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Market Participation of Smallholder Common Bean Producers in Malawi

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ABSTRACT

Smallholder agriculture remains the main engine for livelihood improvement and rural growth in Malawi. Policies that seek to transition rural farmers out of poverty must help transform their livelihood strategies such that they move from subsistence to commercialized production. This study used the Third Integrated Household Survey (IHS3) data, collected in 2010/11 by the National Statistical Office, to analyze factors affecting smallholder common bean production and market participation using a triple hurdle modeling approach. Common beans are an important leguminous crop that can promote soil fertility and improved nutrition in Malawi. The results from the first stage suggested that farmers' geographic location, access to production extension services, receipt of subsidized inputs through the Farm Input Subsidy Program (FISP), distance to the main road and the nearest market, and ownership of a radio affected agricultural households' decision of whether produce common beans. A similar but smaller number of factors, including location, distance to the market, years of marketing experience and radio ownership affected farmers' subsequent decision to participate in the common bean market. Gender of the household head and access to credit and marketing extension services affected both net sales and purchases of common beans. Marital status, location, off-farm income, radio and bicycle ownership, distance to the market and buying price significantly affected amount of common beans purchased on the market. On the other hand, the household head's education level, land owned, post-harvest losses, selling price and mode of common bean transportation affected the amount of common beans sold on the market. Based on these findings, this study recommends further research on the impact of common bean production and market participation on rural poverty, incomes, and nutritional outcomes in Malawi, particularly in relation to other leguminous crops, with an emphasis on better understanding the role of gender and production-to-consumption pathways. The study also suggests development of policies that promote effective extension services, opportunities for collective marketing, and rural road and market development.

Keywords: Market participation, smallholder, common beans, *Phaseolus vulgaris*, triple hurdle model, Malawi

1. INTRODUCTION

Globally, there is a growing emphasis on helping smallholder farmers transition from subsistence to market-oriented production (Jayne et al. 2010; Graeub et al. 2015). Market access and participation have been highlighted for their potential to combat food insecurity and poverty, both of which are on the rise in rural Malawi (Barrett, 2008; Frelat et al. 2015; World Bank 2017). Better market access can increase household incomes, and has also been linked to increased dietary diversity (Sibhatu et al. 2015; Koppmair et al. 2016). Promoting smallholder farmers' participation in markets also contributes to agricultural sector transformation and more broad-based economic growth (Von Braun and Kennedy 1994; Omiti et al. 2009).

Though increasing smallholder market participation has been a goal in Malawi and across sub-Saharan Africa, many smallholders still lack access to assets, institutions and infrastructure necessary to produce a surplus and bring it to market. Across the continent, low productivity, limited access to market information, high transaction costs, and poor road, storage and market infrastructure are among the many hardships smallholders face in taking advantage of both input and output markets (Chapoto et al. 2016; Mango et al. 2017). Attempts to address these issues through trade liberalization and price policies have so far been insufficient to generate the desired results (Orr and Mwale 2001; Bellemare and Barrett 2006; Barrett 2008).

Recent studies to understand the determinants of smallholder market participation in Africa and parts of Asia have focused primarily on high value and export crops such as banana, groundnuts, milk, and coffee (Barrett 2008; Jagwe et al. 2010; Makhura et al. 2001; Burke et al. 2015; Gebreselassie and Sharp 2008). In Malawi, there is little distinction between food and cash crops, but the majority of market participation research has focused on maize, groundnuts, coffee and bananas. There has been less research on legumes and on common beans (*Phaseolus vulgaris*) in particular (Orr and Mwale 2001). However, the factors that affect production and market participation decisions of common beans, maize and other crops differ. To date, researchers have explored common beans' market share, the spatial integration of common bean markets, consumer preferences for beans, and factors determining demand for and prices of common beans (Chirwa and Phiri 2007; Muthoni et al. 2014; Mtumbuka et al. 2014). While there is a growing literature dealing with common beans in Malawi, this is the first study to address the determinants of common bean market participation to the author's knowledge.

1.1 Common Bean Production and Marketing in Malawi

Common beans play an important role in the agricultural landscape in Malawi, which ranked tenth among African countries in terms of bean area harvested and eleventh in total production of beans in 2014. Among pulses, common beans occupy the most area in Malawi, and are second only to pigeonpea in terms of production (FAOSTAT).[1] Common beans are grown primarily by smallholder farmers in Malawi (Appendix Table 1). They are frequently intercropped with maize, the country's primary staple crop, which is seen as a positive alternative to monoculture maize production that deteriorates Malawi's already depleted soils (Chirwa and Phiri 2007; Njuki et al. 2011; Silberg et al. 2017). As a leguminous crop, common beans can contribute to soil fertility improvements through nitrogen fixation, helping to replenish nutrients heavily mined from soils during maize production.

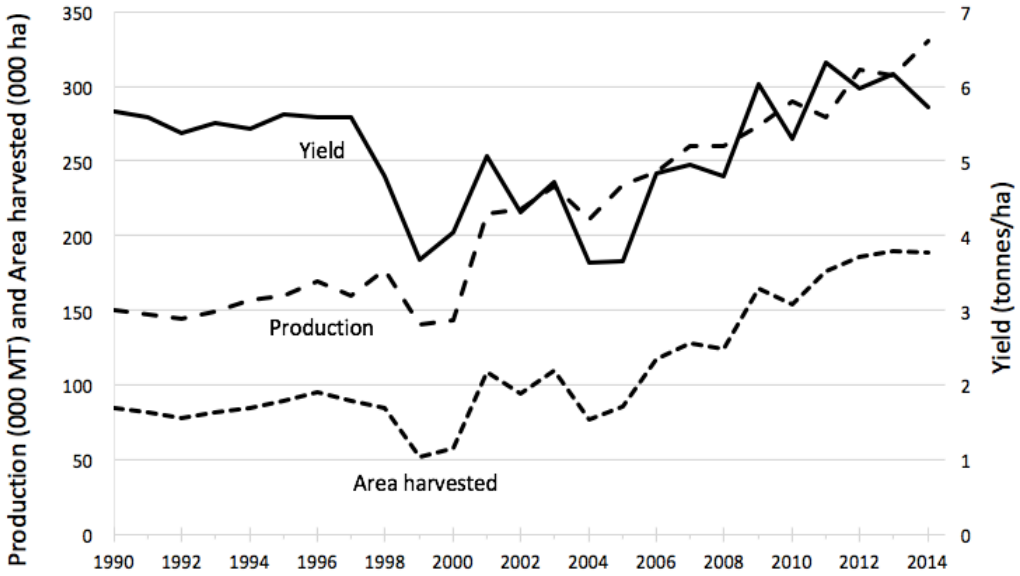
Common beans also serve as an important source of nutrition in Malawi, providing dietary fiber, minerals, and much-needed protein in a diet dominated by maize (Fan and Beta 2016; Njuki et al. 2011). However, consumption of common beans has declined in recent years despite their known health benefits (Verduzco-Gallo et al. 2014). Beans are also an important source of income for Malawi's smallholder farmers,

[1] Statements are based only on African countries, pulses, and oil crops for which data is available in FAOSTAT.

particularly for those with lower crop sales and for those who produce but do not sell maize (Orr and Mwale 2001; Chirwa 2006).

