precision. For this study the target population consists of 9,600 smallholder farmers eligible to engage in Home-Grown School Feeding Program in Chemagel and Ndanai wards in Bomet county. A margin of error of 5% was adopted at 95% confidence level, as recommended in social research. The values were substituted in Yamene's formula as shown in equation (2).

$$n = \frac{N}{1+N(e^2)} = \frac{9600}{1+9600(0.005^2)} = \frac{9600}{25} = 384 \tag{2}$$

Therefore, a total of 384 smallholder farmers were sampled for the study. The sample consists of 200 farmers who participated in HGSFP and 184 non-participants smallholder farmers. Participants and non-participants were sampled randomly from Ndanai and Chemagel wards in proportion in their respective populations to achieve adequate representation as presented in equation (3) and computed in Table 1.

$$n_i = \frac{N_i}{N} \times n \tag{3}$$

Where, n_i is size of the ward i, N_i is the population in ward i, N is the total population and n is the total sample size.

Table 1. *Distribution of Targeted Population and sample size in the study area.*

Ward	Sampling Frame	Overall	Participants	Non-participants
Chemagel	4325	$\frac{4325}{9600} \times 384 = 173$	106	67
Ndanai	5275	$\frac{5275}{9600} \times 384 = 211$	94	117
Total population	9600	384	200	184

4. Analytical Framework

Household income was measured as the total annual income earned by the household from various activities during 2025 production year. The study considered agricultural and non-agricultural sources to present overall economic status of the household. To reduce potential recall bias in reporting yearly household income, the production year 2025 was proportion into main and short seasons for production and income component separately other than a single annual income estimate

through probing. Data was collected on recall quantity produced, sold, price per unit and computing income from various sources. The reported components were summed to get total household income per year as shown inequation (4).

$$Y_i = Y_{1i} + Y_{2i} + \ Y_{3i} + Y_{4i} + Y_{5i} \tag{4}$$

Where, Y_i represents the total annual household income for household I, Y_{1i} income from crop production, Y_{2i} income from livestock activities, Y_{3i} income from off-farm employment, Y_{4i} income from non-farm businesses and Y_{5i} other farm income from other sources such as remittances and transfer payments. To reduce influence of extreme income values and achieve normal distribution of the household income was transformed into logarithm form before used in the econometric estimations.

To approximate the effect of participation in HGSFP on smallholder farmers household income accounting for prospective selection bias resulting from observable and unobservable characteristics. The study used Endogenous Switching Regression (ESR) Model to account for selection bias and endogeneity, as the approach jointly estimates participation decision to engage in HGSFP and outcome equation for determining the effect on household income for beneficiaries and non-beneficiaries while accounting for self-selection using [12, 19]. In the first stage was modelling decision to participate in HGSFP as a latent variable as shown in equation (5).

$$HG_i^* = \delta_i Z_i + \varepsilon_i \tag{5}$$

Where HG_i^* is the latent unobservable propensity to participate, δ_i is the vector of variables influencing decision to participate in HGSFP such as age, access to credit, extension services, gender, years of schooling and an exclusion restriction that influence participation but does not have a direct influence on household income using two instrumental variable distance to extension office and ownership of a radio which were tested and found to be suitable to be used as instrument, Z_i is a vector of parameters to be estimated and ε_i is the random error term. The observable participation status can be expressed as in equation (6).

$$HG_i = \begin{cases} 1, if \ \ HG_i^* > 0 \\ 0, otherwise: \end{cases} \tag{6}$$

Regimes 1 and 2 represent conditional participation on household income for participants and non-participants in HGSFP as shown in equation (7) and (8).

Regime 1: Participants in HGSFP

$$Y_{1i} = X_{1i}\beta_1 + \mu_{1i} \ \text{ if } \ HG_i = 1 \tag{7}$$

Regime 2: Non-Participants in HGSFP

$$Y_{0i} = X_{0I}\beta_0 + \mu_{0i} \ \text{ if } \ HG_i = 0 \tag{8}$$

Where, Y_{1i} is the household income for HGSFP participants, Y_{0i} is the household income for non-participants, X_i is the vector of explanatory variables influencing decision participation in HGSFP and factors influencing household income, β_1 and β_1 are regime-specific parameter vectors, x μ_{1i} and μ_{0i} are the random error terms. Explanatory variables consist of farm and farmers characteristics, institutional and socioeconomic factors influencing decision and outcome equation. The ESR works under the assumption of normal distribution of the error terms $(\varepsilon_i, \mu_{1i}, \mu_{0i}) \sim N(0, \sum)$ with a covariate matrix expressed as shown in equation (9).

$$\begin{pmatrix} 1 & \sigma_{\mu 1} & \sigma_{\mu 0} \\ \varepsilon_1 & \sigma_1^2 & 0 \\ \sigma_i & 0 & \sigma_0^2 \end{pmatrix} \tag{9}$$

correlations computed as shown in equation (10)

$$\rho_1 = \frac{\sigma_{ui}}{\sigma_1}, \rho_0 = \frac{\sigma_{u0}}{\sigma_0}, \tag{10}$$

The correlation between unobservable characteristics influencing participation and household income. Statistically significant values of ρ_1 and ρ_0 suggest the present of endogenous selection, approving the use of ESR Model instead of Ordinary Least Squares (OLS). According to Di Falco et al.[12], the anticipated household income for actual and counterfactual scenarios are estimated as shown in equation (11) and (12) for participants and equation (14) and (15) for non-participants.

Expression for participants.

Actual household income:

$$E(Y_1|HG = 1) \tag{11}$$

Counterfactual household income:

$$E(Y_0|HG = 1) \tag{12}$$

Therefore, the Average Treatment Effects on the Treated (ATT) is calculated as shown in equation (13).

$$ATT = E(Y_1|HG = 1) - E(Y_0|HG = 1) \tag{13}$$

Expressions for non-participants.

Actual household income:

$$E(Y_0|HG = 0) \tag{14}$$

Counterfactual household income:

$$E(Y_1|HG = 0) \tag{15}$$

Therefore, the average Treatment Effects on the Untreated (ATU) is computed as indicated in equation (16).

$$ATU = E(Y_0|HG = 0) - E(Y_1|HG = 0) \quad (16)$$

The ATE indicates the effect of participation in HGSFP on household income for the participants, while ATU estimates household income for the non-participants in the HGSFP.

5. Results and Discussions

Full information maximum likelihood estimation of the endogenous switching regression model of the effect of participation in HGSFP on household income was presented in Table 2. Estimates of the selection equation of factors affecting participation in HGSFP were expressed in the first column. Gender of the household head, awareness of the school tendering procedure, group membership, having a child in public primary school, land size in acres, credit access, Distance to the extension agent's office, and ownership of a radio positively influenced participation in HGSFP. Livestock ownership (TLU) and access to off-farm income negatively influenced participation in HGSFP.

