Beyond access: Evaluating the impact and counterfactual outcomes of input subsidy programmes on smallholder maize farmers' yield and income in Zambia

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DOI: 10.30682/nm2505i
JEL codes: N57, O38, Q13, Q18

Abstract

This study examines the problems of low productivity, inefficiency and food insecurity among smallholder farmers in Zambia despite the efforts of input subsidy programs such as the Farmer Input Support Programme (FISP) to enhance access to improved seeds and fertilisers. Using a counterfactual non-experimental design approach, this study uses a sample of 404 maize farmers (234 FISP beneficiaries and 170 non-beneficiaries) across the Southern province of Zambia. An initial probit regression model was used to identify the determinants of FISP access, and an endogenous switching regression model was used to measure the effect of FISP access on maize yield and income. The results show that age, household size, marital status, cooperative membership, and off-farm income are all positively related to FISP access, while gender, farm size, and farming experience are all negatively related to FISP access. The endogenous switching regression results suggest that FISP access is a real boon for beneficiaries in terms of increasing maize yield and farm income. For instance, beneficiaries of FISP would have harvested 144.97kg/ha less maize and earned 744.69 ZMW less in the absence of input subsidy. On the other hand, the non-beneficiaries would have harvested 730.815kg/ha more maize and earned 2233.09 ZMW more if they had accessed the input subsidy. These results show that FISP positively impacts agricultural production and economic returns and calls for targeted policies that address gender barriers, support smallholder farmers, and improve cooperative structures.

Keywords: *Farmer input subsidy programme, Maize yield, Farm income, Gender disparities, Endogenous switching regression.*

1. Introduction

Agriculture plays a significant role in the economies of nations in Sub-Saharan African countries like Zambia. It provides livelihood means for individuals by offering employment opportunities to most rural residents (ILOSTAT, 2024). Zambia boasts land resources that can enhance agricultural production and make substantial contributions to increased crop yields,

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farm revenues, and food stability (Kuntashula & Mwelwa-Zgambo, 2022) worldwide. Notwithstanding this, farmer input subsidy programmes aimed at promoting both agricultural production diversity and dietary diversity as the gateways for improving household nutritional status, have been a major agricultural policy thrust in most countries in sub-Saharan Africa, including Zambia. However, information on the effects of Zambia's Farmer Input Support Policy (FISP). Small-scale farmers who are major contributors to the country's staple crop struggle with challenges such as productivity and inefficient production methods, leading to increased poverty levels and food insecurity issues. In 2023, Zambia's share of agriculture in the country's Gross Domestic Product (GDP) was at 3.09%, a huge drop from 8.23% over the last 10 years (Aaron, 2024). According to Gatti *et al*. (2023) agricultural productivity remains low. While potential maize yields in Zambia are 9 t per hectare (t/ha, the average national maize production level in Zambia has remained stagnant at 2.2 tons per hectare, lagging behind neighbouring countries in the Saharan African (SSA) zone even though the nation boasts Africa's highest maize output potential of 9.8 tons per hectare. This significant decline underlines the gap between existing crop yields and the attainable standards that can be reached by small-scale farmers. According to recent studies such as Hall *et al*. (2023), the estimated achievable standards for small-scale farmers in Zambia are 5 tons per hectare for open-pollinated varieties and 10 tons per hectare for hybrids. The increase in yield is essential since the majority of rural households rely heavily on farm outputs for livelihood (Silva *et al*., 2023). Muzari (2016) opined that shortages in maize production can cause food scarcity while also undermining the economic sustainability of farming, resulting in a vicious cycle of poverty, malnutrition and economic downturn. This highlights the necessity of implementing specific agricultural measures to increase crop production and ensure both food availability and economic prosperity in rural regions.

Burke *et al*. (2012) argue that growth in the agricultural sector in Africa is hindered by the availability of resources such as quality seeds and fertilizers, attributing this to the inadequate support for their adoption. Additionally, Dlamini *et al*. (2019) highlighted that small-scale farmers continue to face obstacles in accessing inputs like maize seeds due to the high cost of agricultural inputs and low market prices for maize. The use of inputs such as fertilizer in Africa could be higher and also attributed to a need for a more focused approach to increasing fertilizer utilization as a result of market failure (Burke *et al*., 2012). Similarly, in Southern African countries such as Zambia, farmers' access to inputs such as fertilizers and seeds poses a significant challenge for smallholders in their efforts to increase their production. Hence, this drawback encourages farmers to seek out these farm inputs at subsidized prices (Blekking *et al*., 2021).

In order to enhance maize yield and increase farm earnings while ensuring food stability and reducing poverty rates among small-scale farmers, the government of Zambia provide subsidized inputs to impoverished farmers. This initiative is guided by policy frameworks, such as the National Agricultural Policy and the Seventh National Development Plan (SNDP). While the main goal of the National Agricultural Policy is to boost productivity and ensure food security, the 7NDP focuses on diversification and reduction of poverty by stressing the importance of agriculture as a crucial sector for inclusive growth and development (Ministry of Agriculture Zambia, 2023). One significant step towards this agricultural growth and development was the introduction of the Farmer Input Support Programme (commonly known as FISP), which was introduced in 2009 following the initiative called the Fertilizer Support Program (referred to as the FSP), which was launched back in 2002 and is currently being carried out under Zambias National Agricultural Policy (Mason *et al*., 2013). The revised FISP program was designed to support small-scale farmers by offering discounted supplies, like high-quality maize seeds and fertilisers. This initiative aimed to help increase crop yields and boost household incomes (Kuntashula & Mwelwa-Zgambo, 2022; Ministry of Agriculture Zambia, 2023) worldwide. Notwithstanding this, farmer input subsidy programmes aimed at promoting both agricultural production diversity and dietary diversity as the gateways for improving household nutritional status, have been a major agricultural policy thrust in most countries in sub-Saharan Africa, including Zambia. However, information on the effects of Zambia's Farmer Input Support Policy (FISP).

In Zambia, the FISP is overseen by the Ministry of Agriculture, with inputs channelled through agricultural cooperatives, prioritising farmer membership (Blekking *et al*., 2021). This, however, stimulates the membership of farmers in cooperatives, a crucial pillar of agricultural development, to access various programmes that boost input use and improve productivity levels while augmenting their household incomes (Blekking *et al*., 2021). Improving the availability of farm inputs through cooperatives and initiatives plays a huge role in several countries, like Zambia, which prioritizes agricultural growth and development (Blekking *et al*., 2021). Likewise, engaging in subsidised input support programs provides a means to secure farming inputs and enhance productivity while facilitating market access, increasing income levels, ensuring food security and reducing poverty (Fischer and Qaim, 2012; Mason *et al*., 2013).

