# Marketed Surplus and Demand for Improved Groundnut Varieties: Empirical Evidence From Smallholders in Central and Northern Malawi

**Admire Katunga** ( katungaadmire@gmail.com )
Chitedze Agricultural Research Services https://orcid.org/0000-0003-2025-0632

**Edilegnaw Wale Zegeye**
University of the Free State

**Gerald Ortmann**
University of Kwazulu-Natal School of Agricultural

**Research**

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# Marketed surplus and demand for improved groundnut varieties: Empirical evidence from smallholders in central and northern Malawi

[1] *Admire Katunga, Department of Agricultural Research Services, Chitedze Agricultural Research Services, P.O. Box 158, Lilongwe, Malawi.+265 996765015: Email: katungaadmire@gmail.com

[2] Edilegnaw Wale Zegeye, Department of Agricultural Economics, Faculty of Natural and Agricultural Sciences, University of the Free State, P.O. Box 339, Bloemfontein 9300, Republic of South Africa. Mobile: +27 620244330, Email: ZegeyeEW@ufs.ac.za

[3] Gerald Ortmann, University of Kwazulu-Natal School of Agricultural, Earth and Environmental Sciences Discipline of Agricultural Economics P Bag X01 Scottsville 3209, Pietermaritzburg, South Africa, Phone +27 33 260 5410, Fax +27 33 260 5970, Email: ortmann@ukzn.ac.za

* Corresponding author

## Abstract

The quest to increase marketed surplus prompts farmers to demand high-yielding crop varieties. Understanding the farmers' challenges to increase marketed surplus would contribute to policy intervention measures that increase crop yields. Using an Endogenous Switching Probit regression (ESP) model, the study investigated the effect of marketed surplus on-demand for improved groundnut varieties and determined the factors that affect marketed surplus. The study used data collected from 416 farm households in some selected districts of central and northern Malawi. The ESP estimates showed that marketed surplus had a positive impact on the demand for improved groundnut varieties. The demand for improved groundnut varieties increased by 40% among smallholders with a marketed surplus. Conversely, the demand for improved groundnut varieties

among farmers with no marketed surplus declined by 14%. Other findings suggest that increased crop productivity, smallholders' engagement in off-farm economic activities, and enhanced access to market information are critical in increasing marketed surplus. Therefore, policy intervention measures that encounter the farmers' challenges in the output market are critical for the increased marketed surplus to enhance the demand for improved varieties.

*Key Words:* Endogenous switching probit; High yielding crops; Marketed surplus; Smallholders.

## 1 INTRODUCTION

Low crop yields that farmers realize are, among others, attributed to the use of low-yielding conventional crop varieties (Minde *et al.*, 2008). For example, FAOSTAT (2021) reports that between 1980 and 2000, Malawi recorded negative national average annual growth rates in both production and productivity (yield per hectare) of groundnuts. During that period, most farmers cultivated low-yielding conventional groundnut varieties (Minde *et al.*, 2008). However, the situation improved between 2001 and 2010 when average growth rates in production, productivity, and seed supply of improved groundnut variety increased to record highs of 21%, 12%, and 3%, respectively (FAOSTAT, 2021). Thus, in addition to expanding the cultivated land area for groundnuts, high-yielding improved varieties injected into the production system played a role (Minde *et al.*, 2008; Siambi *et al.*, 2015). At the farm level, the increase in production means enough harvest for household consumption and sale. Therefore, the increase in the production of marketable surplus is critical for enhanced commercialized crop production. Besides, commercialized crop production also entails increased demand for highly productive agricultural technologies, including improved crop varieties (Pingali and Rosegrant, 1995; Pingali, 1997).

The demand for particular crop varieties among producers is commensurate with their production orientation. For example, farmers that produce food crops solely for consumption choose varieties that address basic survival needs (Wale and Chianu, 2015). Such farmers would cultivate low-yielding crop varieties since the production is purely for subsistence. Conversely, farmers that consider farming as their primary source of income and are inclined to increase marketed surplus demand high yielding improved varieties (Wale and Chianu, 2015; Wale and Holm-Mueller, 2017). Marketed surplus, which describes the actual quantities of produce sold (Govereh *et al.*, 1999; Strasberg *et al.*, 1999; Chirwa, 2009), triggers farmers to participate in the market as sellers of commodities (Lemi, 2020). Thus farmers with a high propensity to participate in the market would demand high productive farm inputs (Alene *et al.*, 2000), such as improved crop varieties.