5.1. Determinants of Home-Grown School Programme Participation: Selection Equation

The gender of the household was statistically significant and positively associated with smallholder farmers engagement in HGSFP ($\beta = 0.407, \mathrm{p} = 0.013$), suggesting that female-headed households were more inclined to participate in HGSFP compared to male-headed households, holding other factors constant. This finding indicates high engagement of women in household food production, agricultural activities, and children's welfare, which enhances their incentive to participate in institutional markets that offer projectable demand for locally produced food. Female farmers are mostly engaged in the production and marketing of food crops such as vegetables, horticultural and cereal crops that are highly demanded in HGSFP [20]. In addition, the school feeding programme was introduced objectively to promote inclusivity and women's empowerment, encouraging more female-headed households to participate [21]. Furthermore, women's high responsibility for household food security, children's nutrition, and education may increase their awareness and motivation to engage in HGSFP, which enhances children's welfare and household economic gain [22-24]. The results imply that HGSFP is an initiative for strengthening the economic participation of female-headed farming households.

Awareness of school procurement procedures was statistically significant and positively associated with participation of smallholder farmers in HGSFP ($\beta = 0.635, \mathrm{p} = 0.003$), suggesting that farmers highly knowledgeable on school procurement requirements were more likely to participate in supplying school meals. This relation implies that familiarity with the tendering process, food safety standards, delivery schedules, contractual obligations, purchasing procedures, procurement rules, and quality and quantity requirements reduces information asymmetry that constrains smallholder farmers from participating in institutional markets. High awareness may also enhance smallholder farmers' confidence in participating in HGSFP, with schools allowing them to prepare documents, production plans, and supply requirements to compete for school procurement opportunities. This results agreed with previous studies that information asymmetries and improved smallholders capacity to engage in structural markets [9, 25].

Having school-going children enrolled in the nearby public primary schools positively and statistically significantly influencing participation in HGSFP ($\beta = 0.352, \mathrm{p} = 0.049$). These findings reveal that households with children attending nearby beneficiary public primary schools are more inclined to engage in HGSFP than households without children in the schools. A plausible explanation is that parents whose children attend beneficiary schools have higher exposure to the programme and are more likely to identify its national, economic, and market opportunities, as well as the educational gains generated by the programme. Proximity to the beneficiary school improves constant interaction with the school management committee, teachers, and other parents, giving farmers enough information on tendering opportunities, procurement procedures, and quality and quantity requirements for supplying school meals. The interaction lowers transaction costs and information asymmetry that limits farmers' engagement in institutional markets. These findings align with previous research that concluded that proximity to beneficiary schools improves awareness of market opportunities and participation in local food procurement systems. Households connected to school feeding programme aware of the benefits such as food security, nutritional, children attendance and education benefits [3, 9].

Landholding had a statistically significant and positive influence on smallholder farmers to join HGSFP ($\beta = 0.550, \mathrm{p} = 0.010$), suggesting larger landholdings were more inclined to engage in HGSFP compared to those with smaller land sizes. This implies that larger farm size allows farmers to create enough marketable surplus and maintain quantity requirement for constant supply in school meals. Larger landholding offers farmers with high flexibility to proportion part of production to institutional markets without constraining household food consumption. Similar findings were reported in previous research that farm size influence engagement in structured markets and high-value markets by enhancing production ability and capacity to meet institutional procurement requirements [9, 26]. Larger landholdings improve investment in quality inputs and technologies that increase productivity such access to credit, hired labor, mechanization and irrigation, thus strengthening farmers ability to produce regularly and compete in structured markets [27, 28].

Ownership of livestock in Tropical Livestock unit negatively and statistically significantly influencing participation

in HGSFP ($\beta = -0.116, \mathrm{p} = 0.073$), indicate that households with high number of livestock holdings were less inclined to participate in HGSFP compared to that smaller number of livestock. This association indicates variations in livelihood specialization, thus households with larger herd holding obtain high proportion of income and livelihood security form livestock production and have less incentive to participate in crop institutional markets such as HGSFP. Larger herd size constrains household labor, time and financial resources to livestock management such as grazing management, feeds, fodder, animal health and marketing reducing resources and labor available for crop production and engagement in supplying school meals. Previous studies from pastoral and mixed livelihood system confirms the findings that livestock serves as an alternative sources of hosuheold income and livelihood protection, decreasing household dependence on crop production and marketing [29, 30]. Another study reaffirms the results that households with more livestock holding were less likely to engage in crop markets [26].

Receiving off-farm income negatively and statistically significantly influencing engagement in HGSFP ($\beta = -0.786, \mathrm{p} = 0.000$), households receiving off-farm income were less likely to engage in HGSFP compared to those depending mainly on farming. A probable explanation is that receiving off-farm income declines household reliance on agricultural activities as main source of livelihood. Households receiving adequate off-farm income from business, salaried employment, wage labor allocate most of their time, labor and capital resources in off-farm activities limited resources left for agricultural production, thus lowering ability and motivation to supply school meals. This findings agreed with previous studies that concluded that livelihood diversification into non-farm activities constraints allocation of household productive resources and labor decreasing reliance on agricultural income [14, 31]. Similarly the findings were confirms that households generating higher stable off-farm income compared to on-farm income declines their participation in farming agricultural marketing that requires constant production and contractual obligations [28].

Receiving credit by the household positively and statistically significantly associated with participation in HGSFP ($\beta = 0.406, \mathrm{p} = 0.099$), indicates that households who have received credit were more likely to participate in HGSFP than those who did not receive credit. This finding suggests that credit received enables smallholder farmers to overcome financial constraints to finance agricultural production and generate adequate marketable surplus for institutional markets. Access to credit allows farmers to acquire certified seeds, fertilizers, farm equipment, hire labor, pesticides and irrigation techniques for enhancing farm productivity. These investments strengthen farmers' ability to maintain production and meet institutional market procurement requirements. The results confirms previous literature that attributed agricultural finance to improve productive investment and uptake of improved agricultural technologies [32, 33]. Credit boosts financial availability for acquiring agricultural inputs for continuous investment in farm production for meeting contractual obligations in the institutional markets such as HGSFP [34]. Consistent results were documented a significant positive association between credit access and participation in agricultural markets [35, 36].

Membership for farmer-based organizations significantly and positively influencing participation in HGSFP ($\beta = 0.284, \mathrm{p} = 0.094$), implies that farmers belonging to farmer-based organization were more inclined to engage in HGSFP compared to those not in groups. A possible explanation is that farmer groups play a critical role in enhancing access to produce markets, production resources, access to market information and institutional market opportunities. Besides, group membership strengthens collective action, market bargaining power, lowers traction costs, FBOs encourage output aggregation, groups enable farmers to meet food safety standards, quantity and quality requirements by public primary schools. This results agreed to previous research that farmers organization play a key role in connecting smallholder farmers to institutional markets by improving coordination, market access and compliance with procurement [5, 37].

Distance to the nearest extension agent office in Kilometers positively and statistically significantly correlates with engagement in HGSFP ($\beta = 0.142, \mathrm{p} = 0.000$). This finding was contrary to the hypothesized sign, suggesting that farmers located furthest from the nearest extension agent office were more likely to participate in HGSFP compared to those located nearer to the extension agent office. A possible reason is that agricultural advisory services for HGSFP could not be fully delivered by fixed government extension agents. Most agricultural advisory services are currently delivered via farmer-based organizations, digital advisory via mobile extension platforms, community facilitators, and county agricultural outreach initiatives. Thus, farmers located far from extension agent office access adequate technical support through decentralized extension methods, lowering usefulness of proximity to extension agents' office. This finding was supported by previous studies that concluded that located closer to extension agents, farmers have more access to market information on the most profitable market outlets, access diverse market outlets, and private buyers discouraging them from participating in institutional markets [38-40].