While bean production and area harvested have risen relatively steadily in Malawi since the 1990s, yields have fluctuated and risen only slightly during the same time period (Figure 1). Low productivity limits market participation, which hinges on farmers' ability to produce a marketable surplus (Barrett 2008). Fluctuating, low yields persist despite a 'component breeding' program begun in the early 1990s aimed at providing farmers with more seed varieties, both for higher yields and traits such as cooking time and early maturity desired by women who primarily cultivate and prepare beans (Njuki et al. 2011). Recent efforts by Chitedze Research Station, Lilongwe University of Agriculture and Natural Resources (LUANAR), the Department of Agricultural Research Services (DARS), and others have also increased the number of high-yielding, pest and disease-resistant varieties available to farmers (Muthoni et al. 2014; Magreta and Jambo 2012). A total of 15 varieties have been released in Malawi since the 1990s, and it is estimated that over 50 percent of the area planted to common beans in Malawi is planted with modern varieties (Muthoni and Andrade 2015).

Figure 1: Common bean production, area harvested and yield in Malawi (1990 to 2014)



Source: FAOSTAT.

While adoption of modern varieties of common beans is high in Malawi relative to its eastern and southern African counterparts, access to legume and common bean seed remains relatively low (Muthoni and Andrade 2015; Silberg et al. 2017). Low access is due in part to limited interest among private seed multiplication companies, who recognize that farmers' ability to save seeds from self-pollinated crops limits potential profits (Magreta and Jambo 2012; Chirwa 2007). Low quality seed contributes to poor productivity, along with infertile soils, losses due to pests, limited access to markets and credit, lack of extension services, and unfavourable climatic patterns such as droughts and high rainfall variability (Ferguson et al. 1991; Chirwa and Aggarwa 2001; Magreta and Jambo 2012; ICRISAT, CIAT and IITA 2013). The slight uptick in common bean yields in the past decade may be attributed in part to the dissemination of common bean and other legume seed through the FISP (Chirwa and Dorward 2013).

In spite of increased bean production in recent decades, Malawi has not achieved self-sufficiency in common beans and frequently imports them from neighboring countries, particularly through informal channels (Mtumbuka et al. 2014). It is estimated that only 35 percent of common bean production is marketed,

suggesting the potential to increase both domestic production and market participation among common bean producers (ICRISAT, CIAT and IITA 2013). However, unfavorable and variable prices due to seasonality of sales, poor market information, and variable demand by traders dissuade increased production (Mtumbuka et al. 2014). Malawian farmers considering legume production have cited concerns and uncertainty about legume prices, market access, and production risks in the face of rainfall variability (Snapp et al. 2002; Orr and Mwale 2001).

Given the importance of beans for smallholders' food and nutrition security and income in Malawi, as well as calls for increasing agricultural diversification, sustainable intensification, and legume production in particular, understanding the determinants of common bean production and market participation decisions in Malawi is particularly relevant. This paper seeks to inform policies and programmes to incentivize common bean production and market participation, in the hope that Malawi's agricultural architecture can promote diverse food systems and diets.

1.2 Objectives

The main objective of this study was to analyze factors affecting smallholder common bean production and market participation in Malawi. In particular, the following specific objectives were addressed:

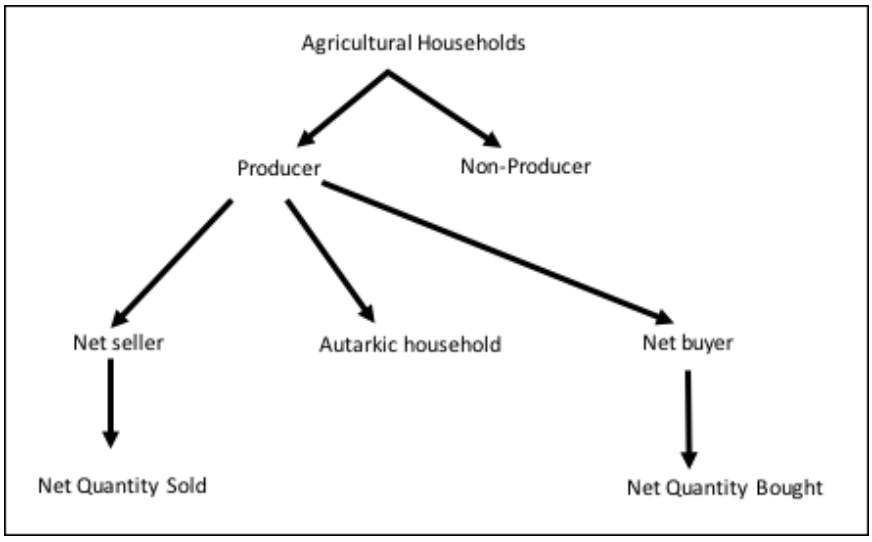
i. To analyze factors affecting smallholder farmers' decision to produce common beans.
ii. To analyze the factors affecting producers' participation in the market for common beans.
iii. To analyze the factors affecting the level of participation and amount of common beans bought and sold.

2. METHODOLOGY

2.1 Conceptual Framework

Most studies treat the market participation decision as a two-stage process involving: (i) the decision to participate in the market and (ii) the decision determining the quantity to buy and sell in the market, an approach which bypasses the initial decision of whether to produce at all. However, particularly for less commonly produced crops like common beans, the initial production decision is an important additional consideration which can distinguish factors that could induce formerly non-producing households to become producers (Burke et al. 2015). Incorporating the production and market participation decisions together, the agricultural household's decision can be represented as in Figure 2:

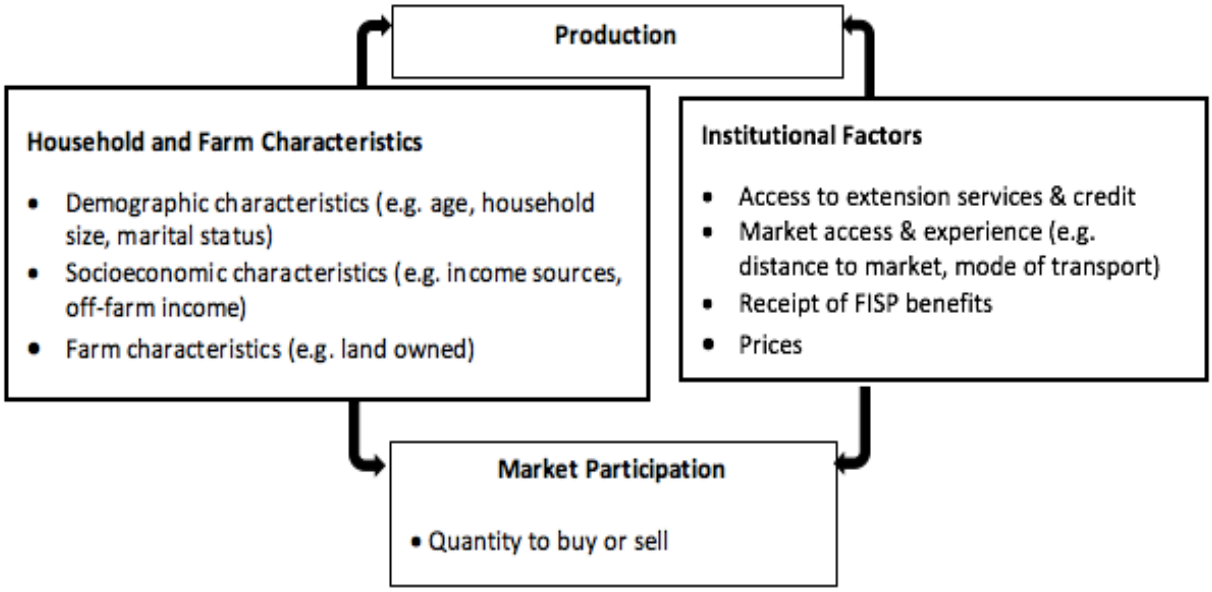
Figure 2: Three stage market participation framework



Source: Burke et al., 2015

In the first stage, the agricultural household decides whether or not to produce common beans. If the household does decide to produce common beans, it must then decide whether to participate in the market as a net buyer or net seller, or to remain autarkic, neither buying nor selling. If the household decides to participate in the market as a net buyer or seller, it must then determine the quantity to be bought or sold. The factors hypothesized to influence these decisions include household socioeconomic and demographic characteristics (e.g. age, household size, off-farm income, etc.), farm characteristics (e.g. land owned), and institutional factors (e.g. access to markets and extension services, prices). These factors can be presented as:

Figure 3: Factors affecting production and market participation.