The preceding discussion associates the demand for improved varieties with the marketed surplus of crops. However, empirical evidence of the impact of marketed surplus on-demand for improved crop technologies among smallholders in sub-Saharan African (SSA) remains sparse. Nonetheless, the empirical literature is awash with studies on the positive impact of adopting improved crop varieties on various welfare indicators. These studies include Manda *et al.* ( 2018), Manda *et al.* (2016) and Khonje *et al.* (2015) in eastern Zambia, Shiferaw *et al.* (2014) in Ethiopia, Bezu *et al.* (2014) in Malawi, Asfaw *et al.* (2012) in Tanzania and Ethiopia and Kassie *et al.* (2011) in Uganda. All these studies considered outcomes of interventions (welfare effects) as continuous variables. Inquiry on such continuous variables requires that farm households recall actual events that happened months or some years in the past. Therefore, it becomes a challenge for smallholders who rarely keep records of their daily production undertakings. The consequence is that in some

cases, one may understate or overstate the situation leading to bias or measurement of error (Beegle *et al.*, 2011)

Because of the above, the current study closes the gap in empirical literature by investigating the impact of marketed surplus on-demand for improved varieties. The study employs an Endogenous Switching Probit (ESP) econometric technique. In the ESP model, both selection and outcome variables are binaries (Aakvik *et al.*, 2000). The ESP estimates the treatment's actual effects on the outcome response variable by controlling for selection biases of treatment decision (Wooldridge, 2010). Application of the ESP, in this paper, addresses the following questions:

1. What is the overall impact of marketed surplus on the probability that smallholders would demand improved groundnut varieties?
2. What are the factors that affect smallholders' marketed surplus of groundnuts?

The study adds to existing empirical studies, other factors that affect marketed surplus. The study also contributes to the policy formulation of strategies that would address the challenges smallholders encounter to increase marketed surplus. The rest of the paper proceeds as follows. Section 2 presents a brief overview of groundnuts in Malawi. The empirical model estimation procedure is presented in section 3. Section 4 presents the definition of variables and data sources used in the study. The study results and discussion are reported in section 5, followed by the conclusion and policy recommendations in the final section.

## 1.1 Overview of Smallholder Groundnut Subsector in Malawi

In Malawi, groundnut (*Arachis hypogea*) is one of the legume crops widely cultivated by smallholders, mainly women (Simtowe *et al.*, 2010; Msere *et al.*, 2015; Tsusaka *et al.*, 2016a). In this case, a policy promotion of its production has implications on women's economic

empowerment. Further, the Malawi Government promotes its increased production for its potential contribution to sustainable food security and increased agricultural incomes (Malawi-Government, 2011; Gourichon and Mkomba, 2014; Malawi-Government, 2016). Farmers cultivate both conventional and improved varieties. Popular conventional and improved varieties are Chalimbana and CG7, respectively (Chiyembekeza *et al.*, 1998; Goyder and Mang'anya, 2009). The latter is a relatively higher-yielding variety than the former, with a potential yield superiority of 60% (Derlagen and Phiri, 2012). The Agro-processing industry demand Chalimbana for confectionary making, while CG7 is suitable for processing cooking oil (Chiyembekeza *et al.*, 1998; Tsusaka *et al.*, 2016b). Similarly, farm households prefer the former for home consumption while cultivating the latter for the market.

Like in any other developing country, smallholders in Malawi own an average of fewer than 0.5 hectares of land to cultivate a diverse number of food and cash crops (Malawi-Government, 2005), thus resulting in low levels of total crop production. In addition, the use of rudimentary agricultural technologies (Mwangi and Kariuki, 2015) contributes to low crop production among the smallholders. Because of the low yields, the smallholders are also less likely to increase their market participation intensity, affecting the crop subsector's commercialization (Collier and Dercon, 2014a). Low crop yields, coupled with limited commercialisation, are linked to smallholder farm households with high poverty incidences (Diao *et al.*, 2010). Groundnut productivity among the smallholders is also relatively low, with smallholders' yields below the potential levels (Siambi *et al.*, 2015). One of the underlying reasons for low productivity is that the smallholder continues to utilize low productive crop technologies, such as conventional groundnut varieties (Simtowe *et al.*, 2010b). With such low yields, it is not surprising to see a low

commercialization drive among the smallholder subsectors. The smallholders consume much of the groundnuts they produce with little to offer to the market (Derlagen and Phiri, 2012).

# 2 METHODS

## 2.1 Empirical Model Estimation Procedure

The study adopts an Endogenous Switching Probit (ESP) model to investigate the impact of marketed surplus on farmers' demand for improved varieties of groundnuts in central and northern Malawi. The ESP controls for endogeneity biases in the treatment effect framework (Lokshin and Sajaia, 2011). Other econometric models that control endogeneity biases include Heckman's two-step, double hurdle, endogenous switch regression, and conditional mixed process (Cragg, 1971; Heckman 1979; Roodman, 2009). The difference between the ESP and the other models is that the former is appropriate in modelling decisions where both the selection and outcome response variables are binaries (Carrasco, 2001; Lokshin and Glinskaya, 2009; Lokshin and Sajaia, 2011). For the other models, only the treatment response variable is binary, while the outcome is continuous.