Ownership of radio by farmers household statistically significantly and positively influencing participation in HGSFP ($\beta = 0.629, \mathrm{p} = 0.017$), indicates that households owning a radio were more inclined to engage in HGSFP compared to those without radios. A plausible reason is that radio is the main source of agricultural information in rural areas, where local radio stations disseminate agricultural information on new production techniques, government initiatives, market opportunities, agricultural advisory services and weather predictions. Households owning radio access timely information on HGSFP procurement opportunities, supply requirements,

quality and quantity requirements, thus improving probability of engaging in HGSFP. Similar findings were attributed by previous studies that concluded that ownership of radio increased access to HGSFP information, thus increasing participation in the programme as radio serves as source of agricultural market information on tendering, procurement opportunities, new programs and output prices [9, 37, 41].

5.2. Determinants of Household Income: Outcome Equations

Factors influencing household income for both participants and non-participants in HGSFP were presented in the second column. Age of the household head was statistically significant and positively influence household income for the non-participants in HGSFP ($\beta = 0.084, \mathrm{p} = 0.008$). The positive coefficient shows that additional age of the household head is correlated with and increase in household income. Possible explanation is that as age increases individuals gather more experience, skills, physical assets and social capital. Older farmers have consistent employment, operate successful businesses, own more productive assets, and have wide social and market networks compared to younger farmers. Non-participants in HGSFP experienced higher income because they mainly depend on own livelihood strategies other than programme associated market opportunities. Elderly farmers were more likely to diversify income-generating activities, hold more savings, access credit, hold more land, have good relationship with financial institutions and strong market social networks, thus capable of earning higher household income compared to younger farmers. Results were supported a positive significant association between age of the household and household income, suggesting older farmers to have higher income than younger ones because of accumulated experience in the market and productive asset ownership [42-44].

Gender of the household head positively and statistically significantly influencing household income for non-participants in HGSFP ($\beta = 1.096, \mathrm{p} = 0.073$). The positive coefficient shows that female-headed households have greater household income compared to male-headed households. A plausible reason is that women usually diversify their income sources has they have limited resources by combining small business, salaried employment, entrepreneurship, remittance, petty trade and engaging in other off-farm activities [45]. Female-headed households usually effectively allocate available resources by investing into productive assets, have strong financial management skills and prioritized household livelihoods. Above findings were seconded by Vimefall and Levin [46] who studied reported female-headed households to have more household income than male-headed household because of women allocate larger proportion of their income to invest in productive assets.

Education level of the household head in schooling years was statistically significant and positively influencing household income for the non-participants in HGSFP ($\beta = 0.162, \mathrm{p} = 0.049$). This suggests that additional years of schooling completed by the household head enhances household income. Possible explanation is that education improves individual technical skills, knowledge, problem solving skills, and productivity, thus increasing earnings. Household heads who are highly educated can acquire formal employment, improve labor market opportunities, use improved agricultural techniques, have good management skills, understand market information, access credit facilities and diversify income sources. Similar findings were reported that recorded a positive association between years of schooling and household income [47-49].

Number of active household members negatively and statistically significantly influencing household income for non-participants in HGSFP ($\beta = -0.469, \mathrm{p} = 0.039$). Additional numbers of economically active household members decrease household income. Findings were counterintuitive as economically active members are usually expected to generate household income. A plausible reason is that in developing countries where employment opportunities are scarce, additional active members participate in low productivity agricultural, informal jobs, casual laborer and underemployment translating to lower household income. Incase productive assets are scare such as opportunities, capital, land, livestock additional economic active members increase competition for limited productive assets and opportunities lowering household income [50, 51] supported above finding concluded that additional household size declines per capita household income as resources are shared amongst many members.

Awareness of institutional procurement procedure positively and statistically significantly influencing household income for participants in HGSFP ($\beta = 0.452, \mathrm{p} = 0.023$). This suggests that households participating in HGSFP possess high knowledge of procurement systems such as tendering methods, quality requirement, contractual obligations, delivery requirements, suppler requirements and pricing method recorded higher household income than households without procurement awareness. Households with higher procurement awareness easily access institutional markets, meet supplier requirements, reduce transaction costs, engage in tendering, contract negotiations and access reliable market, thus increasing household income by participating in HGSFP. Recent studies by [8] in Kenya supported that findings that inadequate ability and limited access to procurement systems limits smallholder farmers participation in HGSFP, thus trainings and enhanced access to procurement information improved linkage of farmers to supply school meals. Kamau et al. [5] further concluded that digitalization of HGSFP procurement can improve transparency, inclusivity and accountability, while availing information to farmers regarding supplies, tenders' selection payment methods and delivery.

Membership to farmer-based organizations significantly and positively influence household income for participants in HGSFP ($\beta = 0.228, \mathrm{p} = 0.095$). Households belonging to farmer-based organizations received higher household income

than those not members of farmer groups. This is because belonging to farmer groups facilitates poor productive resources, lower transaction costs, increase access to credit, extension services, acquire quality agricultural inputs at a favorable price, collective marketing of farm produce and access market information for improved productivity and access to institutional market like HGSFP for enhancing household incom. In addition, membership to farm group enhances capability to comply with procurement requirements, reduce marketing costs, negotiation of contracts, quality, and quantity requirement for regular supply of school meals. Similar findings were documented that belonging to farm cooperative increased household income as it enhances market participation, access to agricultural advisory services, trainings, agricultural market information, platform for knowledge sharing, innovation diffusion, lower transaction costs and build strong bargaining power in the market for better prices for farm produce [52-55].

Number of extensions visits statistically significantly and positively influencing household income for non-participants in HGSFP $(\beta = 0.295, \mathrm{p} = 0.073)$. This implies that increasing the number of extension visits increases household income. Possible reason is that extension services improve farmers knowledge, management ability and technical skills for increasing farm productivity and household livelihood. Constant contact with extension offices expose farmers to modern agricultural technologies, climate-smart agriculture approaches, post-harvest handling, market information, financial management, pests and disease control, reflected to high productivity, decline losses, enhance produce quality and increased farm income [56-59].

Households having school-going children in nearby primary schools negatively and statistically significantly influencing household income for participants in HGSFP $(\beta = -0.406, \mathrm{p} = 0.005)$. This implies that households with children attending nearby public primary schools witnessed lower household income than those without kids in primary schools. The possible explanation is that households with children attending school experienced higher expenditure even though they benefit from HGSFP. School feeding programme declines household costs on food during school hours, but they experienced higher education expenses. Household income is diverted from productive assets investments, agricultural production, business and income generating activities to education expenses [8, 60].