Source: Adapted from Ingabire, 2016.

2.2 Empirical Models and Applications

To capture all three tiers of the decision-making process illustrated in the conceptual framework (Figure 1), this study employs a triple hurdle model, following the approach of Burke et al. (2015). The triple hurdle model is a modification of the hurdle model first introduced by Cragg (1971), one of the most commonly used models in participation studies. The triple hurdle method builds on the double-hurdle models used by Barremore and Barrett (2006) and others by incorporating the household's initial decision of whether or not to produce. This allows for the inclusion of non-producers in the model, and as such maintains the randomness of the parent sample (Akter and Fatema 2011).

The triple hurdle model integrates a probit to model the production participation decision, followed by an ordered probit to capture the factors determining whether common bean producing households are net sellers, net buyers or autarkic. The third stage employs two log-normal regressions to analyze determinants of net purchases and sales among net buyers and net sellers. The log-normal regressions are appropriate to estimate this tier given the truncated nature of the dependent variables (Burke et al. 2015).

Objective 1: The household's decision to produce common beans is measured as a dichotomous variable that assumes a value of 1 if the farmer decides to produce beans and 0 otherwise. Let q_1 represent the level of bean production:

$$y_1 = 1[q_1 > 0]$$

$$y_1 = 0[q_1 = 0]$$

Then, a standard probit model is presented as:

$$\Pr\left(y_1 = 1 \middle| x_1, \omega\right) = \Phi(x_1\omega)$$

$$\Pr\left(y_1 = 0 \middle| x_1, \omega\right) = 1 - \Phi(x_1\omega)$$

where y is the decision to produce common beans, Φ is the standard normal cumulative distribution function, x_1 is a vector of explanatory variables influencing the production decision and ω is a vector of parameters to be estimated, such that $y_1 = 1$ when the household decides to produce common beans and $y_1 = 0$ when the household decides not to produce common beans. The full distribution of y is:

$$f\left(y_1 \middle| x_1\right) = \left[1 - \Phi\left(x_1\omega\right)\right]^{y_1=0}\left[\Phi\left(x_1\omega\right)\right]^{y_1=1} \quad \text{..... (1)}$$

Objective 2: The agricultural household's level of bean consumption is defined as q_2 and ordered probit indicator function as y_2

$$y_2 = 0\left[q_1 - q_2 < 0\right]$$

$$y_2 = 1\left[q_1 - q_2 = 0\right]$$

$$y_2 = 2\left[q_1 - q_2 > 0\right]$$

where $y_2 = 0$ when the producing household is a net buyer of common beans, y_2 =1 when the producing household is autarkic, and y_2 =2 when the producing household is a net seller. The ordered probit model defines the latent variable y_2^* :

$$y_2^* = x_2\delta + u_i$$

Where the random error term u_i is assumed normal (Greene, 2008) and x_2 is a vector of explanatory variables explaining market participation.

Assume $\alpha_1 < \alpha_2$ be unknown threshold parameters defined such that:

$$y_2^* = 0 \quad if \;\; y_2^* < \alpha_1$$

$$y_2^* = 1 \quad if \;\; \alpha_1 < y_2^* < \alpha_2$$

$$y_2^* = 2 \quad if \;\; y_2^* > \alpha_2$$

Following Daykin and Moffat (2002) and Lee and Thies (2010), it is assumed that u_i is normally distributed such that we can estimate the following probabilities:

$$Pr\left(y_2 = 0 \mid x_2, \alpha, \delta\right) = Pr(y_2^* \le \alpha_1 \mid x_2) = \Phi(\alpha_1 - x_2\delta)$$

$$Pr\left(y_2 = 1 \mid x_2, \alpha, \delta\right) = \Phi(\alpha_2 - x_2\delta) - \Phi(\alpha_1 - x_2\delta)$$

$$Pr\left(y_2 = 2 \mid x_2, \alpha, \delta\right) = 1 - \Phi(\alpha_2 - x_2\delta)$$

where $\Phi(\bullet)$ is the standard normal cumulative distribution function. The distribution of y_2 is the ordered probit:

$$f\left(y_2 \middle| x_2\right) = \left[\Phi(\alpha_1 - x_2\delta)\right]^{[y_2=0]} [\Phi(\alpha_2 - x_2\delta) - \Phi(\alpha_1 - x_2\delta)]^{[y_2=1]} [1 - \Phi\left(\alpha_2 - x_2\delta\right)]^{[y_2=2]} \quad \text{..... (2)}$$

Objective 3: Assuming q_3 as buyers' net purchases and q_4 as sellers' net sales:

$$q_3 = q_2 - q_1 \ \ if \ \ q_2 > q_1 \text{, otherwise undefined}$$

$$q_4 = q_1 - q_2 \ \ if \ \ q_1 > q_2 \text{, otherwise undefined}$$

Then, assuming x_3 as the explanatory variables for net purchases, and x_4 as explanatory variables for net sales, the individual distribution can be represented as:

$$f\left(q_3 \middle| x_3, \gamma_3\right) = \phi\left[\left\{\log\left(q_3\right) - x_3\gamma_3\right\} \middle/ \sigma_3\right] \middle/ q_3\,\sigma_3$$

$$f\left(q_4 \middle| x_4, \gamma_4\right) = \phi\left[\left\{\log\left(q_4\right) - x_4\gamma_4\right\} \middle/ \sigma_4\right] \middle/ q_4\,\sigma_4 \quad \text{..... (3)}$$

where σ_i is the random variable, the standard deviation of q_i, and ϕ is the standard normal probability density function.

2.3 Data Sources and Description

The study used the Third Integrated Household Survey (IHS3) data, which were collected by the Malawi National Statistical Office (NSO) from March 2010 to March 2011. The survey forms a part of a wider range of surveys under the support of World Bank: the Living Standards and Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA). The IHS3 was designed to collect data on households that are representative at the national, district, rural and urban level using a stratified two-stage sample design. The primary sampling units (PSUs) selected at the first stage are the enumerations areas (EAs) based on the 2008 Malawi Population and Housing Census. The EA was the smallest operational area established for the census with well-defined boundaries, corresponding to the workload of one census enumerator. The EAs had an average of about 235 households each. A total of 768 EAs and 12,271 households were selected across the country. In each district, a minimum of 24 EAs were interviewed, while in each EA a total of 16 households were interviewed. The IHS data contains household, community, fisheries and agriculture questionnaires. Data from the IHS3's household, agricultural and community questionnaires were used in this study.