Several research studies have looked into the impact of cooperatives and input access on farmers' productivity and resource utilisation levels. For instance, studies by Blekking *et al*. (2021), which examined the impact of agricultural input cooperatives in Zambia on farmers' yields, found that farmers who participated in cooperatives achieved higher yields and used more improved seeds and fertilizers. Other studies by Burke *et al*. (2012) and Mason & Tembo (2015) confirmed that input support programs have a reasonably positive effect on yield measures for maize. Moreover, further crop yields lead to boosted farm earnings income (Blekking *et al*., 2021; Setsoafia *et al*., 2022; Akinola *et al*., 2023) fertilizer, and soil and water conservation, providing families with improved security and lessening their susceptibility to poverty. Using published data by the Ministry of Agriculture in Zambia, Funsani *et al*. (2017) reported that the input support programme increased the household annual maize income of participants by 30.8% and total household income by 13.9% for 2013/15 and 2014/15 crop seasons. The authors are of the opinion that the increment in farmers' income is not large enough to lift farmers' households above the poverty line (Funsani *et al*., 2017). In another study carried out by Kuntashula & Mwelwa-Zgambo (2022) worldwide. Notwithstanding this, farmer input subsidy programmes aimed at promoting both agricultural production diversity and dietary diversity as the gateways for improving household nutritional status, have been a major agricultural policy thrust in most countries in sub-Saharan Africa, including Zambia. However, information on the effects of Zambia's Farmer Input Support Policy (FISP), the authors confirmed that FISP has a direct and positive impact on crop diversity, agricultural production and diversification of household diets. These impacts were attributed to fertilizer usage among farmers in Zambia.

While several studies have tried to examine the impact of input support programs on the income and productivity of farmers (Burke *et al*., 2012; Mason *et al*., 2013; Mason & Tembo, 2015; Blekking *et al*., 2021; Setsoafia *et al*., 2022; Akinola *et al*., 2023) fertilizer, and soil and water conservation, there still exists gaps in terms of understanding the selection mechanisms and heterogeneity in its effects among smallholder maize farmers. Several studies have adopted the use of Propensity Score Matching (PSM) technique to understand the impact of subsidies on farmers' yield and income (Fischer & Qaim, 2012; Funsani *et al*., 2017; Mojo *et al*., 2017; Blekking *et al*., 2021), this approach does not fully account for selection bias and unobserved heterogeneity. This study is novel in terms of using an endogenous switching regression (ESR) model, which is a more robust econometric approach that controls selection bias and allows for counterfactual analysis. This study also offers a more comprehensive assessment of the effectiveness of FISP by not only estimating the impact on beneficiaries but also the potential gains for non-beneficiaries had they received the subsidy. Additionally, this study further contributes to the literature by extending the analysis to include not only individual and farm characteristics as in previous studies but also institutional and social factors to understand barriers and enablers of FISP access further. Furthermore, the study integrates gender-disaggregated analysis to examine disparities in subsidy distribution and impact, thus contributing to the ongoing discussion on inclusive agricultural policy. The objective is to provide policymakers with insights into how access to subsidized inputs can enhance livelihoods and help alleviate poverty.

This study is set up in the following way. Chapter 2 focuses on the study area, the data collection and analytical techniques adopted in this study; section 3 reveals the findings of the study; and finally, sections 4 and 5 delve into the discussion, conclusions and recommendations from this study.

2. Materials and Methods

2.1. *Study Context*

In Zambia, maize is the staple food, predominantly cultivated by smallholder farmers, who manage over 80% of the country's arable land yet often operate on plots smaller than 2 hectares (Mulenga & Chapoto, 2021). Farm typologies are stratified by landholding size, with subsistence-oriented households (≤2 ha) constituting approximately 70% of maize producers, while emergent (2–5 ha) and commercial (>5 ha) farms account for the remainder (Mulenga & Chapoto, 2021; Silva *et al*., 2023). This fragmentation exacerbates yield gaps, as smallholders face unequal access to fertile land, credit, and inputs like fertilizers and hybrid seeds—despite state interventions such as the FISP (Blekking *et al*., 2021) but because not all rural households can afford to join cooperatives, this raises questions about membership inclusivity and whether cooperatives advantage some smallholders over others. Agricultural cooperatives can serve as an institutional vehicle for policymakers to deliver direct benefits to smallholder farmers in the form of subsidized agricultural inputs, usually improved seed varieties and fertilizers. They can also serve as platforms for collective action through which smallholders can reduce transportation and transaction costs or disperse the costs of marketing. In Zambia farmers are required to join a cooperative to qualify for seed and fertilizer support through the national Farmer Input Support Program (FISP). Critically, gendered land tenure norms further constrain women's participation in input subsidy schemes (Fisher & Kandiwa, 2014). These structural barriers raise questions about whether input subsidies alone can overcome systemic productivity constraints, motivating this study's evaluation of FISP's effectiveness in Southern Zambia, a region typifying these challenges.

2.2. *Sampling and Data Collection*

Maize plays an important role in Zambia's national diet and food security. It is also the FISP's primary focus, making it integral to the program's objectives. Hence, this study aims to determine the direct effect of FISP on maize, the most widely cultivated crop among smallholder farmers in Zambia. The study employed counterfactual non-experimental analytical methods to determine the effect of FISP on the yield and income among smallholder maize farmers in Zambia. The methodology adopted for this study was a comparison between two different groups of farmers: those who had received the subsidy and those who had not.

This sampling technique was used to provide a representative sample of both subsidy beneficiaries and non-beneficiaries across four districts of the Southern province: Pemba, Monze, Choma, Kalomo, Mongu and Limulunga. These districts were selected on the basis of their agricultural activities to ensure a good representation of smallholder farmers. For beneficiaries of the FISP, a random sampling method was used, using a list of subsidy recipients from local agricultural offices which keep records of subsidy distribution within these districts. This guarantees that the selection of participants was random and, therefore, not biased in any way and representative of the various means by which farmers can receive subsidies. On the other hand, purposive sampling was adopted for farmers who did not receive the subsidy but were from the same areas as the recipients to ensure that the non-recipients were also included in the same local samples. This decision was made since there was no complete list of the non-recipients, and it was necessary to target

Table 1 - Questionnaire Structure.

Sections	*No of questions per section*	*Variables per section*
Farmer Characteristics	5	Age, gender, marital status, education (years), household size
Farm Characteristics	7	Farming experience (years), no. of cattle, maize area cultivated (ha), maize yield (kg/ha)
Institutional Characteristics	6	Membership in cooperatives, land ownership, participation in other social groups, frequency of extension contacts in a year
Access to FISP	9	Status of access to FISP, frequency of access, satisfaction with FISP, challenges in accessing FISP, farm income

farmers who had not received FISP for a balanced comparative study.