Household land holding was statistically significant and positively influencing household income for non-participants in HGSFP $(\beta = 2.162, \mathrm{p} = 0.010)$. The positive coefficient implies that additional land acreage increases household income. This is because land is a productive asset for promoting agricultural production, agroforestry and other enterprises that generate income for the household. Larger land size allows households to increase production, diversify agricultural enterprises, use modern agricultural technologies and enjoy economies of scale thus improving household income [14, 26]. Furthermore, larger land holding encourages surplus production to the market, diversification to high valued crops, encourage investment in irrigation, mechanization, commercialization agriculture for generating high income for the households [61, 62].

Livestock ownership in Tropical Livestock Unit (TLU) reported a positive and statistically significant association with household income for participants in HGSFP $(\beta = 0.211, \mathrm{p} = 0.000)$. Positive correlation implies that an increase in livestock assets is related with an increase in household income. Households who own more livestock have diverse income sources from sales of meat, eggs, milk manure, hides, skin, breeding stock and sales of live animals. Furthermore, livestock is a productive asset, source of nutritious food, improved crop productivity through use of manure, enhance market participation, insured against climate shocks and a sign of wealth liquidated during time of financial needs by the household. Households with livestock sales milk, eggs and meat in the HGSFP to generate additional household income. Similarly, previous studies concluded that livestock ownership positively increases smallholder farmers household income as livestock acts as financial asset, commercialization of dairy and livestock products generates more income for the household [63, 64].

Table 2. *Full Information Maximum Likelihood Estimation for Endogenous Switching Regression for Participation in School Feeding Program.*

	Participation in HGSFP (0=No 1=Yes)	**Participants in HGSFP (n=200)**	**Non-Participants in HGSFP (n=184)**
Variables	**Selection Equation**	**Log Household income**	**Log Household Income**
Age HH	-0.013 (0.008)	-0.004 (0.006)	0.084*** (0.032)
Gender of HH (1=male 2-female)	0.407** (0.164)	0.210 (0.138)	1.096* (0.612)
Schooling Years of HH	-0.011 (0.022)	-0.004 (0.017)	0.162** (0.082)

Variables	Participation in HGSFP (0=No 1=Yes) Selection Equation	Participants in HGSFP (n=200) Log Household income	Non-Participants in HGSFP (n=184) Log Household Income
Number of active members	0.012 (0.060)	-0.029 (0.042)	-0.469** (0.228)
Number of inactive members	-0.051 (0.063)	-0.006 (0.049)	0.103 (0.224)
Aware of school tendering (0=No 1=Yes)	0.635*** (0.212)	0.452** (0.198)	0.075 (0.960)
Group membership (0=No 1=Yes)	0.284* (0.169)	0.228* (0.136)	0.562 (0.660)
Extension visits	0.036 (0.045)	-0.006 (0.038)	0.295* (0.165)
Child in primary school ((0=No 1=Yes)	0.352** (0.178)	-0.406*** (0.146)	-0.898 (0.633)
Log Land size (Acres)	0.550*** (0.214)	0.188 (0.175)	2.162*** (0.841)
TLU	-0.116* (0.065)	0.211*** (0.058)	-0.323 (0.238)
Received off-farm income (0=No 1=Yes)	-0.786 *** (0.201)	0.061 (0.145)	3.275*** (0.713)
Own Bicycle (0=No 1=Yes)	-0.222 (1.329)	-0.893 (0.779)	-6.597* (3.806)
Received Credit (0=No 1=Yes)	0.406* (0.246)	0.541*** (0.189)	-0.728 (1.039)
Distance to extension office (KM)	0.142*** (0.035)		
Own Radio (0=No 1=Yes)	0.629*** (0.264)		
Constant	-1.638*** (0.611)	10.691*** (0.504)	0.030 (2.184)
σ		-0.293*** (0.073)	1.314*** (0.076)
ρ		0.374 (0.327)	-0.491** (0.248)
LR test of independence equation Rho 1=Rho 0 chi2= 3.94 Prob > chi2 = 0.1339**			

Note: *, **, *** represents significant at 10%, 5%, 1% level, respectively. In parentheses are the robust standard errors.

Receiving off-farm income by the farmers household had a positive significant effect on the household income of non-participants in HGSFP ($\beta = 3.275, \mathrm{p} = 0.000$). The positive correlation suggests that households receiving off-farm income reported a significantly more household income compared to those relying mainly on farming activities. A plausible explanation is that access of off-farm income from business, remittance, salaried employment boost household income. Income diversification lower high dependency on agricultural production which is usually constrained by climate change, price volatility, and production risks. Off-farm income allows acquiring quality agricultural inputs for improving productivity and farm income [65, 66]. Results were seconded by studies document off-farm income to positively influence household income [42, 67].

Household owning bicycles reported a negative and statis-

tically significant association with income for non-participants in HGSFP ($\beta = -6.597, \mathrm{p} = 0.083$). This implies that households owning a bicycle had a lower household income compared to those without bicycles. Results were counterintuitive as bicycle is a productive asset to enhance mobility, and transportation of produce to the market. Bicycle ownership in developing economies usually indicates limited accumulation of assets rather than a sign for wealth. Therefore, bicycle ownership constraints farmers transport huge volumes of produce, access distance markets and limit engagement in high valued market reducing household income [26, 68].

Households that receive agricultural credit had a positive and statistically significant association with household income of participants in HGSFP ($\beta = 0.541, \mathrm{p} = 0.000$). This implies farmers receiving agricultural credit increases household income than those without credit. Possible explanation is that credit enhances access to quality agricultural inputs for increasing productivity and farm income. In addition, credit enables farmers to acquire modern agricultural technologies, hire labor and invest in value addition for farm produce for higher income. Credit access promotes consistent production system, compliance with quality standards and timely delivery required in HGSFP. Results were supported by previous studies that concluded that agricultural credit improves household income by increasing productivity, promote commercialization and enhance uptake of improved agricultural technologies [69].

Estimations of the correlation coefficient of the error terms and covariates (σ and ρ) for the outcome and selection equation are presented in the second rows of Table 2 [19]. Negative coefficient of ρ indicates the presences of self-selection bias and endogeneity demonstrating that farmers households with relatively higher income were more likely to participate in HGSFP compared to those with lesser household income [12]. Results exposed observable and unobservable characteristics of farmers that influence participation in HGSFP, and household income indicated by σ having p-value less than 1%. Therefore, farmers who currently not supplying school meal if decided to engage in the program may experience a different impact on household income than the current beneficiaries in the programme.

5.3. Average Treatment Effects of HGSFP Participation on Household Income

Table 6 presents Endogenous Switching Regression estimates of the treatment effect of participation in HGSFP on smallholder farmers' household income. The ESR estimator evaluated observed and counterfactual outcomes after correcting for selection bias caused by observable and unobservable traits of the farmer. The estimated expected household income for participants in HGSFP under actual scenarios was (a) 11.5907 and counterfactual (b) 9.4389. Therefore, the difference between outcomes indicates Average Treatment Effects on the Treated (ATT) of 2.1519, with a positive statistically significant at 1% significance level ($p < 0.01$). These results revealed that engaging in HGSFP increased household income for smallholder farmers by 2.15% compared with if participants had not participated in the programme. The positive coefficient of ATT denotes that engagement in HGSFP generates relatively economic benefits for participating in farmers' households. Increased household income is attributed to improved access to reliable farm-produce markets through schools, reduced market risks, assured demand for farm produce, and enhanced agricultural commercialization. Besides, the institutional procurement system strengthens smallholder farmers' engagement in agricultural produce marketing and enhances rural household livelihoods. Positive ATT could be explained by the role of the institutional procurement scheme in enhancing market access and household livelihoods by creating a market for locally produced food, guaranteeing farmers an assured market for their produce, lowering transaction costs, reducing price volatility, and enhancing agricultural commercialization. Institutional markets enhance agricultural commercialization, strengthen the agricultural value chain, increase household welfare, and promote sales of agricultural produce [10, 26].