Let $MP_i$ (treatment variable) denote a binary taking 1 for smallholders who are inclined to increase a marketed surplus, 0 otherwise. Similarly, $DI_i$ (outcome variable), also a binary, with 1 indicating smallholders that demand for improved varieties and 0 otherwise. The selection and outcome equations are, in turn, specified in equations (1), (2), and (3).

$$MP_i = 1 \text{ if } \gamma Z_i + \mu_i > 0; MP_i = 0 \text{ if } \gamma Z_i + \mu_i \leq 0 \quad (1)$$

$$DI_{1i}^* = \alpha_1 X_{1i} + \varepsilon_{1i} \; ; DI_{1i} = I(DI_{1i}^* > 0); DI_{0i}^* = \alpha_0 X_{0i} + \varepsilon_{0i}$$

$$DI_{0i} = I(DI_{0i}^{*} > 0) \quad (2)$$

$DI_i$ is observable when $DI_i = DI_{1i}$ if $MP_i = 1$;

$$DI_i = DI_{0i} \text{ if } MP_i = 0, \quad (3)$$

Where $DI_{1i}^{*}$ and $DI_{0i}^{*}$ are the latent variables that determine the binary outcomes $DI_1$ and $DI_0$, $X_1$ and $X_0$ are vectors of weakly exogenous variables, $Z$ is a vector of variables that determine a switch between and $\alpha_0$ $\gamma$ are vectors of parameters; and $\mu_i$, $\varepsilon_{1i}$ and $\varepsilon_{0i}$ are the error terms. The observed demand for improved varieties $DI_i$ is a dichotomous realization of $DI_i^{*}$ if the farmer has no marketed surplus.

The assumption made in this type of model is that farmers' decision to demand improved varieties is endogenous to having a marketed surplus. Some unobservable characteristics that influence the probability that a farmer would have marketed surplus could also influence improved varieties' demand. Neglecting this endogeneity in the unobservable covariates in both treatment and outcome regression equations is likely to yield biased estimates of the impact of marketed surplus on-demand for improved varieties. The use of instrumental variables in the selection equation overcomes biased estimates' problems (Makate *et al.*, 2016). A falsification test is conducted on the outcome equation's probit regression to identify the correct instrumental variables. The chi-squared's insignificance $p$-value indicates that the variables are the suitable instruments used in the selection equation but not in the outcome.

A post estimation is conducted to find parameters that measure the treatment variables' effects on the desired outcome (Heckman and Vytlacil, 2000). In this study, marketed surplus of groundnuts is the treatment or selection variable, while the demand for improved varieties of groundnuts is the

outcome variable. The most relevant post estimation parameters are the average treatment effect on the treated (ATET), which estimates the effect of marketed surplus on-demand for improved varieties for smallholders with the marketed surplus. The effect of farmers with no marketed surplus on-demand for improved varieties estimates the average treatment effect on untreated (ATU). Other parameters are the average treatment effect (ATE) and the average marginal treatment effect (MTE). The former is the average effect of marketed surplus for groundnuts on-demand for improved varieties for smallholders selected at random from the population. The latter describes the treatment effect for smallholders that are indifferent as to whether to increase marketed surplus or not. Lokshin and Sajaia (2011) and Aakvik *et al.* (2000) provide more details of the ESP model.

Estimating the parameters that indicate the impact of marketed surplus on-demand for improved varieties proceeds with determining factors that affect marketed surplus. Denote the marketed surplus as $MP_i = Q_i - X_i^{'}$, where $MP_i$ is a marketed surplus, $Q_i$ is the total household output, $X_i$ is a vector of household consumption that includes part of the harvest used as seed and given away as gifts. In autarky, nothing is traded, $MP = 0 \forall_i \in$ not traded. However, when the farmer sells part of the harvest, then $MP_i > 0 \ \forall_i \in$ is traded. Then the selection equation with its determinants is given as,

$$\begin{aligned} MP_{i=}\alpha_0 &+ \alpha_1 AGERESS + \alpha_2 AGERESSQD + \alpha_3 PCWORK + \alpha_4 OXCART \\ &+\alpha_5 PGNUTHA + \alpha_6 YIELD + \alpha_7 SEEDCOST + \alpha_8 OUTPUTMARK \\ &+\alpha_9 MOBP + \alpha_{10} SEEDLOAN + \alpha_{11} EXT + \alpha_{12} SEEDMULT \\ &+\alpha_{13} PRDBUYERS + \alpha_{14} RODST + \alpha_{15} DISTMARK + \varepsilon_i \end{aligned} \quad (4)$$

where all the variables are as defined in Table 1 and $\varepsilon_i$ are the unobservable covariate.