A sample size of 404 maize farmers (273 men and 131 women), where 234 were FISP beneficiaries (158 men and 76 women) and 170 were non-beneficiaries of the subsidy (115 men and 55 women). Data collection was carried out between July to September 2022. Questionnaires in the form of closed-ended questions were used to collect data on farmer, farm and institutional characteristics (see Table 1). The questionnaire also included specific questions relating to FISP to ensure that the subsidy receipt was well captured for each participant.

Additional data was collected through interviews with key informants: five regional government units (Departments of Cooperatives) and eight members of the boards of farmers' cooperatives involved in the distribution of FISP. This was done to gather more elaborate information on the system of operation and the relations between the government representatives, the Camp Agriculture Committee (CAC) and the cooperatives. Also, five Focus Group Discussions (FGDs) were held with the farmers. The target groups for these discussions included three groups of FISP beneficiaries and two groups of non-beneficiaries.

The interviews and FGDs focused mainly on topic areas such as the criteria used for selecting the FISP beneficiaries, local power dynamics, the efficiency of the existing distribution process, as well as the challenges faced by both subsidy beneficiaries and non-beneficiaries. The participants involved were from units of the regional government and cooperatives involved in the distribution of FISP in the six provinces.

2.3. *Analytical Framework on Access to Input Subsidy*

Farmers' access to FISP was conceptualized within the context of the random utility theory framework. This theory is based on the assumption that a farmer's decision to apply for an input subsidy is based on the utility they expect to derive from the subsidy. Even though the final decision is made by the CAC, we applied random utility theory to explain the factors that influence farmers to apply for the subsidy.

The utility associated with the perceived benefits of accessing input subsidy is captured by a latent variable, D_J^*, which is a function of observable characteristics and attributes denoted as Z in the latent variable model:

$$D_J^* = Z_J \gamma + \varepsilon_J;\ D_J = 1 \ if\ D_J^* > 0;\quad D_J = 0 \ if\ D_J^* \leq 0 \tag{1}$$

Here, D_J^* is a dummy variable, which takes the value of 1 for access to input subsidy and 0 for non-access. γ represents the estimated parameters in the model, while ε is the error term with a mean value of zero. The farm, farmer, and institutional factors that influence access to input subsidy is denoted by Z. The binary choice model was estimated using a probit regression in Stata 15 to analyse the factors influencing farmers' access to input subsidies.

Fischer & Qaim (2012) and Mojo *et al*. (2017) recommended the use of personal and demographic characteristics as independent variables for the binary model. These include age, gender, marital status, household size, farmer's education level, farm size, farming experience, number of cattle (a proxy for farmer's wealth),

Table 2 - Variables included in the study.

Variables	*Description*	*Measurements*
Access to input subsidy	Farmer's access to input subsidies	Non-access – 0; Access – 1
Age	Age of farmers	Years (continuous)
Household size	Number of people living in the farmer's household	Number of individuals (continuous)
Education	Educational attainment of farmers	Years (continuous)
Farming experience	Years of farming experience	Years (continuous)
Gender	Gender of farmers	Female – 0; Male – 1
Marital status	Marital status of farmers	Non-married – 0; Married – 1
Membership in cooperatives	Membership in any farmers cooperative	No – 0; Yes – 1
Land ownership	Ownership of land	No – 0; Yes – 1
Participation in other social group	Membership in any social group aside from agricultural cooperatives - a proxy for farmers' social capital	No – 0; Yes – 1
No. of cattle	Number of cattle owned by the farmer	Number of cattle (continuous)
Farm size	Area of maize cultivation in the last farming season	Hectares (continuous)
Farm income	Income generated from maize farming activities in last farming season	ZMW (continuous)
Off-farm income	Income generated from non-farming activities in the last farming season	ZMW (continuous)
Extension contacts	Number of contacts with agricultural extension services in a year	Number of contacts (continuous)
Distance to extension service	Distance from farm to extension office	km (continuous)
Maize yield	Yield of maize produced in last farming season	kg

ZMW is Zambian Kwacha. 1 US Dollar is 17.88 ZMW in December 2022.

access to extension, off-farm income, land ownership, and participation in social groups. Table 2 contains a detailed description and measurement of all variables used in the study.

Our outcome variables in the model are maize yield and farm income. While the maize yield is used as a direct indicator of the program's effectiveness, it reflects the productivity and efficiency of farming outputs that are affected by access to subsidy. Farm income is also used as an outcome variable to capture the farmer's economic well-being and the financial stability of smallholder farmers, which is important in determining the impact of subsidies on improving their living standards.

2.3.1. *Endogenous Switching Regression Model*

The endogenous switching regression (ESR) model was preferred over instrumental variable (IV) or Heckman selection methods due to its ability to account for both observable and unobservable sources of selection bias, estimate heterogeneous treatment effects by specifying separate outcome equations for FISP beneficiaries and non-beneficiaries, and also generate robust counterfactuals without relying on exclusion restrictions (Lokshin & Sajaia, 2004). Given the non-random allocation of FISP subsidies by CACs—where unobserved factors (for instance, farmer motivation, local political ties) likely influence both access and outcomes—ESR provides consistent estimates under such endogeneity. While some studies analyze subsidy reforms using demand systems (for instance, Hosni & Ramadan, 2018), our approach focuses on causal identification of program impacts using quasi-experimental methods suited to household-level observational data.

This ESR model was therefore employed to address potential selection bias in estimating the effect of input subsidy access on farmers' yield and farm income. The model was estimated using Stata version 15. The utility (yield and farm income) that farmers get from input subsidy is denoted by Y_{JM} while the utility from non-access is represented by Y_{JNM}. The two regimes for the endogenous switching regression is estimated mathematically as follows:

Regime 1 (access):

$$Y_{JM} = X_J \beta_M + u_{JM} \text{ if } D_J = 1 \quad (2)$$

Regime 0 (non-access):

$$Y_{JNM} = X_J \beta_{NM} + u_{JNM} \text{ if } D_J = 0 \quad (3)$$

Here, Y_{JM} and Y_{JNM} are the outcome variables (for yield and farm income) for access (M) and non-access (NM), respectively. Also, X_J is a vector of the farm, farmer characteristics, and institutional characteristics, while β is the parameter to be estimated for access (M) and non-access (NM), respectively. Lastly, u represents the error term in the model.