Table 3. *Conditional Expectations, Treatment and Heterogeneity Effects.*

Treatment Effects	Decision Stage Participants in SFP (n=200)	Non-Participants in SFP (n=184)	ATE
Participants in SFP	(a) 11.5907 (0.4344)	(b) 9.4389 (2.7091)	ATT=2.1519*** (2.6287)
Non-Participants in SFP	(c) 12.44174 (0.0342)	(d) 9.6655 (0.1926)	ATU=2.7762*** (0.1924)
Heterogeneity Effects	BH1=-0.8510	BH2=-0.2267	TH1=-0.6243

Note: *, **, *** represents significant at 10%, 5%, 1% level, respectively. In parentheses are the standard errors.

Similarly, expected household income for non-participants in HGSFP for actual was (d) 9.6655 and counterfactual (c) 12.4417. The differences between the two give a positive statistically significant Average Treatment Effect on the Untreated (ATU) of 2.7762. This suggests that the current non-participants in HGSFP would increase their income by 2.78% if they decided to engage in supplying school meals. The value of ATU is greater than ATT $(2.7762 > 2.1519)$ This implies that households currently not participating in HGSFP have greater potential to gain income benefits than current participants if barriers to participation are eliminated. This demonstrates underutilized production abilities among non-beneficiaries in the programme, such as limited access to school procurement information, poor market linkages, limited access to procurement information, and lack of farm organization membership. Generally, the reported positive and significant coefficients of ATT and ATU estimates denote that HGSFP has a significant positive effect on household income, and increasing participation in the programme would create extra livelihood gains among the current non-participants. The larger ATU value revealed that more eligible households are excluded from HGSFP despite having the potential to benefit greatly from participating in the programme, attributed to inadequate awareness of the procurement system, institutional barriers, and limited membership for FBOs [9].

The based heterogeneity for participants $BH1 = -0.8510$ demonstrates that even if the programme is absent engagement, households that selected to participate would have earned a lower income compared to those who did not participate in HGSFP. This implies the programme meaningfully reaches absolutely disadvantage households with lower income generation abilities. While the base heterogeneity effect for the non-participants was $BH2 = -0.2267$ denotes relative limited differences in household income for non-participants and participants in different situations. The study reported transitional heterogeneity effect of $TH1 = -0.6243$ contrasting treatment effects for participants and non-participants in HGSFP. The negative coefficient implies that income gained by the current participants is lower than income gained by non-participants if they decide to participate in HGSFP. This result supports large magnitudes of ATU estimates and shows that if non-participants engage in the programme, they will experience higher income gains. Negative transitional heterogeneity is attributed to non-participants in HGSFP having the potential to benefit from the programme but being constrained by limited access to assets, market challenges, programme targets vulnerable households, weak institutional linkages, lack of awareness of procurement procedures, financial constraints, limited productive assets, and lower income, which could be eliminated by engaging in the programme [2, 26].

The results revealed that ESR not only enhances participation in HGSFP but also improves household outcomes, and that the distribution of potential programme benefits is asymmetric: current non-beneficiaries in the programme exhibit a larger estimated counterfactual benefit than existing beneficiaries. This shows a potentially overlooked high return for non-participants and offers an empirical basis for designing beneficiary identification around potential effects beyond participation status alone. Generally, the ESR results contribute to more nuanced policy insights than the conventional conclusion that HGSFP participation is beneficial. The results suggest more opportunities for enhancing the programme aggregate effect that may lie not only in strengthening gains for current participants, but in determining and integrating currently excluded households with more predicted benefits from participation. The negative transitional heterogeneity thus provides a quantitative basis for moving from a participation-oriented targeting strategy toward a potential impact-oriented targeting strategy, particularly where programme resources are limited.

6. Conclusion and Recommendations

Results indicate that participation in HGSFP is primarily influenced by access to information, institutional networks, productive capacity and financial capabilities other than socioeconomic household characteristics. Strongest drivers of decision to join HGSFP were awareness of school tendering procedure, ownership of radio, access to credit, land size and presence of school going children. Households having adequate access to market information, institutional networks and productive assets were more inclined to join the programme, whereas household diversifying income sources and depending mainly on livestock production were less inclined to join the programme. Findings revealed existence of participation barriers in HGSFP attributed to information asymmetry, limited finance, gender inequalities and lack of membership to farmer groups. Study recommends enhancing dissemination of HGSFP procurement related information, use local radio to communicate technologies for programme outreach, integrate HGSFP with the existing extension services, promote livelihood diversification, support vulnerable households, strengthening farmer groups, increase credit access and promote inclusivity in participation amongst women, youths and people with disabilities (PWD).

Household income between participants and non-participants is positively influenced by livestock ownership, access to extension services, land size, awareness on procurement procedures, access to off-farm income access to agricultural credits, and membership to farmer groups. Maximum benefits of HGSFP require access to productive assets, access to market information, financial resources, and institutional support. Bicycle ownership, number of active household members and children attending school negatively influence household income. Therefore, education expenses, limited productive assets and resource constraints decline in disposable household

income for participant and non-participants in HGSFP. Results of endogenous switching regression model indicate that participation in HGSFP effectively increases household income, more effects could be achieved through enhancing programme coverage, farmers' capacity building and eliminating participation barriers. The study recommended that HGSFP provide meals to school going children but also strengthen rural economic development initiatives. Promote integrated method combining institutional procurement, Farmer organizations, avail to agricultural finance, access to agricultural advisory services, strengthen livelihood diversification, create awareness of institutional procurement procedures, promote collective marketing of farm produce, strong market information platform, expand HGSFP participation to eligible farm households currently excluded, and livestock development to enhance HGSFP contribution to smallholder farmer household income and elimination of rural poverty.

Abbreviations

ATT	Average Treatment Effects on the Treatment
ATU	Average Treatment Effects on the Treatment
BH	Base Heterogeneity
ESR	Endogenous Switching Regression Model
FILM	Full Information Maximum Likelihood
HGSFP	Home-Grown School Feeding Programme
OLS	Ordinary Least Squares
PSM	Propensity Score Matching
PDW	Persons with Disability
TH	Transitional Heterogeneity
TLU	Tropical Livestock Unit

Acknowledgments

I acknowledge God, government of Gambia, Egerton university department of Agricultural Economics and Agribusiness, my supervisors, my father Ba Yerro Sowe, Mother Tacko Baldeh, my siblings, sisters Isatou Sowe late, Mayram Sowe, Suwadou Sowe, Mariatou Sowe, Suntukung Sowe and Fatoumata Sowe and my only brother Alieu Sowe. Special thanks to my wife Maimuna Bah and my son Ahmad Sowe.