## 2.2 Data Sources and Definition of Variables

Table 1 defines the variables used in the study. Dependent variables comprised a selection variable, marketed surplus ($MP$), and an outcome variable, demand for improved varieties ($DI$). In the former case, farm households indicated, in local measurements, the quantity of the crop harvest that they sold in 2015/16. According to Patnaik (1975), this is the marketed surplus. The marketed surplus was then converted as the proportion of the total harvest. Because it is the produce sold, such proportion indicates the household's commercialization index (Govereh *et al.*, 1999; Strasberg *et al.*, 1999; Chirwa, 2009). According to Strasberg *et al.* (1999) and Govereh *et al.* (1999), a commercialization index of close to 0 means that crop production is purely for subsistence. The index close to 1 implies that the household produces for the market. In this study, all index values equal to and above 0.5 were considered to be marketed surplus. Commercialization indices below 0.5 were considered to be non marketed surplus. A binary variable was generated for marketed surplus with 1 and 0 otherwise. For the outcome variable, farmers who replaced conventional varieties with improved ones in 2016/17 were considered to have expressed demand for the latter. Consequently, the variable was coded 1 for the demand, 0 otherwise.

Explanatory variables hypothesized to explain a marketed surplus of groundnuts were identified based on past empirical work (Alene *et al.*, 2008; Zanello, 2012; Adenuga *et al.*, 2013; Burke *et al.*, 2015). These variables were categorized as socio-economic characteristics, market access-related factors, institution factors, and market transaction cost factors

### 2.2.1 Socio-economic characteristics

Farmers' age (AGERESS and AGERESSQD) is expected to have a nonlinear relationship with a marketed surplus. Young farmers are more inclined to increase marketed surplus than older ones (Gebremedhin and Jaleta, 2010; Mirie and Zemedu, 2018; Das, 2020). Involvement in piece work jobs (PCWORK), known as 'ganyu' in Malawi, is an income diversification strategy for farm households (Ellis, 1998). However, Whiteside (2000) pointed out that *ganyu* is counterproductive to household productivity as it competes with its labour demand. Because *ganyu* contributes to low household crop productivity, the marketed surplus is also expected to decline. The oxcart is the most used means of transporting inputs and produce to and from the market in some of SSA countries' rural areas. Therefore, it is expected that farm household that own oxcarts (OXCART) to increase marketed surplus.

Households' productive assets, such as the proportion of land allocated for the cultivation of crops (PGNUTHA), are expected to increase production, hence marketed surplus (Goyal and Berg, 2004; Faris *et al.*, 2018). An increase in yield per hectare of land (YIELD) increases the marketed surplus (Wambua *et al.*, 2019). The seed for modern varieties, especially groundnuts, are costly. Their supply is low because private traders consider the enterprise to have narrow profit margins (Minde *et al.*, 2008; Siambi *et al.*, 2015). Therefore, their demand falls with an increase in cost (SEEDCOST). The decline in the demand for certified seed reduces crop productivity, negatively affecting marketed surplus.

### 2.2.2 Market access related factors

Farmers with access to output market information (OUTPUTMARK) are more likely to intensify their participation in the market (Aslam *et al.*, 2019), hence increase marketed surplus due to the prospects of finding buyers that offer better prices.

238 Table 1: Definition of variables used in the study

| *Dependent Variables* | Measurement | Expected Sign |
|---|---|---|
| Demand for Improved Varieties (DI) | 1=Smallholder demand for improved groundnut varieties | |
| Marketed Surplus (MP) | 1=Smallholder with marketed surplus | |
| *Independent Variables* | | |
| | *Socio-economic Characteristics* | |
| AGERESS | Age of the farmer in years | Positive |
| AGERESSQD | Age squared of the farmers in years | Negative |
| PCWORK | 1=Household involved in piece work jobs | Negative |
| OXCART | 1=Household owns an oxcart | Positive |
| PGNUTHA | The proportion of land planted with groundnuts | Positive |
| YIELD | The yield of groundnuts in kg ha-1 | Positive |
| SEEDCOST | Cost of seed per hectare (Malawi Kwacha; MK730=1US$) | Negative |
| | *Market Access* | |
| OUTPUTMARK | 1= Smallholder' access to market information | Positive |
| MOBP | 1=Household possess a mobile phone | Positive |
| *Institutional Factors* | | |
| SEEDLOAN | 1=Household has access to seed loan | Positive |
| EXTS | 1=Household has access to extension services | Positive |
| SEEDMULT | 1=Household is located in areas with seed multiplication activities | Positive |
| PRDBUYERS | 1=Smallholder sold produce to mobile grain buyers | Negative |
| | *Transaction Costs Factors* | |
| RODST | 1=Households resides in areas with poor road network | Negative |
| DISTMARKT | Time, in minutes, taken to reach the nearest market | Negative |

239 Source: Farm household survey (2017); n=Total sample size

In addition, farmers who possess mobile phones (MOBP) can link with many prospective buyers of produce (Aker, 2010; Aker, 2011; Zanello, 2012), leading to an increased marketed surplus.