Based on the inspiration from Kanburi Bidzakin *et al*. (2019) and Mojo *et al*. (2017), it is assumed that the three error terms (u) in equation (1), (6) and (7) follow the trivariate normal distribution with the mean vector zero and the covariance matrix below:

$$Cov\,(u_M,\, \varepsilon,\, and\; u_{NM}) = \Sigma = \begin{bmatrix} \sigma_M^2 & \sigma_{MNM} & \sigma_{M\varepsilon} \\ \sigma_{MNM} & \sigma_{NM}^2 & \sigma_{NM\varepsilon} \\ \sigma_{M\varepsilon} & \sigma_{NM\varepsilon} & \sigma_\varepsilon^2 \end{bmatrix} \quad (4)$$

Here, *M* and *MN* denote the farmers who have access to input subsidy and non-access, respectively $Var\,(u_M) = \sigma_M^2$; $Var\,(u_{NM}) = \sigma_{NM}^2$; $Var(\varepsilon) = \sigma_\varepsilon^2$ and $Cov\,(u_M,u_{NM}) = \sigma_{MNM}$; $Cov\,(u_M,\varepsilon) = \sigma_{M\varepsilon}$; *and* $Cov\,(\varepsilon,u_{NM}) = \sigma_{NM\varepsilon}$

In equation (8), the error terms, which are conditional on the sample selection criterion, have non-zero expected values. The OLS estimates of coefficients β_M and β_{NM} will also be affected by sample selection bias, according to Kanburi Bidzakin *et al*. (2019) and Lee (1982). The values of the truncated error term $u_M\,|D = 1)$ and $u_{NM}\,|D = 0)$ is given as:

$$u_M\,|D = 1) = E(u_M|\,\varepsilon > -z'\gamma) = \sigma_{M\varepsilon}\frac{\partial\left(\frac{z'\gamma}{\sigma}\right)}{1\text{-}\emptyset\left(\frac{z'\gamma}{\sigma}\right)} \equiv \sigma_{M\varepsilon}\lambda_M \quad (5)$$

and

$$u_{NM}|\,D = 0) = E(u_{NM}|\,\varepsilon \leq -z'\gamma) = \sigma_{NM\varepsilon}\frac{\partial\left(\frac{z'\gamma}{\sigma}\right)}{1\text{-}\emptyset\left(\frac{z'\gamma}{\sigma}\right)} \equiv \sigma_{NM\varepsilon}\lambda_{NM} \quad (6)$$

Where ∂ and $\emptyset$ denotes the probability density and cumulative distribution function of the standard normal distribution, respectively. λ_M and λ_{NM} represent the inverse Mills ratio of M and NM, respectively. The inverse Mills ratio λ_M and λ_{NM} is included in the equation (5) and (6) to account for selection bias. If the estimated covariance of σ_M and σ_{NM} are statistically significant, it implies that access to input subsidy and outcome variables (maize yield and farm income) are correlated. This means that there is endogenous switching, and consequently, the null hypothesis of no selection bias has to be rejected.

In order to estimate the endogenous switching regression, there have to be instrument variables in the utility model in equation (1). The access of farmers to extension services is endogenous with access to input subsidies. Hence, the distance to the extension service centre (in km) was used as the instrument that affects access to extension service, and the residual of the extension was added to the utility model. This instrument was tested for validity before being used in the endogenous switching regression, as other researchers have used.

The endogenous switching regression model will be employed to compare the maize yield and farm income of the farmers who accessed input subsidy in equation (7) and those who did not in equation (8). Furthermore, the model will be used to estimate the hypothetical yield and farm income in the counterfactual scenarios: what the yield and farm income would be if the farmers who accessed input subsidy had not accessed it (equation 9), and what the yield and farm income would be if the non-accessing farmers had accessed the subsidy (equation 10). Below are defined the four scenarios' conditional expectations of yield and farm income:

D_i = 1 represents access to input subsidy; D_i = 0 represents non-access to input subsidy; Y_{JM} and Y_{JNM} are the yield and farm income if the farmer accessed input subsidy and non-access, respectively. ATT represents the average treatment effect on the treated (farmers who accessed input subsidy); ATU represents the average treatment effect on the untreated (farmers who did not receive input subsidy).

$$E\,(Y_{JM}\,|\,D = 1) = X\beta_{JM} + \sigma_{M\varepsilon}\,\lambda_M \qquad (7)$$

$$(Y_{JNM}\,|\,D = 0) = X\beta_{JNM} + \sigma_{NM\varepsilon}\,\lambda_{NM} \qquad (8)$$

$$E\,(Y_{JNM}\,|\,D = 1) = X\beta_{JM} + \sigma_{NM\varepsilon}\,\lambda_M \qquad (9)$$

$$E\,(Y_{JM}\,|\,D = 0) = X\beta_{JNM} + \sigma_{M\varepsilon}\,\lambda_{NM} \qquad (10)$$

Equations (7) and (8) are the actual expectations observed in the sample; equations (9) and (10) are the counterfactual expected outcomes. Further, following Kanburi Bidzakin *et al*. (2019) and Mojo *et al*. (2017), we calculate the average effect on the treated (access to input subsidy on yield and farm income) as the difference between equations (7) and (9). We also calculate the average treatment on the untreated as the difference between equations (10) and (8). ATU and ATT are estimated below in equations (11) and (12), respectively.

$$TT = E\,[Y_{JM}\,|\,D = 1] - E\,[Y_{JNM}\,|\,D = 1] = X\,(\beta_{JM} - \beta_{JNM}) + (\sigma_{M\varepsilon} - \sigma_{NM\varepsilon})\,\lambda_M \qquad (11)$$

$$ATU = E\,[Y_{JM}\,|\,D = 0] - E\,[Y_{JNM}\,|\,D = 0] = X\,(\beta_{JM} - \beta_{JNM}) + (\sigma_{M\varepsilon} - \sigma_{NM\varepsilon})\,\lambda_{NM} \qquad (12)$$

As suggested by Kanburi Bidzakin *et al.* (2019), the difference between equations (7) and (10) (for members) and the difference between equations (8) and (9) is the heterogeneous treatment effects. Hence, the heterogenous treatment effect can be defined as the differences in the yield and farm income to inherent differences but not that of the treatment.

$$BH_M = E\,[Y_{JM}\,|\,D = 1] - E\,[Y_{JM}\,|\,D = 0] = \beta_{JM}\,(X_{JM} - X_{JNM}) + (\lambda_M - \lambda_{NM})\,\sigma_{M\varepsilon} \qquad (13)$$

$$BH_{NM} = E\,[Y_{JNM}\,|\,D = 1] - E\,[Y_{JNM}\,|\,D = 0] = \beta_{JNM}\,(X_{JM} - X_{JNM}) + (\lambda_M - \lambda_{NM})\,\sigma_{MM\varepsilon} \qquad (14)$$

To determine whether the effect of access to input subsidy is greater or smaller for the subsidised or non-subsidised farmers in the counterfactual case, or in other words, to estimate transitional heterogeneity, we calculate the difference between equations (11) and (12).