Author Contributions

Modou Musa Sowe: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Resources, Software, Supervision, Writing – original draft, Writing -review &editing

Benjamin Mutai: Data curation, Methodology, Supervision, Validation, Visualization, Writing – review & editing

Hilary Bett: Methodology, Supervision, Validation, Visualization, Writing – review & editing

Funding

This study was fully funded by the government of Gambia.

Data Availability Statement

Data used in this study will be readily available upon formal request.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] S. K. Lowder, M. V. Sánchez, R. Bertini, Which farms feed the world and has farmland become more concentrated?, World Development 142 (2021) 105455. https://doi.org/10.1016/j.worlddev.2021.105455

[2] T. A. Desalegn, S. Gebremedhin, B. J. Stoecker, Successes and challenges of the Home-grown School Feeding Program in Sidama Region, Southern Ethiopia: a qualitative study, J Nutr Sci 11 (2022) e87. https://doi.org/10.1017/jns.2022.77

[3] S. Di Prima, D. Nguyen Dinh, D. D. Reurings, E. P. Wright, D. Essink, J. E. W. Broerse, Home-Grown School Feeding: Implementation Lessons From a Pilot in a Poor Ethnic Minority Community in Vietnam, Food Nutr Bull 43 (2022) 271–302. https://doi.org/10.1177/03795721221088962

[4] V. Bitzer, F. Kruijssen, J. Mugisha, L. Waswa, J. Aliso, B. Nakazzi, Vulnerability and resilience among farmers and market actors in local agri-food value chains in the face of COVID-19 disruptions: findings from Uganda and Kenya, Food Sec. 16 (2024) 185–200. https://doi.org/10.1007/s12571-023-01414-z

[5] J. Kamau, C. Okoyo, T. Kanyui, C. Mwandawiro, S. Singh, L. Drake, Exploring smallholder farmers' access and participation in the Home Grown School Feeding Programme in selected counties of Kenya, Front. Public Health 12 (2025) 1476888. https://doi.org/10.3389/fpubh.2024.1476888

[6] E. Kangogo, D. J. Otieno, J. Okello, O. Mwenye, E. Kapalasa, Effect of uptake of improved seed potato and donor-funded training on smallholder farmers' market participation, Crop Science 64 (2024) 1432–1441. https://doi.org/10.1002/csc2.21118

[7] Z. Shitaye, B. Tadesse, K. Enkuahone, Sources and intensity of access to agricultural information technologies by smallholder farmers: evidence from Northwest Ethiopia, Front. Sustain. Food Syst. 8 (2024) 1455037. https://doi.org/10.3389/fsufs.2024.1455037

[8] A. Gupta, M. K. Doan, H. Zhu, E. Whitney, M. Filipski, E. Gonzalez-Estrada, D. Ryckembusch, J. Edward Taylor, Rural Economy-wide Impacts of Kenya's Home-Grown School Meals Program, Food Policy 134 (2025) 102887. https://doi.org/10.1016/j.foodpol.2025.102887

[9] J. Liguori, H. A. Osei-Kwasi, M. Savy, S. Nanema, A. Laar, M. Holdsworth, How do publicly procured school meals programmes in sub-Saharan Africa improve nutritional outcomes for children and adolescents: a mixed-methods systematic review, Public Health Nutr. 27 (2024) e213. https://doi.org/10.1017/S1368980024001939

[10] B. Barnabas, S. Agyemang, E. Zhllima, M. Bavorova, Impact of Homegrown School Feeding Program on Smallholders' Farmer Household Food Security in Northeastern Nigeria, Foods 12 (2023) 2408. https://doi.org/10.3390/foods12122408

[11] M. Lokshin, Z. Sajaia, Maximum Likelihood Estimation of Endogenous Switching Regression Models, The Stata Journal: Promoting Communications on Statistics and Stata 4 (2004) 282–289. https://doi.org/10.1177/1536867X0400400306

[12] S. Di Falco, M. Veronesi, M. Yesuf, Does Adaptation to Climate Change Provide Food Security? A Micro-Perspective from Ethiopia, American J Agri Economics 93 (2011) 829–846. https://doi.org/10.1093/ajae/aar006

[13] N. Singh, J. Wang'ombe, N. Okanga, T. Zelenska, J. Repishti, J. G. K, S. Mishra, R. Manokaran, V. Singh, M. I. Rafiq, R. Gandhi, A. Nambi, Farmer. Chat: Scaling AI-Powered Agricultural Services for Smallholder Farmers, (2024). https://doi.org/10.48550/ARXIV.2409.08916

[14] C. B. Barrett, T. Benton, J. Fanzo, M. Herrero, R. J. Nelson, E. Bageant, E. Buckler, K. Cooper, I. Culotta, S. Fan, R. Gandhi, S. James, M. Kahn, L. Lawson-Lartego, J. Liu, Q. Marshall, D. Mason-D'Croz, A. Mathys, C. Mathys, V. Mazariegos-Anastassiou, A. Miller, K. Misra, A. Mude, J. Shen, L. M. Sibanda, C. Song, R. Steiner, P. Thornton, S. Wood, Socio-Technical Innovation Bundles for Agri-Food Systems Transformation, in: Socio-Technical Innovation Bundles for Agri-Food Systems Transformation, Springer International Publishing, Cham, 2022: pp. 1–20. https://doi.org/10.1007/978-3-030-88802-2_1

[15] S. Fan, C. Rue, The Role of Smallholder Farms in a Changing World, in: S. Gomez Y Paloma, L. Riesgo, K. Louhichi (Eds.), The Role of Smallholder Farms in Food and Nutrition Security, Springer International Publishing, Cham, 2020: pp. 13–28. https://doi.org/10.1007/978-3-030-42148-9_2

[16] V. Ricciardi, N. Ramankutty, Z. Mehrabi, L. Jarvis, B. Chookolingo, How much of the world's food do smallholders produce?, Global Food Security 17 (2018) 64–72. https://doi.org/10.1016/j.gfs.2018.05.002

[17] CIDP, Bomet County Integrated Development Plan 2023-2027., 2023. https://bomet.go.ke/wp-content/uploads/2023/08/APPROVED-CIDP-2023.27-Monday-24-july-2023.pdf

[18] T. Yamane, Statistics: An introductory analysis (2nd ed.). Harper & Row., 1967. https://books.google.co.ke/books/about/Statistics.html?id=KTYkvgAACAAJ&redir_esc=y

[19] N. W. Wanyonyi, K. A. Anangwe, Is The Participation of Women Smallholder Farmers in a Food Production Program The Panacea to Household Food Security?, AWSC Journal 8 (2024) 84–96. https://doi.org/10.66563/awscjournal.v8i1.2057

[20] G. A. Abiye, S. Svizzero, D. B. Tenessa, The Impact of a Homegrown School-Feeding Intervention on Children's Educational Outcomes in Low-Income Countries, Sage Open 16 (2026) 21582440261418862. https://doi.org/10.1177/21582440261418862

[21] K. N. Addai, J. N. Ng'ombe, O. Temoso, Can farmer organization membership improve household food security and nutrition? Evidence from Northern Ghana, World Food Policy 10 (2024) 180–202. https://doi.org/10.1002/wfp2.12076