### 2.2.3 Institutional factors

Mobile grain buyers (PRDBUYERS) are the informal market sources to which smallholders sell produce. However, crop producers claim that such grain buyers cheat them by using unstandardized weighing scales and offer lower prices (Pokhrel and Thapa, 2007). As a result, groundnut producers, whose main buyers are mobile traders, are less inclined to increase marketed surplus. On the other hand, agricultural extension agents (EXT) enable farm households to access market information for their produce. Therefore, contacts with extension agents would positively affect marketed surplus (Bahta and Bauer, 2012.; Faris *et al.*, 2018).

Most smallholder farmers cannot afford to purchase improved seed varieties because they are expensive. To ease their access, some farmer organizations offer seed loans (SEEDLOAN) to them. Access to the seed loans would increase production through farmers' access to viable seed, hence would increase marketed surplus (Mmbando *et al.*, 2015).

### 2.2.4 Market transaction cost factors

Poor status of rural roads (RODST) increases transportation costs to bring produce to markets. Therefore, not only would producers' transportation costs increase with poor road conditions, but also buyers of produce. As a consequence, the marketed surplus would decline (Fentie *et al.*, 2017). Similarly, smallholders who take a long time to reach markets (DISTMARKT) are also less likely to decrease marketed surplus (Fentie *et al.*, 2017) due to increased transportation costs.

# 3 EMPIRICAL RESULTS AND DISCUSSION

## 3.1 Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in the analysis. About 74% of the smallholders had a marketed surplus of groundnuts, while 41% demanded improved groundnuts varieties. The farmers' mean age was about 46 years, and about 43% of them engaged in piece work jobs. Most smallholders' engagement in piece work jobs indicates their importance as a livelihood coping strategy (Whiteside, 2000) and income diversification avenue among rural households (Ellis, 1998). A moderate percentage of the smallholders (31%) possessed oxcarts, which they mostly use to transport farm inputs and produce.

The average land allocated to the cultivation of groundnuts was 0.33 ha, while the average yield realized was about 890 kg $ha^{-1}$. Allocation of 0.33 ha of land to groundnut cultivation against a mean landholding size of 1.5 ha indicates that smallholders perceive the crop as a potential cash crop. Above 50% of farmers possessed mobile phones and had access to market information from different sources. On average, the farmers take one and a half hours to travel to the nearest output market, and 14% of them reside in areas with poor road conditions.

The poor road conditions and the long time that smallholders take to reach markets imply that they incur more transportation costs, negatively affecting marketed surplus. A small percentage of the farmers (18%) had access to seed loans, while most of them (84%) had access to extension services. The small percentage of farmers who had access to seed loans shows that most of them still face challenges to access better quality seeds. The percentage of smallholders that were aware

of improved groundnut varieties was 63%. Most smallholders (97%) sold their produce to mobile grain buyers.

Table 2: Socio-economic characteristics of smallholder groundnut producers (n=416)

| *Dependent Variables* | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Demand for Improved Varieties | 0.411 | 0.493 | 0 | 1 |
| Marketed Surplus | 0.738 | 0.440 | 0 | 1 |
| *Independent Variables* | | | | |
| *Socio-economic Characteristics* | | | | |
| AGERES | 45.957 | 12.869 | 20 | 82 |
| AGERESSQD | 2277.231 | 1243.837 | 400 | 6724 |
| PCWORK | 0.433 | 0.496 | 0 | 1 |
| OXCART | 0.306 | 0.251 | 0 | 1 |
| PGNUTHA | 0.333 | 0.323 | 0.025 | 6.075 |
| YIELD | 892.429 | 537.049 | 49.180 | 2926.829 |
| SEEDCOST | 8.042 | 4.591 | -4.605 | 11.711 |
| *Market Access* | | | | |
| OUTPUTMAKINFOR | 0.596 | 0.491 | 0 | 1 |
| MOBP | 0.548 | 0.498 | 0 | 1 |
| *Institutional Factors* | | | | |
| SEEDLOAN | 0.180 | 0.385 | 0 | 1 |
| EXTS | 0.841 | 0.366 | 0 | 1 |
| SEEDMULT | 0.632 | 0.483 | 0 | 1 |
| PRDBUYERS | 0.974 | 0.160 | 0 | 1 |
| *Transaction Costs Factors* | | | | |
| RODST | 0.142 | 0.349 | 0 | 1 |
| DISTMARKT | 1.498 | 3.754 | -4.605 | 5.991 |