3. Data Description

3.1. *Socio-economic Characteristics of Respondents*

Table 3 presents a comparison between maize farmers with and without access to FISP. The result reveals several differences in demographic characteristics, resource availability, and economic outcomes. On average, farmers with access to input subsidies are older (46 years), with approximately 68% of them being male. The result shows a statistically significant and positive difference between farmers with and without access to input subsidy in terms of household size, number of cattle, number of contacts with extension agents in a year, distance to extension service and yield. Additionally, farmers with access to subsidies are members of one or more agricultural cooperatives while they are also participants in other social groups.

3.2. *Determinants of Access to Input Subsidy*

The result of the probit regression model, as shown in Table 4, shows that farmers' likelihood to get input subsidy increases significantly and positively with age, household size, off-farm income, and being married. The result also suggests that the gender of the farmer, that is, being female, having more farming experience, and having larger farm sizes, decreases the chances of getting input subsidies. Additionally, membership in cooperatives and participation in other social groups significantly increase the likelihood of receiving an input subsidy.

Table 3 - Socio-economic Characteristics of Maize Farmers (N=404).

Variables	*Access (SD)*	*Non-access (SD)*	*Mean Difference*
Age (years)	45.80 (11.17)	43.91 (12.71)	1.90
Household Size	7.47 (2.83)	6.93 (2.82)	0.54 *
Education (years)	8.75 (2.24)	8.29 (2.39)	0.46 *
Farming experience (years)	19.43 (10.72)	20.14 (11.25)	-0.70
No. of cattle	7.43 (5.28)	6.34 (4.72)	1.09 **
Farm size (ha)	2.21 (0.96)	2.17 (1.11)	0.04
Farm income (ZMW)	12,454.14 (8,083.45)	11,407.35 (7,014.77)	1,046.79
Off-farm income (ZMW)	2,881.47 (2,904.08)	3052.94 (2605.28)	-171.46
No of Extension contacts in a year	7.20 (4.56)	5.54 (4.92)	1.66 ***
Distance to extension service (km)	4.11 (2.62)	4.94 (2.60)	00.83 ***
Yield (kg/ha)	2,289.27 (1,668.01)	1976.72 (996.60)	312.55 **
	Categories	*Access Freq. (%)*	*Non-access Freq. (%)*
Gender	Female	76 (32.48)	55 (32.35)
	Male	158 (67.52)	115 (67.65)
Marital status	Non-married	34 (14.53)	32 (18.82)
	Married	200 (85.47)	138 (81.18)
Membership in cooperatives	No	173 (73.93)	166 (97.65) ***
	Yes	61 (26.07)	4 (2.35)
Land ownership	No	208 (88.89)	146 (85.88)
	Yes	26 (11.11)	24 (14.12)
Participation in other social group	No	22 (9.40)	84 (49.41) ***
	Yes	212 (90.60)	86 (50.59)

*Note: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively.*
SD = Standard Deviation
Mean difference estimated with independent sample T-test at 5% level of probability.

3.3. *Effect of Access to Input Subsidy on Yield and Farm Income*

3.3.1. *Estimation Results of the Endogenous Switching Regression*

Table 5 shows the effects of input subsidy access on both the actual and hypothetical scenarios for both the beneficiary and non-beneficiary groups. In the case of yield, the results show that the farmers who took the subsidy would have produced 144.97 kg/ha less maize than they actually did had they not received subsidy (ATT). On the other hand, farmers without access to subsidy would have produced approximately 730.82 kg/ha more if they had access to the subsidy.

In terms of farm income, the results of the study show that the farmers who got the input subsidy would have earned 744.69 ZMW less without the subsidy. On the other hand, farmers who did not receive the subsidy would have earned 2,233.09 ZMW more had they received it.

Additionally, the analysis reveals the presence of transitional heterogeneity, with estimated values of 585.84 kg/ha for yield and 1,488.40 ZMW for income. These results suggest that the potential benefits of the subsidy programme would have been greater for non-participants than for those who actually received it. This highlights the need to improve targeting mechanisms to

Table 4 - Determinants of FISP Access.

Input subsidy	*Coef.*	*St. Err.*	*Marginal effect*	*St. Err.*
Age	0.016*	0.01	0.006*	0.004
Gender	-0.59***	0.211	-0.215***	0.072
Household size	0.065**	0.032	0.025**	0.012
Marital status	0.442*	0.236	0.173*	0.093
Education	-0.045	0.04	-0.017	0.015
Farming experience	-0.039***	0.011	-0.015***	0.004
No. of cattle	0.025	0.02	0.01	0.008
Farm size	-0.263***	0.097	-0.101***	0.037
Land ownership	-0.012	0.231	-0.005	0.089
Cooperative membership	1.644***	0.294	0.443***	0.042
Participation in other social groups	1.296***	0.237	0.483***	0.076
Extension access	0.092	0.064	0.035	0.025
Off-farm income	0.012**	0.004	0.013**	0.005
Extension residual	-0.065	0.066	-0.025	0.025
Constant	-0.975**	0.472		
Number of obs.	404			
Pseudo r-squared	0.279			
Chi-square	153.213			
Prob > chi2	0			
Correctly predicted observations	365			
Overall prediction accuracy (%)	90.4			

*Note: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively.*

Table 5 - Average expected maize yield and farm income; heterogeneity and participation effect in Southern province.

Yield (kg/ha)	*To have access*	*Not to have access*	*Effect of Access*
Farmers who have access	2288.655 (47.521)	2143.682 (30.025)	ATT= 144.973 (56.211)***
Farmers who do not have access	2707.622 (54.805)	1976.807 (34.963)	ATU= 730.815 (65.007)***
Diff.	HE1= -418.967 (72.735)***	HE2= 166.875 (46.141)***	HE3=-585.842 (6.053)***
Farm Income (ZMW)			
Farmers who have access	12453.63 (270.903)	11708.94 (275.666)	ATT= 744.69 (386. 497)**
Farmers who do not have access	13640.31 (272.165)	11407.22 (359.429)	ATU= 2233.09 (450.847)***
Diff.	HE1= -1186.68 (393.509)***	HE2= 301.72 (445.466)	HE3= -1488.4 (41.798)***

ATT is Average Treatment Effect on the Treated; ATU is Average Treatment Effect on the Untreated; HE1is the difference in outcome for those with access compared to those without access; HE2 is the difference in the potential outcome for those with access if they did not have access; HE3 is the difference in the potential outcome for those without access if they had access.
*Note: ***, **, and * represent 1%, 5%, and 10% levels of significance, respectively.*

Table 6 - Outcomes of the endogenous switching regression for maize yield and farm income.