2.4 Variable Description

Description of the variables used in the triple hurdle model are presented in Table 1. Household demographic characteristics controlled for include the age of the household head, number of adult equivalents in the household, and the gender, marital status, and highest level of education attained by the household head. The level of education attained is included using categorical variables for the completion of primary, secondary, or tertiary education. Attainment for formal education helps in technology adoption, processing and marketing practices. Formal education also helps farmers to better understand various extension services, which increases their probability of producing a particular crop, participating in the market and their level of market participation (Jari 2009; Abafita et al. 2016; Holloway et al. 2000). Geographic location was also considered, with dummy variables for urban households as well as rural households in each region of Malawi (North, Centre and South).

Table 1: Descriptive statistics of selected variables used in the analysis for producers and non-producers of common beans

		Producers (N=972)		Non-producers (N=9,428)	
Variable name	**Variable description**	**Mean**	**SE**	**Mean**	**SE**
Household characteristics					
Age of household head	Age in years	43.04	0.512	42.07	0.153
Gender of household head	Binary; male=1	0.75	0.014	0.76	0.004
Household size	Adult equivalent units	4.00	0.056	3.87	0.017
No education	Binary	0.74	0.014	0.07	0.004
Primary education	Binary	0.10	0.009	0.10	0.003
Secondary education	Binary	0.15	0.011	0.17	0.004
Tertiary education	Binary	0.02	0.004	0.03	0.002
Rural center	Binary	0.30	0.015	0.28	0.004
Rural north	Binary	0.22	0.013	0.14	0.003
Rural south	Binary	0.39	0.017	0.39	0.005
Urban	Binary	0.10	0.009	0.19	0.004
Log off-farm Income	Malawian Kwacha (MWK)	0.16	0.019	0.16	0.006
Ownership of radio	Binary	1.51	0.016	1.53	0.005
Ownership of mobile phone	Binary	0.33	0.015	0.39	0.005
Ownership of bicycle	Binary	1.60	0.016	1.61	0.005
Amount of land owned	Acres	1.78	0.048	1.99	0.245
Institutional factors					
Access to credit	Binary	1.86	0.011	1.87	0.003
Production extension services	Binary	0.72	0.014	0.70	0.005
Market extension services	Binary	0.90	0.009	0.89	0.003
FISP beneficiary	Binary	1.40	0.016	1.47	0.005
Buying price	MWK/kg of beans	686.65	61.39	702.93	22.15
Selling price	MWK/kg of beans	120.90	13.74	-	-
Marketing experience	Years	0.24	0.022	0.34	0.013
Distance to main road	Kilometers	8.00	0.258	8.40	0.097
Distance to the nearest market	Kilometers	7.54	0.149	8.10	0.056
Mode of transportation to market					
On foot	Binary	0.07	0.008	0.05	0.002
Bicycle taxi	Binary	0.01	0.003	0.01	0.001
Own bicycle	Binary	0.06	0.007	0.07	0.003
Truck/mini bus	Binary	0.81	0.013	0.78	0.004
Buyer picked up	Binary	0.05	0.007	0.09	0.003

Notes: Variables are continuous unless otherwise noted, and binary variables are defined as 1=yes unless otherwise noted. HH= household head; SE = standard error.

Household socioeconomic status is represented by dummy variables for certain productive assets, as well as off-farm income and land owned by the agricultural household. The effects of off-farm income vary by crop and may affect production and market participation decisions in different ways; higher off-farm income could allow a household to purchase productivity-enhancing inputs and become a net seller of common beans, or it could indicate that a household produces fewer common beans and purchases the deficit on the market (Martey et al. 2012; Woldeyohanes et al. 2017). Off-farm income is also believed to increase market access and reduce entry barriers (Wickramasinghe et al. 2014).

Institutional factors incorporated into the model include binary variables indicating access to credit, receipt of production and market extension services and FISP benefits. Access to production and market extension services and access to credit were expected to have a positive effect on the decision to produce and participate in the common bean market (Barrett 2008). Farmers who frequently receive extension services are more likely to have knowledge of production, handling, quality standards and market information on input and output prices (Zeberga 2010; Holloway et al. 2000). According to Abu (2015), access to credit gave farmers in Ghana funds to buy improved varieties, and produce and sell more groundnuts.

Additional market access variables include selling and buying prices, along with a variable capturing the number of years of experience the household has transacting in the market. While transaction costs are difficult to observe, they are represented in this analysis by distance to the main road, distance to the nearest market, and by dummy variables indicating the mode of transportation used to reach that market. The expectation was that long distance from roads and markets would negatively affect the decision to produce common beans and participate in the market, as well as the amount of common beans sold and purchased on the market (Makhura et al. 2001; Muricho et al. 2015).

3. RESULTS AND DISCUSSION

3.1 Sample Distribution and Descriptive Analysis

Of the 12,271 households in the IHS3, only 10,400 agricultural households were included in this analysis. Nine percent of agricultural households were common bean producers and 91 percent were not (Table 2). The majority of common bean producers interviewed in the IHS3 were smallholder farmers with less than two acres of land (Appendix Table 1). Furthermore, of the 972 common bean producers, 52.5 percent were net buyers, 28.3 percent were autarkic and 19.2 percent were net sellers.

Table 2: IHS3 sample distribution of agricultural households

Production and Market Participation	Frequency	Percent
Common bean Production		
Non-producer	9,428	90.65
Producer	972	9.35
Total	10,400	100.00
Common beans market participation		
Net Buyers	510	52.47
Autarkic	275	28.29
Net Sellers	187	19.24
Total	972	100.00

While the majority of common bean producers are net buyers, net sales are higher on average (131.46 kg) than net purchases (5.82 kg) (Table 3). This could be attributed to the fact that net selling agricultural households sell common beans in bulk, while net buying households frequently purchase common beans in smaller quantities for household consumption and as recycled seeds.

Table 3: Average net sales and net purchases of common beans

Variable	Obs.	Mean	Std. Dev
Net sales	187	131.46	532.13
Net purchases	510	5.82	29.98

3.2 Econometric Results

Table 4 presents the results from the triple hurdle model. Results in the first and second hurdle are marginal effects from the probit and ordered probit models. Explanatory variables used in one hurdle are not required

to be used in subsequent hurdles, but rather can differ based on model specifications and other econometric assumptions (e.g. significance of the threshold parameters explained in section 2.2). The first column of results (i) presents marginal effects from the probit model, estimating factors affecting smallholder farmers' decision to produce common beans. The following three market participation columns (ii) present marginal effects of the ordered probit, estimating factors affecting the probability that a producer is a net buyer, autarkic or a net seller. The final two columns (iii) present the results of the log normal regressions predicting the extent of market participation, namely net sales and net purchases of common beans. Standard errors presented are robust standard errors (see Appendix Table 2 for results from the heteroscedasticity test).

As the first and second hurdles can be considered selection models, Inverse Mills Ratios (IMR) were predicted to address possible selection bias. IMR were predicted around the probability of being a producer in the first stage, and the probability of being a net buyer or net seller in the second stage. The IMR predicted in the first hurdle was included in the second hurdle as an additional explanatory variable. A standard t-test was used to test the null hypothesis that the first and second hurdle errors are uncorrelated. The same procedure was used for the third hurdle, where the IMR was predicted around net buyers and net sellers and included in the last hurdle, based on the null hypothesis that the second and third hurdle errors are uncorrelated. Given the failure to reject the null hypotheses as defined above, the IMR was not included in the final results (Burke et al. 2015). As such, the IMR is absent from the table of results in the first and second hurdle, but presented in the net sales and net purchases results and is statistically significant ($p<0.05$). A statistically significant IMR implies that standard errors in second and third hurdle are correlated and there is presence of selection bias.