Source: Farm household survey data (2017); n=Total sample size

295 ### 3.2 Farm Household Utilization of Groundnut Harvested in 2015/16

296

297 Table 3 presents farm household utilization of groundnut they harvested in the 2015/16 growing
298 season. The mean productivity (yield per hectare) of the groundnut was about 890 kg $ha^{-1}$. The
299 yield is slightly above what was previously reported (Simtowe *et al.*, 2010; Siambi *et al.*, 2015).
300 Farm households' average commercialization index, which is the marketed surplus, was 0.58. The
301 mean consumption and seed recycling indices were at 0.24 and 0.18, respectively. As indicated,
302 the household commercialization index (HCI), the marketed surplus, was higher than what
303 previous empirical literature observed (Gourichon and Mkomba, 2014). The change in the farmers'
304 production orientation explains the increase in the marketed surplus.

305

306 Table 3: Utilization of groundnut produced by smallholders in the study areas (n = 416)

| Quantity of Groundnut | Min. | Max. | Mean | Std. Dev. |
|---|---|---|---|---|
| Total production (kgs) | 15.00 | 2500.00 | 402.820 | 376.077 |
| Productivity (kg $ha^{-1}$) | 49.18 | 2926.83 | 892.429 | 537.049 |
| Marketed Surplus | 0.00 | 1.00 | 0.580 | 0.270 |
| Seed Index | 0.00 | 1.00 | 0.180 | 0.156 |
| Consumption Index | 0.00 | 1.00 | 0.240 | 0.216 |

307 Source: Farm household survey (2017); n= Total sample size

308

309 Over a decade ago, groundnut producers in Malawi consumed more of the harvest than what they
310 sold (Diop *et al.*, 2004; Gourichon and Mkomba, 2014). During the same period, low-yielding
311 varieties dominated the production system (Minde *et al.*, 2008). The increase in marketed surplus
312 and household commercial index for groundnuts in Tables 2 and 3 suggests that the smallholders
313 cultivate relatively more improved varieties than they previously did.

314

### 3.3 Impact of Marketed Surplus on-Demand for Improved Varieties

Table 4 shows the impact of the marketed surplus on-demand for improved varieties of groundnuts. Parameters that summarize the impact of marketed surplus on-demand for improved varieties appear in column 1 of the Table, while their mean effects are in column 3. The results in the Table show that the probability of demand for improved varieties increased by 40% among smallholders with a marketed surplus (ATET). Conversely, for smallholders that did not have a marketed surplus (ATU), the probability of demand for improved varieties declined by 14%. Furthermore, the average effect of marketed surplus on the probability to demand improved varieties among smallholders picked at random in the population (ATE) increased by about 30%. The average effect of marketed surplus on the probability for smallholders in the margin of increasing marketed surplus (MTE) to demand improved groundnuts increased by 26%. The study's findings suggest that marketed surplus had positive effects on increasing demand for improved groundnut varieties.

Table 4: Effect of marketed surplus on-demand for improved varieties

| Variable | Obs. | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| ATET | 307 | 0.407 | 0.185 | -0.980 | 0.783 |
| ATU | 108 | -0.141 | 0.292 | -0.904 | 0.332 |
| ATE | 416 | 0.264 | 0.195 | -0.980 | 0.759 |
| MTE | 100 | 0.295 | 0.043 | 0.224 | 0.372 |

Source: Output from data analysis

The positive impact of marketed surplus on-demand for improved varieties is a manifestation that the farmers who are inclined to participate in the market demand relatively more high-yielding varieties than those who do not participate. The current study's findings are consistent with Wale and Holm-Mueller (2017), who suggest that farmers who get income mainly from crop production

demand high yielding improved crop varieties. Similarly, Derlagen and Phiri (2012) indicated that improved varieties of groundnuts are relatively more superior in yield to conventional ones. Thus, for increased marketable surplus and the desire to intensify market participation, crop producers would indeed demand improved crop varieties.

### 3.4 Estimates of Endogenous Switching Probit Regression

The ESP model's estimated results (Table 5) showed that the Wald chi-squared was highly significant, suggesting the joint explanatory power of independent variables on the selection's response variables and outcome equations. The $\rho$ estimates indicate that the errors' correlation is significantly different from zero at about a 5% level, indicating the unobserved covariates' dependence in the two equations. Therefore, unobservable covariates in the equations for the smallholders' marketed surplus and demand for improved varieties are associated, hence estimating the equations jointly.