Variables	*Yield*		*Farm income*	
	Access	*Non-access*	*Access*	*Non-access*
Age	-5.645 (13.986)	2.333 (9.585)	52.131 (65.561)	-23.16 (58.54)
Gender	405.244 (267.355)	-415.833 (189.409)**	1334.2 (1290.14)	-2309.13 (1166.212)**
Household size	-18.086 (43.414)	4.591 (35.208)	-134.745 (205.079)	90.889 (213.597)
Marital status	-8.653 (355.113)	458.101 (231.487)**	2197.139 (1668.549)	1878.648 (1405.804)
Education	-77.46 (47.036)*	68.504 (37.395)*	128.982 (217.188)	209.459 (221.902)
Farming experience	13.591 (15.363)	7.537 (12.687)	-36.129 (75.27)	143.046 (78.781)*
Number of cattle	76.269 (22.99)***	42.286 (22.136)*	316.229 (105.536)***	399.887 (130.405)***
Farm size	-624.785 (119.807)***	1.504 (89.186)	640.754 (640.754)	1428.171 (525.299)***
Land ownership	-517.66 (321.248)*	-781.231 (212.31)***	2561.993 (1485.254)*	-1339.193 (1263.495)
Cooperative membership	150.255 (291.213)	69.842 (567.68)	1923.371 (1595.117)	1052.749 (3663.594)
Participation in other farmer association	-220.498 (397.454)	-128.809 (275.021)	-999.152 (2117.633)	-1254.173 (192)1.929
Off-farm income	0.028 (0.039)	-0.019 (0.033)	0.771 (0.186)***	-0.075 (0.204)
Extension access	81.414 (22.756)***	-7.961 (18.009)	-12.779 (105.412)	293.404 (107.212)***
Constant	3407.59 (846.94)***	1088.697 (422.216)***	2758.677 (4405.412)	653.197 (2491.540)
rho	-0.997 (0.001)	0.924 (0.034)***	-0.988 (0.008)***	−0.089 (0.537)
LR test of indep. eqns.		($\chi^2(2) = 37.46$***		($\chi^2(2) = 11.04$***
Number of observation		404		404
Wald chi2(13)		44.6		124.65
P-value		0		0

ensure that farmers with the highest potential to benefit are prioritized in subsidy distribution.

The outcome of the endogenous switching regression model, as presented in Table 6. To validate the appropriateness of the Endogenous Switching Regression (ESR) model, we examined the significance of the rho parameters, which measure the correlation between the error terms of the selection and outcome equations. Statistically significant rho values indicate the presence of unobserved selection bias, thereby justifying the use of the ESR framework. For maize yield, the rho estimates were −0.997 (0.001) for the non-access group and 0.924 (0.034) for the access group, both statistically significant at the 1% level. For farm income, the rho estimate for the non-access group was −0.988 (0.008), also significant, while the estimate for the access group (−0.089 with a standard error of 0.537) was not statistically significant. In addition, the likelihood ratio (LR) tests of independence between the selection and outcome equations were statistically significant for both models, with chi-squared values of 37.46 for yield and 11.04 for income. These results confirm the presence of selection bias and support the application of the ESR model.

For maize yield, the gender coefficient shows that female farmers who did not receive input subsidies had a consistently negative effect compared to their male counterparts in the same situation. Also, the size of the maize farm has a consistently negative and significant impact on the yield of farmers with access to subsidies. Conversely, marital status has a positive and significant impact on the farmers who have not received input subsidies. This suggests that married farmers tend to achieve higher maize yields than their unmarried counterparts, even when they have not received subsidies. The result showed that land ownership has a significant and negative influence on both subsidised and non-subsidised farmers. Furthermore, farmers' wealth, measured as the number of cattle owned, has a consistently significant and positive effect on both subsidized and non-subsidized farmers. Access to extension services also showed a positive and significant effect on maize yield for the farmers who received input subsidies.

The findings from the endogenous switching regression model show that being a female farmer has a negative effect on the farm income of non-subsidised farmers. This result contrasts with the positive effects that are observed in the farming experience and the size of maize farms within the same group of farmers. The wealth of farmers has a consistent positive influence on farm income for both subsidised and non-subsidised farmers. Furthermore, land ownership and off-farm income demonstrate significant positive associations with farm income among subsidised farmers.

Moreover, based on interviews conducted with smallholder maize farmers in the study area, it was a unanimous opinion that receiving input subsidies through the FISP enhances maize yield and farm income. The farmers pointed out that without these subsidies, their maize yield would be considerably lower, affecting their financial position and their ability to continue farming.

4. Discussion

The probit regression estimates of determinants of access to the FISP indicate that the age of the farmers is a positive determinant of access to subsidy. It appears that older farmers are more likely to get or have the FISP. Older farmers are probably more aware of the programme, have more experience with the subsidy system, or are considered more credible or deserving recipients by the subsidy administrators. This result is in line with other similar studies in Zambia and Malawi, where Holden & Lunduka (2010) argued that older farmers have more experience and have more connections with the agricultural sector networks to access subsidies and other agricultural support services.

The analysis also shows that being a female farmer is a deterrent to FISP access, as shown by the analysis in this paper. This suggests that female farmers are less likely to get the input subsidy packages than their male counterparts. Authors like Fisher & Kandiwa (2014) argued that women farmers are discriminated against in their access to inputs and services, including subsidies. As pointed out by these authors, such biases are based on gender stereotypes and cultural norms that prevent women from participating in agricultural production and resource management decisions. Furthermore, extension services, which are a common channel through which subsidies are offered, are not fully available to women farmers, which reduces the take-up rate among female farmers (Diaz & Najjar, 2019). This restricted accessibility is, to some extent, because extension programs are usually developed without taking into consideration the particularities of female farmers—for instance, their restricted access to transport and time because of their domestic responsibilities.

Household size and marital status were also seen to be significant and positive in influencing access to the FISP among farmers. This could mean that married farmers who have larger households are more likely to get subsidies than those who are not married and have smaller households. This could be due to their stability, the need for them to be more responsible in the running of the farming business and the availability of labour and resources. Therefore, households with more labour resources and a stable farm operation can improve their position to take advantage of the input subsidies and other agricultural programs (Njuki *et al*., 2013; Fisher & Kandiwa, 2014).