The gender of the household head positively and significantly influenced the amount of common beans sold on the market, and negatively influenced the amount of common beans purchased on the market. However, the household head's gender had a negligible and statistically insignificant influence on the decision to produce common beans and to participate in the market, demonstrating that factors that affect production decisions, market participation decisions and intensity of participation in the market differ. Male-headed households increased the amount of common beans sold on the market by 39.6 percent and reduced the amount purchased by 51.2 percent relative to female-headed households. As it is the case in most countries in sub-Saharan Africa, men tend to focus on commercial crops while women focus more on food crops (Boserup 1970). The results are also in line with Ingabire (2016), who reported that male-headed households in Rwanda participate largely in the market by selling more beans and buying less.

The education level of the household head was found to negatively affect the amount of common beans sold on the market. Those households whose head had a secondary education sold 58 percent fewer common beans than households whose head had no education ($p<0.10$). The results are consistent with Lapar et al. (2003) who found an inverse relationship between education of the household head and amount of produce marketed. Lapar et al (2008) reported that when alternative opportunities are available, for instance, in a non-farm sector, an increase in household head's education lowers the likelihood of market participation and amount of produce market. This result differs with other studies which has reported a direct relationship between level of education and amount supplied on the market. For instance, Holloway et al. (2000) reported a positive and significant relationship between education and quantity of milk sold in the Ethiopian highlands.

Marital status dummy variables were only included in the first and third hurdles, including it in the second hurdle, the variables made the threshold parameters to be insignificant. The variables were found to have a negligible influence on production and a negative, significant effect on net purchases ($p<0.10$). Households

whose head was divorced or never married reduced the amount of common beans purchased by 28.7 percent and 41.1 percent, respectively, compared to those who are married.

Location dummy variables were used in the analysis to determine whether there is significant difference among agricultural households from urban, rural north, rural central and rural south areas on production and marketing decisions. The results revealed that farmers from the rural north are more likely to produce common beans (4.3 percent) than farmers from urban areas. Agricultural households in the rural central and southern regions were no more likely to produce common beans than those in urban areas, and the negative coefficient on these dummy variables, while statistically insignificant, suggest that farming households in these regions have a low probability of producing common beans. This is interesting given the existence of large areas that are highly or moderately suitable for growing both short and long-duration common beans in the central and southern parts of the country (Benson et al. 2016; see Appendix Figures 1 and 2 for crop suitability maps).

Despite being more likely to produce common beans, producing farmers in the rural north were not more likely to participate in the market than their urban counterparts, and intensity of participation was not significantly different either. Agricultural households from the rural central region were 8.8 percent more likely to be net sellers than autarkic, and 6.6 percent more likely to be autarkic than net buyers. Farmers from the rural central region were also less likely (88.3 percent) to purchase common beans than those in urban areas. In addition, farmers from rural south were 7.2 percent more likely to participate in the market as net sellers of common beans, 5.4 percent as autarkic and 12.6 percent less likely as net buyers. These results show that rural common bean farmers tend to sell a surplus of common beans; after keeping the beans needed for household consumption, households need to buy less on the market.

Off-farm income did not have a significant influence on the decision to produce common beans, participate in the market or the amount of common beans sold on the market. However, off-farm income had a positive and significant effect on amount of common beans purchased on the market. The result revealed that a one percent increase in off-farm income increased the amount of common beans purchased on the market by 16.7 percent. The findings are in line with the findings of Martey et al. (2012) who reported a positive association of off-farm income and intensity of market participation for maize in Ghana.

Agricultural households that owned a radio were more likely to produce common beans (8.1 percent) than those who did not. Khanal (2011) reported that farmers receive useful information through radio programs, which motivates them to alter farming methods and apply new technologies. Results from the second stage revealed that common bean producers who owned a radio were 11 percent more likely to be net buyers, 4.7 percent less likely to be autarkic and 6.3 percent less likely to be a net seller, than those who did not. The log normal regression shows that agricultural households that own radios are expected to purchase 74.3 percent more common beans that those that do not. This follows results reported by Mather et al. (2011) showing that radio programs that provide farmers with information on market prices increase both the probability of participation in the market and the extent of participation. Additionally, ownership of a bicycle by agricultural households had no effect on either production or market participation decisions, but significantly reduced the amount of common beans purchased on the market by 38.2 percent.

Table 4: Three tier results of common bean market participation

	Production (i)	Market Participation (ii)			Intensity of Participation (iii)	
Variables		**Net buyer**	**Autarkic**	**Net Seller**	**Net sales**	**Net Purchase**
Age of household head (years)	-0.0002	-	-	-	0.002	-0.001
	(0.0002)				(0.007)	(0.003)
Gender of household head *(1=Male)*	-0.004	-0.051	0.022	0.029	0.396**	-0.512**
	(0.012)	(0.034)	(0.015)	(0.020)	(0.187)	(0.216)
Household size (adult equivalent units)	-0.001	-0.007	0.003	0.004	-0.037	-0.030
	(0.002)	(0.008)	(0.004)	(0.005)	(0.046)	(0.027)
Education level of household head						
Primary school	-0.009	-	-	-	-0.062	0.121
	(0.010)				(0.255)	(0.144)
Secondary school	0.011	-	-	-	-0.579*	-0.045
	(0.009)				(0.332)	(0.092)
Tertiary education	0.03	-	-	-	1.278	-0.153
	(0.023)				(1.282)	(0.133)
Marital status						
Separated/divorced	-0.002	-	-	-	0.052	-0.287*
	(0.014)				(0.237)	(0.174)
Widow/widower	0.010	-	-	-	0.168	-0.040
	(0.014)				(0.355)	(0.204)
Never Married	-0.024	-	-	-	0.930	-0.411*
	(0.027)				(0.647)	(0.248)
Location						
Rural North	0.043***	-0.027	0.012	0.016	0.210	-0.185
	(0.013)	(0.057)	(0.025)	(0.033)	(0.516)	(0.136)
Rural Central	-0.005	-0.154***	0.066***	0.088***	0.116	-0.883**
	(0.011)	(0.054)	(0.023)	(0.031)	(0.490)	(0.439)
Rural South	-0.008	-0.126**	0.0541**	0.072**	0.047	-0.467
	(0.012)	(0.052)	(0.022)	(0.030)	(0.468)	(0.376)
Log off-farm income (MWK)	0.008	0.002	-0.001	-0.001	0.169	0.167*
	(0.005)	(0.024)	(0.010)	(0.014)	(0.171)	(0.097)
Ownership of radio	0.014**	0.110***	-0.047***	-0.063***	-	0.743**
	(0.006)	(0.030)	(0.013)	(0.018)		(0.296)
Ownership of mobile phone	-0.010	-	-	-	0.184	0.080
	(0.007)				(0.277)	(0.092)
Ownership of bicycle		-0.050	0.021	0.029	-	-0.382**
		(0.031)	(0.013)	(0.018)		(0.162)
Land owned (acres)	-0.0001	-	-	-	0.153*	-
	(0.0004)				(0.078)	
Production extension services	0.0121*	-	-	-	-	-
	(0.007)					
Market extension service	0.014	0.0219	-0.009	-0.013	0.439*	0.259**
	(0.011)	(0.048)	(0.021)	(0.027)	(0.238)	(0.119)
Access to credit	0.011	-0.028	0.012	0.016	0.528*	0.248*
	(0.009)	(0.039)	(0.017)	(0.023)	(0.294)	(0.146)
FISP beneficiary	0.025***	-	-	-	-	-
	(0.006)					
Distance to main road (km)	-0.001***	0.0007	-0.0003	-0.0004	0.0018	0.002
	(0.0003)	(0.002)	(0.001)	(0.001)	(0.011)	(0.006)
Distance to the market (km)	-0.002***	0.007**	-0.003**	-0.004**	-0.001	0.068***
	(0.0005)	(0.003)	(0.001)	(0.00179)	(0.020)	(0.022)
Post-harvest losses (kg of beans)	-	7.05e-05	-3.02e-05	-4.03e-05	0.003***	-0.0003
		(0.0003)	(0.0001)	(0.0002)	(0.001)	(0.0008)
Market experience (years)	-	-0.424***	0.181***	0.243***	-	-
		(0.024)	(0.017)	(0.015)		
Log selling price (MWK/kg)	-	-	-	-	0.218***	-
					(0.059)	
Log buying price (MWK/kg)	-	-	-	-	-	-0.054***
						(0.010)