### 3.5 Determinants of Marketed Surplus for Smallholder Groundnut Producers

In the treatment effect framework, only determinants of the response variable of the selection equation are relevant. Therefore, Table 5 reports the factors that determine the marketed surplus, which is the treatment response variable, of this study. The results in the Table show that socio-economics and market access factors had positive effects on marketed surplus.

#### 3.5.1 Socio-economic factors

The proportion of land allocated to groundnut positively affected marketed surplus at a 1% significance level.

Table 5: Estimates of determinants of marketed surplus for groundnuts (n=416)

| Variables | Coef. | Std. Err | Z Score | P >Z |
|---|---|---|---|---|
| CONSTANT | -1.846 | 1.086 | -1.700 | 0.089 |
| *Socio-economic factors* | | | | |
| AGERESP | 0.019 | 0.041 | 0.460 | 0.643 |
| AGERESPSQD | 0.000 | 0.000 | -0.650 | 0.514 |
| PGNUTHA | 2.105*** | 0.584 | 3.610 | 0.000 |
| YIELD | 0.001*** | 0.000 | 6.800 | 0.000 |
| PCWORK | 0.353** | 0.155 | 2.270 | 0.023 |
| OXCART | 0.383 | 0.374 | 1.020 | 0.306 |
| SEEDCOST | 0.015 | 0.017 | 0.890 | 0.376 |
| *Market access factors* | | | | |
| OUTPUTMAKTINFOR | 0.242* | 0.136 | 1.780 | 0.075 |
| MOBP | 0.165 | 0.158 | 1.050 | 0.294 |
| DISTRICT_DUMM | -0.101 | 0.261 | -0.390 | 0.697 |
| DISTMARKT | 0.012 | 0.021 | 0.580 | 0.561 |
| *Institution factors* | | | | |
| PRDBUYERS | 0.081 | 0.397 | 0.200 | 0.838 |
| SEEDLOAN | -0.273 | 0.202 | -1.350 | 0.177 |
| EXTS | -0.037 | 0.212 | -0.170 | 0.862 |
| SEEDMULT | 0.152 | 0.195 | 0.780 | 0.435 |

| | |
|---|---|
| Number of Observations: 416 | Wald Chi2(15)=80.5 |
| Log likelihood =-434.765 | Prob>Chi2=0.000 |
| /athrho1 | 0.422(0.977) |
| /athrho0 | -13.043(506.626) |
| Rho1 | 0.399(0.821) |
| Rho0 | -1.000(9.50e-09) |
| Likelihood Ratio test of Independent equations rho1=rho0=0 | |
| Chi2(2)=5.69 | Prob> Chi2=0.058 |
| *,**,*** : Significance at 10%, 5%, 1% | |

Source: Farm household survey data (2017), n=Total sample size

The positive effect of this coefficient estimate on marketed surplus suggests that as land for crop cultivation increases, crop production also increases. Similary, FAOSTAT (2021) reports that when the land area for cultivation of groundnuts increased, the crop's production increased by 21%

between 2001 and 2010. Further, Goyal and Berg (2004), Chinn (1976), and Belayneh *et al.* (2018) attest to the positive effect of cultivated land area on marketed surplus. To this end, Bardhan (1970) observed that the increase in production also entails an increase in marketed surplus. With increased production, producers would have sufficient for consumption as well as for sale. However, the expansion of land for the cultivation of crops is not feasible at the current moment with the increase in the country's population (Malawi-Government, 2018). In this case, farmers may reduce land for some crops and reallocate to those with high market demand at a particular point in time.

Further results show that the coefficient estimates of the yield of groundnuts positively affected marketed surplus at a 1% significance level. In Malawi, groundnut is an essential income source (Minde *et al.*, 2008; Simtowe *et al.*, 2010; Makoka, 2012). In this case, an increase in marketed surplus is a prerequisite for the farm households to increase the quantity of commodities they would sell (Bardhan, 1970; Barrett, 2008; Belayneh *et al.*, 2018; Lemi, 2020). To increase yield, hence marketed surplus, requires that farm households use high productive farm inputs or practice good crop husbandry (Chinn, 1976; Baba *et al.*, 2010). The use of improved varieties and reduction in pre-harvest losses, timely crop harvest could contribute to yield increase and marketed surplus.