In terms of farming experience, the result of the probit model shows a negative relationship with FISP access. This suggests that experienced farmers may use their own approaches and are not very interested in subsidy programs. Matuschke & Qaim (2009) and Baffoe-Asare *et al*. (2013) established that veteran farmers tend to prefer the conventional approach and, therefore, are less likely to embrace new programs or technologies. In the same manner, farm size emerged as another key factor that determines FISP access. According to the results, smaller farms are more likely to receive subsidies. This is in conformity with policy changes favouring equitable resource distribution to help small-scale farmers. For instance, Mason & Tembo (2015) argued that FISP targets smallholder farms in order to achieve the highest impact; Abbott *et al*. (2017) pointed out that subsidies are usually given to smaller farms in order to increase food security and improve the fight against poverty. These findings are also supported by Mason *et al*. (2013), who stated that farmers with land holdings of less than 2.5 hectares are targeted to ensure that resources are equally distributed.

Analysis of determinants of FISP access also indicates that cooperative membership and participation in other farmer associations positively influence farmers' access to FISP.

The analysis of the determinants of FISP access also shows that cooperative membership and participation in other social groups have positive effects on farmers' access to FISP. The influence of cooperative membership on access shows that cooperative networks play a very important role in facilitating access to subsidies through group support and information sharing. In relation to the FISP eligibility criteria, cooperatives are a channel through which farmers get the subsidy package (Mason *et al*., 2013). In the same manner, the participation of farmers in other farmer groups–a measure of farmers' social capital, degree of openness to work with other people, and willingness to accept new technologies and innovations (Matuschke & Qaim, 2009; Fischer & Qaim, 2012), stresses the significance of social networks and collaborative use of agricultural resources to influence FISP access among farmers. Collective action among smallholder farmers increases the chances of accessing resources and markets, validating our observation that membership in social groups and other farmer groups plays a significant role in subsidy access (Fischer & Qaim, 2012; Donkor & Hejkrlik, 2021).

Farmers with other sources of income are more likely to navigate the subsidy application process successfully than farmers without such sources. This is because farmers who have a better financial situation as a result of having other sources of income may have the necessary stability and resources to pay for or meet any other costs or conditions that are associated with the subsidy application process. Haggblade *et al.* (2010) argued that non-farm income diversification increases financial stability and enhances the availability of agricultural inputs, a hypothesis that is consistent with our finding that off-farm income improves farmers' ability to navigate the FISP application process.

Our results on the actual impact of subsidy access using an endogenous switching regression model reveal that beneficiaries of input subsidies would have harvested significantly less maize—approximately 144.97 kg/ha less—if they had not participated in the subsidy programme. At the same time, farmers would have gained 744.69 ZMW less in annual farm income if they had not received the subsidy. This indicates that subsidy access enhances agricultural productivity and income among its beneficiaries (Burke *et al.*, 2012; Mason *et al.*, 2013; Blekking *et al*., 2021). Such an increase in yield due to subsidy access can translate into higher farm income (Funsani *et al.*, 2017), emphasising the economic viability of smallholder farming operations. Similar findings in other regions have supported this direct relationship between input subsidies and increased yield. For example, Xu *et al.* (2009a) demonstrated in their study that input subsidies in China significantly boosted rice yields by enabling access to fertilisers and improved seed varieties.

Based on qualitative interviews with smallholder maize farmers in the study area, farmers consistently reported that without these subsidies, their maize yields would be significantly lower, thus affecting their overall farm income.

Farmers shared that the increased yields from subsidies enable them to generate higher income, which is crucial for sustaining their farming operations and improving their livelihoods. According to one of the male respondents, "As a smallholder farmer in Zambia, the FISP subsidies have improved my maize yields and farm income. Since receiving the subsidies, my harvest has increased by about 145 kilograms per hectare, improving my family's economic stability by 745 ZMW per hectare. The access to quality fertilisers and seeds has made all the difference, enhancing both productivity and profitability on my farm."

Our model also highlights a significant opportunity cost for farmers without access to the FISP. Our analysis suggests that non-subsidised farmers could have also increased their maize yield if they had participated in the FISP. This aligns with the findings of Xu *et al.* (2009b) and Mason *et al.* (2013) that access to subsidies, such as fertiliser, significantly increases maize yields. Their findings suggest that subsidies provide crucial inputs that enhance crop productivity for all farmers. Holden & Lunduka (2010) also argued that fertiliser subsidies significantly improve land productivity and crop yields, supporting our result that farmers without access to the FISP miss out on substantial yield increases. Furthermore, our findings could suggest that the lack of FISP access contributes to income disparities among farmers, as those without subsidies miss out on increased revenue from higher yields. While FISP access plays a significant role according to our results, it is important to recognise that other factors also influence income disparities, including market access (Camara & Savard, 2023), availability of extension services (Nnahiwe *et al.*, 2023), farming techniques (Phiri *et al.*, 2020), and socio-economic conditions (Zulu *et al.*, 2007). Hence, the productivity gap affects individual farm incomes and has broader implications for food security, gender inequality and economic stability in rural communities (Funsani *et al.*, 2017).

The endogenous switching regression model results reveal that gender significantly, and in the case of women farmers, negatively influences maize yield and farm income among farmers without access to the FISP. Specifically, the negative impact of gender on maize yield suggests that female farmers face greater challenges in achieving high yields without subsidies. According to Quisumbing & Pandolfelli (2010), female farmers often have less access to agricultural inputs, services and technology, such as land, credit and training, which are crucial not only for improving crop yields but also for enhancing overall farm productivity, income stability, and resilience to economic and environmental shocks. This limited access results from socio-cultural norms and institutional biases favouring men in agricultural extension services and input distribution. These disparities negatively impact the productivity of female farmers but also perpetuate gender inequalities in agriculture, aligning with the findings from our analysis. Consequently, this limited access to agricultural inputs, services, and technology can negatively impact the income generated from the farm, leading to income disparities. This aligns with our findings on the impact of gender on non-subsidised farmers, where female farmers, in particular, experience lower yields and reduced farm income due to these constraints (Njuki *et al.*, 2013).

The positive effect of marital status on yield for non-subsidised farmers could suggest that married farmers have better access to labour and resources within their households. This includes the support of their spouses and children, who can contribute to farming activities, thereby enhancing productivity even without subsidies. Additionally, married farmers might benefit from pooled financial resources and shared responsibilities, which can further improve farm management and efficiency. This aligns with findings from Fisher & Kandiwa (2014) that being married provides a stable family structure that supports farm operations through shared responsibilities and collective decision-making. This stable environment can lead to more efficient farm management and higher productivity, even without subsidies. These findings also underscore the importance of social and family networks in enhancing agricultural productivity (Ramirez, 2013).