[22] J. Ayarkwa, R. A. Atanga, D. Osei-Asibey, I. M. A. Abu, S. Osei-Tutu, Level of awareness and knowledge of procurement practitioners on green public procurement: a systematic review, Journal of Public Procurement 25 (2025) 276–298. https://doi.org/10.1108/JOPP-05-2024-0060

[23] M. Mainje, L. Matumba, J. J. W. Harvey, H. Phiri, A. P. Gama, A. Phiri, I. Phangaphanga, R. Chizimba, B. Wamey, P. Gallagher, E. Rutto, J. F. Leslie, Long-term sustainability of African school feeding programs, a review, Front. Sustain. Food Syst. 8 (2024) 1424354. https://doi.org/10.3389/fsufs.2024.1424354

[24] Y. Tamiru, A. Mulugeta, A. Ayelign, D. Jara, E. Melaku, S. Gebremedhin, Perceived benefits and challenges of school feeding program in Addis Ababa, Ethiopia: a qualitative study, J Nutr Sci 13 (2024) e32. https://doi.org/10.1017/jns.2024.42

[25] A. Wineman, M. C. Ekwueme, L. Bigayimpunzi, A. Martin-Daihirou, E. L. De Gois V. N. Rodrigues, P. Etuge, Y. Warner, H. Kessler, A. Mitchell, School Meal Programs in Africa: Regional Results From the 2019 Global Survey of School Meal Programs, Front. Public Health 10 (2022) 871866. https://doi.org/10.3389/fpubh.2022.871866

[26] S. G. Adjognon, L. S. O. Liverpool-Tasie, T. A. Reardon, Agricultural input credit in Sub-Saharan Africa: Telling myth from facts, Food Policy 67 (2017) 93–105. https://doi.org/10.1016/j.foodpol.2016.09.014

[27] I. Baltenweck, D. Cherney, A. Duncan, E. Eldermire, E. T. Lwoga, R. Labarta, E. J. O. Rao, S. Staal, N. Teufel, A scoping review of feed interventions and livelihoods of small-scale livestock keepers, Nat. Plants 6 (2020) 1242–1249. https://doi.org/10.1038/s41477-020-00786-w

[28] T. K. Nganga, R. Kara, F. K. Donkor, E. Mkuna, Nexus between agriculture and livestock sectors in Kenya and Tanzania, Journal of Contemporary African Studies 44 (2026) 5–23. https://doi.org/10.1080/02589001.2026.2635739

[29] D. J. M. Braamhaar, B. Van Selm, J. Van Der Lee, S. J. Oosting, Circular food systems in Kenya: Exploring the role of livestock, Agricultural Systems 231 (2026) 104536. https://doi.org/10.1016/j.agsy.2025.104536

[30] Y. Tilahun, B. Tadesse, E. Gebre, K. Haile, M. Bayu, Z. Adimasu, Z. Tolera, B. Zegeye, A. Bayu, Factors influencing the intensity of market participation of smallholder livestock producers in southwest Ethiopia, Cogent Economics & Finance 11 (2023) 2258672. https://doi.org/10.1080/23322039.2023.2258672

[31] G. T. Abate, K. A. Abay, J. Chamberlin, Y. Kassim, D. J. Spielman, M. Paul Jr Tabe-Ojong, Digital tools and agricultural market transformation in Africa: Why are they not at scale yet, and what will it take to get there?, Food Policy 116 (2023) 102439. https://doi.org/10.1016/j.foodpol.2023.102439

[32] B. B. Balana, M. A. Oyeyemi, Agricultural credit constraints in smallholder farming in developing countries: Evidence from Nigeria, World Development Sustainability 1 (2022) 100012. https://doi.org/10.1016/j.wds.2022.100012

[33] K. Haile, E. Gebre, A. Workye, Determinants of market participation among smallholder farmers in Southwest Ethiopia: double-hurdle model approach, Agric & Food Secur 11 (2022) 18. https://doi.org/10.1186/s40066-022-00358-5

[34] P. K. Nkegbe, A. Araar, B. M. Abu, H. Alhassan, Y. Ustarz, E. D. Setsoafia, S. Abdul-Wahab, Nonfarm activity and market participation by farmers in Ghana, Agric Econ 10 (2022) 4. https://doi.org/10.1186/s40100-022-00210-1

[35] J. D. Bonilla, A. Coombes, D. Romney, P. C. Winters, Changing the logic in agricultural extension: evidence from a demand-driven extension programme in Kenya, Journal of Development Effectiveness 16 (2024) 118–141. https://doi.org/10.1080/19439342.2023.2181848

[36] R. Fabregas, M. Kremer, F. Schilbach, Realizing the potential of digital development: The case of agricultural advice, Science 366 (2019) eaay3038. https://doi.org/10.1126/science.aay3038

[37] H. M. Mwololo, J. M. Nzuma, C. N. Ritho, A. Aseta, Is the type of agricultural extension services a determinant of farm diversity? Evidence from Kenya, Development Studies Research 6 (2019) 40–46. https://doi.org/10.1080/21665095.2019.1580596

[38] C. Ayim, A. Kassahun, B. Tekinerdogan, C. Addison, Adoption of ICT innovations in the agriculture sector in Africa: A Systematic Literature Review, (2020). https://doi.org/10.48550/arXiv.2006.13831

[39] I. Koomson, K. Amakye, P. L. Kodom, D. K. Ampah, Relative effect of digital financial inclusion on financial resilience across Kenya, Tanzania and Uganda: exploring linkages and potential pathways, Journal of Financial Economic Policy (2026) 1–29. https://doi.org/10.1108/JFEP-08-2025-0329

[40] J. Van Der Lee, S. Oosting, L. Klerkx, F. Opinya, B. O. Bebe, Effects of proximity to markets on dairy farming intensity and market participation in Kenya and Ethiopia, Agricultural Systems 184 (2020) 102891. https://doi.org/10.1016/j.agsy.2020.102891

[41] M. Ngubane, V. Mbewana, I. Kaseeram, The effect of household head education on household income: evidence from quantile regression model, Cogent Economics & Finance 14 (2026) 2662711. https://doi.org/10.1080/23322039.2026.2662711

[42] M. Giger, A. Reys, W. Anseeuw, E. Mutea, B. Kiteme, Smallholders' livelihoods in the presence of commercial farms in central Kenya, Journal of Rural Studies 96 (2022) 343–357. https://doi.org/10.1016/j.jrurstud.2022.11.004

[43] E. W. Kamau, R. Gitau, H. K. Bett, Effects of adoption of ecological farming practices on farm income in rural households: Evidence from Central Kenya, Heliyon 10 (2024) e34610. https://doi.org/10.1016/j.heliyon.2024.e34610

[44] M. J. Ogada, E. J. O. Rao, M. Radeny, J. W. Recha, D. Solomon, Climate-smart agriculture, household income and asset accumulation among smallholder farmers in the Nyando basin of Kenya, World Development Perspectives 18 (2020) 100203. https://doi.org/10.1016/j.wdp.2020.100203