In other results, smallholders' involvement in piece work jobs was positive and affected marketed surplus at a 5% significance level. However, the current study's findings on the positive effects of piece work jobs and the increased marketed surplus are unexpected. By undertaking the piece work, farm households experience reduced labour availability at their farms (Whiteside, 2000), thus negatively affecting production and reducing the marketed surplus. Furthermore, farm

391 households use the income from piece work jobs to meet other home necessities (Ralitza *et al.*,
392 2010). Therefore, such income cannot be available to purchase productive farm inputs. Further,
393 households' wages from piecework jobs are always low (Ralitza *et al.*, 2010), making such income
394 inadequate for investment on the farm. However, the current study's finding suggests that farm
395 households opted to be paid in kind (farm inputs), which increased crop yields. Also, the
396 households might have undertaken the piecework jobs during off-peak periods of labour demand
397 in their fields which never affected them.
398

399 ### 3.5.2 Market access factors

400
401 Access to market information positively affected marketed surplus at a 10% significance level. In
402 Malawi, farmers access market information from different sources, namely, extension agents,
403 farmer organizations, fellow farmers, and produce buyers. The expectation is that farmers with
404 access to various information sources would increase marketed surplus due to reduced market
405 transaction costs. Without access to market information, farm households would incur search costs
406 in finding the market of their produce through personal visits to the markets. Similarly, Omiti *et*
407 *al.* (2009) and Bukul and Washo (2018) suggest that access to market information increased market
408 participation intensity, increasing the marketed surplus among the smallholders in Kenya's peri-
409 urban areas and Ethiopia respectively.
410

411 ## 4 CONCLUSION AND POLICY IMPLICATIONS

412
413 The study employed the Endogenous Switching Probit model to investigate the effect of marketed
414 surplus on-demand for improved varieties of groundnuts among smallholder groundnut producers
415 in Malawi. The ESP model was preferred to other econometrics models, such as the endogenous

switching regression because both the selection and outcome equations had response variables which were binaries. The study also determined the factors that affect marketed surplus. The study results indicated that despite groundnut production and productivity not changing much for over a decade, the average commercialization index for groundnuts was higher than previously reported. The ESP estimates results showed that increased marketed surplus positively impacted the demand for improved varieties among the smallholders. In addition, the demand for improved varieties of groundnuts increased among farmers that were inclined to increase marketed surplus. The positive impact of marketed surplus on-demand for improved varieties suggests that farmers who want to increase the intensity to participate in the market put more value on high-yielding traits of groundnuts than any other varietal attributes.

Conversely, the demand for improved varieties among the farmers that had no marketed surplus declined. The reduction in demand for improved varieties among smallholders with no marketed surplus suggests that production for this category of farmers was purely for subsistence. Other findings suggest that increased crop and land productivity, smallholders' engagement in off-farm economic activities, and enhanced access to market information are critical for the marketed surplus to trigger demand for improved groundnut varieties. The study's findings have policy implications on the output market's performance as a catalyst to increase the demand for improved varieties. Thus, policy interventions should not only focus on the input market but also on the challenges farmers encounter in the output market that financially capacitates them to meet the cost of improved seeds.

## DECLARATIONS

### Availability of Data and Materials

The data supporting the findings for this study can be obtained upon request from the corresponding author.

### Competing Interests

The authors declare that they have no competing interests.

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### Author's Contributions

AK: Conceptualized the idea, handled the data analysis and the discussion of the results and approved the final manuscript.

EWZ: Provided guidance from the research's conceptualization, data collection, analysis, and discussion of the result and read and approved the final manuscript.

GFO: Proofread the manuscript to ensure its quality and approved the final manuscript.

### Author's information

Admire Katunga has a Ph.D. in Agricultural Economics. He works for the Department of Agricultural Research Services, Chitedze Agricultural Research Station, Malawi, as an Agricultural Research Economist. His research interests are Agricultural Development Economics, Cost-Benefit Analysis of Development Projects/Programs/Policies, and Impact Assessment/Technology Adoption.

Edilegnaw Wale Zegeye is a Professor in the Department of Agricultural Economics, Faculty of Natural and Agricultural Sciences, University of the Free State, Republic of South Africa. His research interests are The Economics of Water Use in Smallholder Agriculture, Natural Resources Economics, Agro biodiversity Economics, Agricultural Development Economics, Cost-Benefit Analysis of Development Projects/Programs/Policies, and Impact Assessment/Technology Adoption.

Gerald Ortmann is a Professor Emeritus at the University of KwaZulu-Natal, School of Agricultural, Earth and Environmental Sciences, Discipline of Agricultural Economics, Republic of South Africa. His research interests are in Farm and Financial Management, Agricultural Policy (including Institutional Economics) and Development Economics.

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**Ethics Approval and Consent to Participate**

The study received ethical clearance from the hosting institution (University of KwaZulu Natal) and consent from the participating farmers.

**Consent for Publication**

Not Applicable

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