Farmers' education has a contrasting influence on maize yield, with a negative impact among the

FISP beneficiaries and a positive impact among non-beneficiaries. This suggests that while educated farmers can better utilise available resources without subsidies, the specific requirement to channel the subsidy to designated crops, primarily maize, may limit the flexibility of educated farmers who might have alternative methods that could potentially yield better results. While education generally empowers farmers with better knowledge and skills, which can lead to improved agricultural practices and higher yields, their benefits may be maximised when farmers have access and flexibility of use regarding necessary inputs and resources (Xu *et al.*, 2009b; Njuki *et al.*, 2013). However, when participating in subsidy programmes, they may be constrained by programme stipulations, reducing their ability to innovate or apply their advanced knowledge effectively (Xu *et al.*, 2009b). This implies that while education generally enhances farmers' ability to improve productivity, the terms of subsidy programmes like the FISP may not fully utilise the potential of educated farmers. For non-beneficiaries, education directly translates to better yields as they can independently apply their knowledge and innovations without the constraints of subsidy guidelines.

The number of cattle, a proxy for farmers' wealth, positively and significantly influences both maize yield and farm income among farmers with and without access to subsidies. This consistent positive influence indicates that wealthier farmers, as measured by livestock ownership, have better resources and resilience, enhancing their productivity. Holden & Lunduka (2010) pointed out that asset ownership, such as livestock, provides farmers with the financial stability and resources needed to invest in productive inputs and technologies. This investment capability allows wealthier farmers to achieve higher yields and, consequently, higher farm incomes, which aligns with our findings.

Farm size significantly influences yield and income, with a negative effect on yield among subsidised farmers and a positive effect on income among non-subsidised farmers. The negative effect on yield suggests that farmers with lesser farm size benefit more from subsidies, likely due to better management and utilisation of inputs. Mason & Tembo (2015) and Camara & Savard (2023) argued that smaller farms, when given subsidies, experience significant productivity gains, aligning with our findings. However, larger farms, with their inherent resource advantages, can achieve higher incomes without subsidies, indicating a differential impact based on farm size (Camara & Savard, 2023). The positive impact on income for larger farms without subsidies indicates a knowledge and resource advantage that can be leveraged to assist less experienced and smaller-scale farmers (Mason & Tembo, 2015; Camara & Savard, 2023).

Our analysis showed contrasting impacts of land ownership on maize yield and farm income. While land ownership positively influence farm income, we find a negative influence of this variable on maize yield. While land ownership could enhance access to credit and long-term investment and diversification (Jiang *et al.*, 2020), which could significantly boost farm income, Holden & Ghebru (2016) argued that during the initial adjustment period after obtaining land title, productivity might decline as farmers focus on securing and managing their newly formalised land holdings, despite the long-term benefits for farmers. Hence, when farmers acquire land, they might focus on long-term investments in their land, such as infrastructure improvements, soil conservation, and other practices that do not yield immediate increases in crop productivity. This shift can temporarily decrease crop yields as immediate inputs are sacrificed for future gains.

Off-farm income positively impacts farm income among farmers with access to the FISP, which indicates that farmers with additional income sources are better positioned to navigate subsidy applications and enhance overall farm profitability (Haggblade *et al.*, 2010).

Our analysis indicates that access to extension services has a positive impact on maize yield among farmers with access to the FISP and positively influences farm income for farmers without access to the FISP, highlighting the dual role of extension services in enhancing agricultural productivity and economic outcomes, depending on farmers' access to subsidies (Nnahiwe *et al.*, 2023). For farmers with access to subsidies, extension service could impact yield due to the knowledge and support that help to utilise the inputs provided by subsidy programmes effectively. Extension services could equip farmers without subsidies with the necessary skills and knowledge to optimise their existing resources and diversify their income sources (Quisumbing & Pandolfelli, 2010). Hence, for both categories of farmers, extension services are crucial for maximising the effectiveness of subsidy programmes and improving the overall economic well-being of farmers.

5. Conclusion

This study aimed to identify factors that determine access to the Farm Input Subsidy Programme (FISP) and how this influences maize yield and farm income in the Southern province of Zambia. The probit regression model was employed to identify the determinants of FISP access among farmers. The study also adopted the use of an endogenous switching regression model to address unobservable bias in our estimate of the effect of input subsidy on yield and farm income. The model was used to compare the yield and farm income of the FISP beneficiaries and the non-beneficiaries, as well as estimate the values of the outcome variables in the counterfactual hypothetical cases. The probit regression analysis results showed that age, household size, marriage, cooperative membership, participation in other social groups, and off-farm income positively influence FISP access. Farm size and the farmer's gender (being female), as well as farming experience, were found to be negative predictors of FISP access. The endogenous switching regression model revealed that the farmers who were subsidy beneficiaries had higher maize yield and higher income compared to those who were not subsidy beneficiaries and could have had a significantly higher yield and income if they had been subsidized.

The study's findings reveal several key policy implications. First of all, gender inequality in FISP access indicates a need for targeted policies to support female farmers by providing gender quotas to pursue parity, enhanced access to extension services, and credit facilities to ensure gender equity. Additionally, the eligibility criteria for FISP might be challenging for female farmers to meet, necessitating a review and potential adjustment of these criteria to make them more inclusive and accessible to women. This could include considerations such as flexibility in land ownership requirements and tailored support to address the unique barriers faced by female farmers. Prioritising smallholder farmers, with particular emphasis on women farmers, in subsidy programmes is crucial for equitable resource distribution, which can promote productivity and income among the most vulnerable groups. Strengthening cooperative networks and farmer associations is essential to facilitate better access to subsidies and support collective action, which can improve agricultural productivity. Expanding extension services is vital to provide all farmers, especially women, with the necessary training and support, maximising the effectiveness of subsidies and improving economic outcomes. Encouraging income diversification through policies facilitating access to credit, training, and market opportunities can enhance farmers' financial stability, enabling better investment in agricultural inputs and overall farm profitability.

List of Abbreviations

ATT - Average Treatment Effect on the Treated
ATU - Average Treatment Effect on the Untreated
CAC - Camp Agricultural Committee
FGD - Focus Group Discussion
FISP - Farmer Input Support Programme
FSP - Fertilizer Support Programme
FSPP - Food Security Pack Programme
MAL - Ministry of Agriculture and Livestock
SD - Standard Deviation
ZMW - Zambian Kwacha

Funding

This work was supported by the Internal Grant Agency of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague [Grant No. 20253128].

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