Table continues on next page

Mode of transportation to market						
On foot	-	-	-	-	-0.622**	-
			-		(0.275)	
Bicycle taxi	-	-	-	-	0.160	-
					(0.510)	
Own bicycle	-	-	-	-	-0.231	-
					(0.373)	
Buyer picked up	-	-	-	-	-0.243	-
					(0.354)	
invmills2	-	-	-	-	-1.342**	-3.957**
					(0.642)	(1.580)
Constant	-	-	-	-	1.602**	3.084***
					(0.638)	(1.163)
Observations	10,164	968	968	968	187	507
R-squared					0.322	0.164

Note: Robust standard errors in parentheses; ***: significant at 1% level;**: significant at 5% level; *: significant at 10% level

Contrary to the author's expectation, this study found that the amount of land owned had a negative and insignificant effect on an agricultural household's decision to produce common beans. This result may indicate that most farmers grow common beans alongside other crops. However, an increase of one acre of land owned increased the probability of common beans being sold on the market by 15.3 percent. Larger farms may have more land available for common bean production, resulting in larger surpluses to be sold. The results agree with those of Branson and Norvell (1983), Abayneh and Tefera, (2013) and Momanyi, et al. (2016) who reported an increase in amount of marketable produce as farm size increases.

With regard to the receipt of extension services, the results showed that production extension had a positive and significant influence on households' decision to produce common beans. On the other hand, marketing extension had a positive but insignificant effect on both agricultural households' decisions to produce common beans and participate in the market. Alternatively, market extension positively and significantly influenced net sales and net purchases; the quantity of common beans sold increased by 43.9 percent for net sellers, while the amount bought increased by 25.9 percent among net buyers who received marketing extension compared to those who did not. In agreement with this result, studies by Abykoon et al. (2013) and Altalb and Felipek (2016) reported a direct relationship between extension services and amount of produce supplied on the market.

Access to credit had a negligible influence on both production and market participation decisions, but positively influenced the amount of common beans sold and purchased on the market. We expected the quantity of common beans sold to increase and amount purchased to decrease with access to credit, however, this study indicates that access to credit has a similar effect on both net sales and net purchases. This may be due to the fact that farming households access credit for both agricultural and non-agricultural activities, which may in turn provide income or capital to be used to purchase more beans on the market. The probability of selling common beans was 52.8 percent higher for households with access to credit, while the probability of purchasing common beans was 24.8 percent higher than for those without credit access. As reported by Abu (2015), access to credit provides farmers with income that can be used to pay for market transactions and increase the quantity of marketed produce.

Being a beneficiary of the Farm Input Subsidy Program (FISP) had a positive and significant influence on an agricultural household's decision to produce common beans. Farmers who benefited from the program were 2.5 percent more likely to produce common beans than non-beneficiaries. This result explains the importance of subsidies in reducing the cost of production and availability of improved seeds. Chibwana and Fisher (2011) studied the impacts of agricultural input subsidies in Malawi, and reported that input subsidies

increased land allocated to maize production. This may also be true for common beans, which are supported under the same program.

As expected, distance to the main road had a negative and significant influence on common bean production, given that proximity to good roads can reduce the cost and difficulty of transporting produce to market. Each additional kilometer from the household to the main road reduces the probability of producing common beans by 0.6 percent, which may also be a result of easier access to farm inputs such as seeds and fertilizer (Tunde and Adeniyi 2012). Distance to the main road did not have a significant influence on market participation and extent of participation, potentially because common bean traders often open small trading posts to buy produce in the villages, such that farmers do not have to travel far to sell common beans.

Distance to the nearest market had a negative and significant influence on the probability of common bean production and on market participation, but a positive influence on the amount purchased by net buyers. The result shows that an additional kilometer from the agricultural household to the market reduced the probability of producing common beans by 1.4 percent. These results are in line with the authors' expectations and theory, as long distances act as a disincentive to farming households who cannot easily travel to buy farm inputs. On the other hand, as distance to market increases for a given common bean producer, they are 0.65 percent more likely to be net buyers, 0.28 percent less likely to be autarkic and 0.37 percent less likely to be net sellers. In addition, the third hurdle results show that a kilometer increase in the distance to the market increases the amount of common beans purchased by 6.8 percent. These results are in line with the findings of Key et al. (2000), Bahta and Baue (2007), Alene et al. (2008) and Mengie (2014). However, the result is in contrast with the findings of Balagtas et al. (2007) and Muricho et al. (2015) who reported that distance to the market increased the probability of a producer participating in the market as a net seller in Cote d'Ivoire and Kenya, respectively. Distance to the market is associated with both fixed and proportional transaction costs, such as transportation and handling costs, which are high for most smallholder farmers.

As expected, post-harvest losses of common beans revealed a negative and significant effect on net sales. Each kilogram of common bean lost due to post-harvest handling reduced the amount of common beans expected to be sold on the market by 0.3 percent. Farmers sell agricultural produce when they have realized a surplus, and losses reduce the amount available for sale on the market.

Common beans selling price positively and significantly affected the amount of common beans supplied on the market. An increase in price by 1 percent increased the amount of common beans sold on the market by 21.8 percent. The results are in line with the findings of Mailu et al. (2012) who reported that an increase in price increased the amount of chickens supplied on the market. Buying price for common beans, on the other hand, had a significant and negative effect on amount of common beans purchased. This implies that an increase in purchasing price by 1 percent reduced the amount of common beans bought on the market by 5.44 percent.

Marketing experience of the household head suggested a positive and significant influence on market participation decision. An additional year of marketing experience increases the probability of the producer participating in the market as net seller by 24.3 percent, of being autarkic by 18.1 percent and decreases the probability of being a net buyer by 42.2 percent. More years of experience can give the producer an advantage when making deals, and increase bargaining power, the ability to predict fluctuations in the market, and social capital. These factors also result in the increase of quantity sold on the market (Muricho et al. 2015). In line with this finding, Abay (2007) reported that farmers' increased years of experience resulted in an increase in the amount of tomatoes supplied on the market in Ethiopia. In addition, Martey et

al. (2012) reported that experienced household heads are able to make better production decisions and have better contacts, which allow for trading opportunities at lower cost. More experienced farmers may also acquire an understanding of market dynamics and therefore improve decisions about the amount of output sold (Makhura et al. 2001).