[45] B. W. Gitonga, A. W. Odek, Socio-Economic Determinants of Livelihoods: A Case of Female-Headed Households in Kiambu, Kenya, OALib 12 (2025) 1–21. https://doi.org/10.4236/oalib.1114217

[46] E. Vimefall, J. Levin, Income Diversification Among Farming Households Headed by Women in Rural Kenya, Feminist Economics 29 (2023) 219–251. https://doi.org/10.1080/13545701.2022.2159056

[47] J. Huang, L. M. Neufeld, O. Badiane, P. Caron, L. S. Forsse, Equitable livelihoods must underpin food systems transformation, Nat Food 3 (2022) 394–396. https://doi.org/10.1038/s43016-022-00529-4

[48] C. Kubitza, S. Hackfort, A. Opiyo, C. Rauh, C. S. Stokes, S. Huyskens-Keil, The effects of market-oriented farming on living standards, nutrition, and informal sharing arrangements of smallholder farmers: the case of African indigenous vegetables in Kenya, Food Sec. 16 (2024) 1363–1379. https://doi.org/10.1007/s12571-024-01480-x

[49] C. N. Maindi, W. N. Nyarindo, S. N. Ndirangu, H. N. Isaboke, Collective action typologies and their implications for policy targeting: The case of smallholder households from the central region of Kenya, Journal of Agriculture and Food Research 18 (2024) 101288. https://doi.org/10.1016/j.jafr.2024.101288

[50] A. T. W. Kangethe, F. E. K. Mukabi, D. N. Simiyu, Primacy of Awareness Raising on Uptake of Access To Government Procurement Opportunities by The Youth A Study of Isiolo County, IJARBSS 11 (2021) Pages 230-247. https://doi.org/10.6007/IJARBSS/v11-i4/9665

[51] R. Lupapa, P. Silwimba, The Impact of Household Size on Economic Welfare: A Case Study of Lilayi Township, Lusaka, Zambia, J. Econ. Bus. Com. 2 (2025) 361–368. https://doi.org/10.69739/jebc.v2i2.1122

[52] Y. Zou, Q. Wang, Impacts of farmer cooperative membership on household income and inequality: Evidence from a household survey in China, Agric Econ 10 (2022) 17. https://doi.org/10.1186/s40100-022-00222-x

[53] W. N. Nyarindo, A. Mugera, What determines market participation and trade intensity? The case of smallholders in Kenya, Scientific African 30 (2025) e03057. https://doi.org/10.1016/j.sciaf.2025.e03057

[54] V. A. Onyango, G. Owuor, E. J. Rao, D. J. Otieno, Impact of cooperatives on smallholder dairy farmers' income in Kenya, Cogent Food & Agriculture 9 (2023) 2291225. https://doi.org/10.1080/23311932.2023.2291225

[55] M. J. Ali, G. Qianqian, G. Wenguang, Measuring the impacts of cooperative membership on household income: A case study of Zanzibar, South African Journal of Economic and Management Sciences 27 (2024) a5329. https://doi.org/10.4102/SAJEMS.v27i1.5329

[56] M. K. Kansiime, I. Mugambi, H. Rware, C. Alokit, C. Aliamo, F. Zhang, J. Latzko, P. Yang, D. Karanja, D. Romney, CHALLENGES AND CAPACITY GAPS IN SMALLHOLDER ACCESS TO DIGITAL EXTENSION AND ADVISORY SERVICES IN KENYA AND UGANDA, Front. Agr. Sci. Eng. 9 (2022) 642. https://doi.org/10.15302/J-FASE-2021423

[57] M. E. Marwa, J. Mburu, R. E. J. Oburu, O. Mwai, S. Kahumbu, Impact of ICT Based Extension Services on Dairy Production and Household Welfare: The Case of iCow Service in Kenya, JAS 12 (2020) 141. https://doi.org/10.5539/jas.v12n3p141

[58] P. A. Ogola, F. Ngesa, D. L. Makanji, Influence of access to extension services on milk productivity among smallholder dairy farmers in Njoro Sub-County, Nakuru County, Kenya, Heliyon 9 (2023) e20210. https://doi.org/10.1016/j.heliyon.2023.e20210

[59] W. Ongachi, I. Belinder, B. Bhat, S. Hussain, R. Dub, Strengthening agricultural extension services to enhance farmers' capacity and resilience for sustainable development; a systematic review, BMC Agric. 2 (2026) 17. https://doi.org/10.1186/s44399-026-00039-9

[60] H. Wang, Z. Cheng, Kids eat free: School feeding and family spending on education, Journal of Economic Behavior & Organization 193 (2022) 196–212. https://doi.org/10.1016/j.jebo.2021.11.023

[61] A. M. Eyasu, T. Zewotir, Z. G. Dessie, The role of household savings in linking crop commercialization and multidimensional poverty for sustainable rural development in Ethiopia, Discov Sustain 7 (2026) 1141. https://doi.org/10.1007/s43621-026-03530-0

[62] E. Mutea, J. Jacobi, S. Rist, B. Kiteme, M. S. Hossain, Agricultural commercialization and food security: Evidence and policy implications for smallholder farmers in Kenya, World Development Sustainability 6 (2025) 100214. https://doi.org/10.1016/j.wds.2025.100214

[63] A. Acosta, F. Nicolli, W. Tirkaso, Cattle ownership and households' welfare: Evidence from Southern Africa, Global Food Security 42 (2024) 100772. https://doi.org/10.1016/j.gfs.2024.100772

[64] H. A. Awiti, E. O. Gido, G. A. Obare, Smallholder Farmers Climate-Smart Crop Diversification Cost Structure: Empirical Evidence From Western Kenya, Front. Sustain. Food Syst. 6 (2022) 842987. https://doi.org/10.3389/fsufs.2022.842987

[65] M. E. Musyoki, J. R. Busienei, J. K. Gathiaka, G. N. Karuku, Linking farmers' risk attitudes, livelihood diversification and adoption of climate smart agriculture technologies in the Nyando basin, South-Western Kenya, Heliyon 8 (2022) e09305. https://doi.org/10.1016/j.heliyon.2022.e09305

[66] M. Musumba, C. A. Palm, A. M. Komarek, P. K. Mutuo, B. Kaya, Household livelihood diversification in rural Africa, Agricultural Economics 53 (2022) 246–256. https://doi.org/10.1111/agec.12694

[67] M. A. Otitoju, A. Q. Olaiya, Do Farmer-Based Organizations Shape Welfare? Evidence from Rice-Farming Households in Niger and Nasarawa States, Nigeria, East Afr. j. Bus. Econ. 7 (2024) 251–265. https://doi.org/10.37284/eajbe.7.2.2554

[68] S. Kipkogei, J. Han, G. Mwalupaso, J. Tanui, R. Brenya, The synergistic effects of microcredit access and agricultural technology adoption on maize farmer's income in Kenya, PLoS ONE 20 (2025) e0316014. https://doi.org/10.1371/journal.pone.0316014

[69] A. E. Lelisho, M. E. Lelisho, Impact of credit use on crop productivity and gross income of smallholder farmers: a propensity score matching approach, Discov Agric 2 (2024) 38. https://doi.org/10.1007/s44279-024-00058-7