Mode of transportation dummies were used to see if there is a statistical difference in terms of quantity sold among those who transported their common beans on foot, using a bicycle taxi, with their own bicycle, a truck or minibus, and those whose common beans were picked up by the buyer. The result revealed a negative and significant influence of transporting common beans on foot to the market. Those common bean producers who transported their produce on foot reduced of amount of common beans sold on the market by 62.2 percent compared to those who used a truck or minibus.

4. CONCLUSIONS AND RECOMMENDATIONS

This study has analyzed the factors affecting common bean production and marketing decisions by agricultural households in Malawi. The empirical results from applying the triple hurdle model to the IHS3 data demonstrate that different sets of factors affect smallholder farmers' production, market participation and the intensity of participation decisions with respect to common beans. The location of the farmer, ownership of a radio, receipt of production extension services and FISP benefits, distance to main road and distance to the nearest market affected the agricultural household's decision to produce common beans. Contrary to the authors' expectations, the study revealed that most smallholder farmers mix common beans with other crops, to the extent that the size of the land does not affect their decision to produce.

In addition, the study found that location of the producer, distance to the nearest market, ownership of a radio, and years of marketing experience affected a producer's decision to participate in the common bean market. Gender of the household head and access to marketing extension services affected both net sales and net purchases. Location of the producer, marital status, off-farm income, ownership of a radio, distance to the nearest market and buying price significantly affected the amount of common beans purchased on the market. An increase in off-farm income increased agricultural households' purchasing power to buy more beans. On the other hand, educational attainment of the household head, the amount of land owned, access to credit, post-harvest losses, the selling price and mode of common bean transportation affected the amount of common beans sold on the market.

This analysis makes clear that that factors that affect production decisions, market participation decisions and intensity of participation in the market for common beans differ considerably. This has implications for interventions targeting common bean producers. Building on these findings, this study recommends that future studies investigate the impact of common bean market participation on rural poverty, income, and nutritional status. In particular, a better understanding of production-to-consumption pathways for common beans is needed to inform agricultural and nutrition interventions. This would help policymakers and development practitioners understand whether promoting common bean production and market participation is an appropriate and efficient lever to improve poverty and nutrition outcomes. This type of analysis would be particularly useful if conducted in relation to other leguminous crops that might also be promoted to improve soil fertility and the nutritional status of farming households. Given that women have traditionally been in control of common bean production, a deeper analysis of why the gender of household heads had such a significant influence on the amount of common beans bought and sold would also be informative.

Policymakers should also consider how access to FISP benefits influences common bean production decisions. This is particularly relevant given recent reductions in the scale of the program, and previous research that the FISP influences cropland allocation by favoring maize and tobacco over other food crops (Chibwana et al. 2012). More research on how producers allocate land to common beans, particular in relation to other legumes, is of interest given the increasing number of programs focused on legume intercropping and increasing land scarcity.

Distance to the main road and nearest market had a negative effect on both decisions to produce common beans and participate in the market, and intensity of participation in the market. Along with the mode of transportation to market and the disincentives to market participation from traveling on foot, these findings underscore the importance of developing rural roads and transportation and market infrastructure to reduce transaction costs for smallholder farmers.

As extension services affect both the production and marketing decisions of common bean producers, is it likely that improved extension services focusing on common bean production, post-harvest losses and marketing would be beneficial to smallholders. Given the significance of radio ownership to common bean producers, radio programming has a high potential to improve the reach of extension services to common bean farmers at a relatively low cost. The influence of marketing experience on producers' level of market participation also suggests that connecting farmers to market information services, cooperative and collective market opportunities may improve market participation.

Improvements to extension services for common bean producers may also help reduce the impact of geographic location on production and market participation decisions. Detailed crop suitability maps for common beans are available, and alongside this study they highlight that regions with large areas well-suited for common bean production are not necessarily more likely to produce them (Benson et al. 2016). As such, it is important for extension workers to help producers determine which mix of crops is best suited for their land and how to maximize production and earnings from their small landholdings.

APPENDICES

Appendix Table 1: IHS3 agricultural households and landholding size

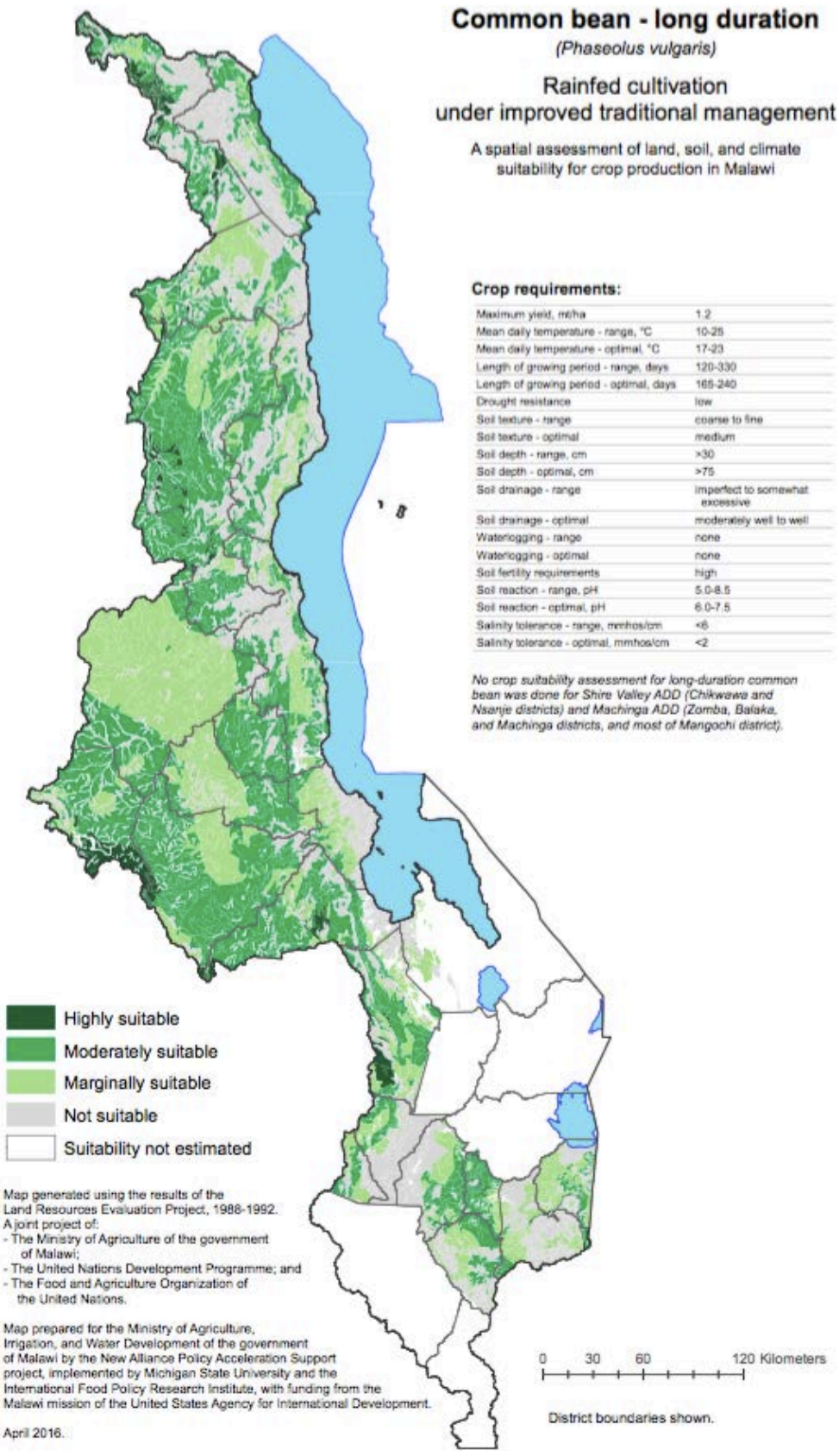
	Observations	Mean (Acres)	Std. dev
Common bean producers	972	1.78	1.50
Common bean non-producers	9,429	1.99	23.83
Total	10,401		

Source: IHS3 Data

Appendix Table 2: Coefficients for stage 1 and 2

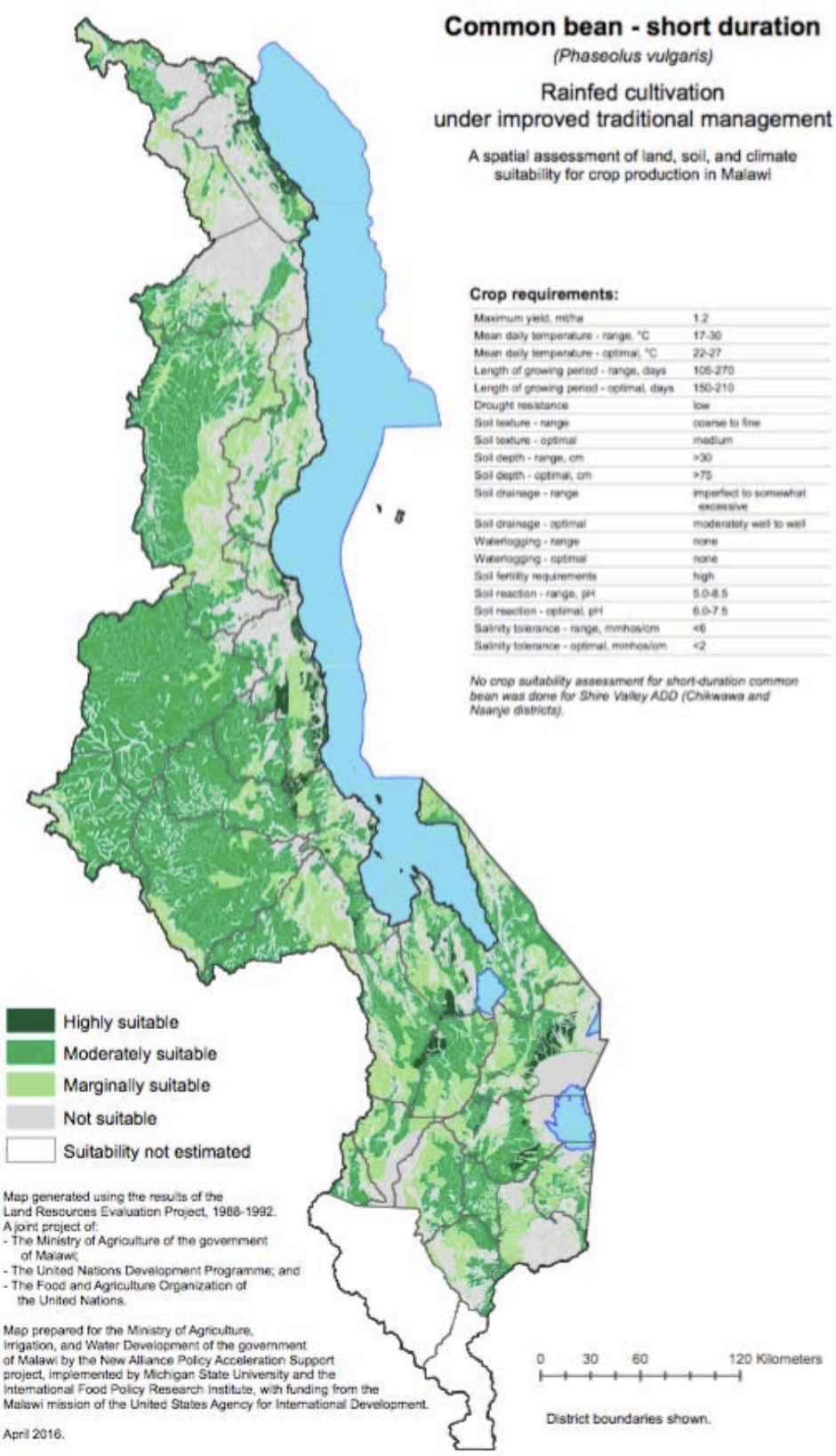
Variable	Production	SE	Market Participation	SE
HH Age	-0.001	0.001	-	
HH Gender (*1 = Yes*)	-0.018	0.072	0.146	0.099
Adult equivalent	-0.003	0.011	0.022	0.024
HH Education Level				
Primary school (*1 = Yes*)	-0.056	0.061	-	
Secondary School (*1 = Yes*)	0.069	0.056	-	
Tertiary Education (*1 = Yes*)	0.172	0.138	-	
Marital Status				
Separated/divorced (*1 = Yes*)	-0.02	0.083	-	
Widow/widower (*1 = Yes*)	0.054	0.086	-	
Never Married (*1 = Yes*)	-0.151	0.163	-	
Location				
Rural North (*1 = Yes*)	0.256***	0.076	0.077	0.168
Rural Central (*1 = Yes*)	-0.027	0.071	0.448***	0.158
Rural South (*1 = Yes*)	-0.043	0.071	0.366**	0.152
Log off-farm income	0.047	0.031	-0.005	0.07
Ownership of Radio (*1 = Yes*)	0.095**	0.039	-0.320***	0.088
Ownership of Bicycle (*1 = Yes*)	-0.066	0.04	0.145	0.09
Ownership of Phone (*1 = Yes*)	-0.049	0.043	-	
Land Owned	-0.001	0.002	-	
Production Extension (*1 = Yes*)	0.072*	0.042	-	
Market Extension (*1 = Yes*)	0.082	0.063	-0.064	0.139
Access to credit (*1 = Yes*)	0.068	0.051	0.081	0.114
FISP Beneficiary (*1 = Yes*)	0.156***	0.036	-	
Distance to main road	-0.006***	0.002	-0.002	0.005
Distance to the market	-0.014***	0.003	-0.019**	0.009
Post-harvest losses	-		-0.0002	0.001
Market Experience	-		1.229***	0.078
Log Selling Price	-		-	
Log Buying Price	-		-	
Mode of Transportation				
On Foot (*1 = Yes*)	-		-	
Bicycle Taxi (*1 = Yes*)	-		-	
Own Bicycle (*1 = Yes*)	-		-	
Buyer Picked-up (*1 = Yes*)	-		-	
Constant cut1	-		0.567*	0.321
Constant cut2	-		1.630***	0.324
IMR	-		-	
Constant	-1.329***	0.13	-	
Observations	10,165		968	

Appendix Figure 1: Crop suitability map for long-duration common beans



Source: Benson et al. 2016

Appendix Figure 2: Crop suitability map for short-duration common beans



Source: Benson et al. 2016

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