INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

IFPRI

IFPRI Discussion Paper 01498

January 2016

The Impact of Agricultural Extension Services in the Context of a Heavily Subsidized Input System

The Case of Malawi

Catherine Ragasa

John Mazunda

Mariam Kadzamira

Development Strategy and Governance Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), established in 1975, provides evidence-based policy solutions to sustainably end hunger and malnutrition and reduce poverty. The Institute conducts research, communicates results, optimizes partnerships, and builds capacity to ensure sustainable food production, promote healthy food systems, improve markets and trade, transform agriculture, build resilience, and strengthen institutions and governance. Gender is considered in all of the Institute's work. IFPRI collaborates with partners around the world, including development implementers, public institutions, the private sector, and farmers' organizations, to ensure that local, national, regional, and global food policies are based on evidence. IFPRI is a member of the CGIAR Consortium.

AUTHORS

Catherine Ragasa (c.ragasa@cgiar.org) is a research fellow in the Development Strategy and Governance Division of the International Food Policy Research Institute (IFPRI), Washington, DC.

John Mazunda (j.mazunda@cgiar.org) was a policy analyst in the Malawi Strategy Support Program of IFPRI, Lilongwe, Malawi, when this paper was written. He is currently program manager of the Nigeria Strategy Support Program of IFPRI, Abuja, Nigeria.

Mariam Kadzamira (maleytata@yahoo.com) is director of Institutional Development and Investments for the Farmers Union of Malawi, Lilongwe.

Notices

Contents

Tables

ABSTRACT

Since 2005, the government of Malawi has focused on the Farm Input Subsidy Programme (FISP) as its major strategy for increasing maize production, promoting household food security, and enhancing rural incomes. Amid concerns about the program's high costs and inconsistent impact, expenditure on FISP is declining and attention is beginning to shift to other enablers of agricultural productivity growth, such as agricultural extension and education. There is a growing hypothesis that lack of knowledge on state-of-the-art and improved management practices may be a factor that contributes to the limited substantial impact of the fertilizer subsidy in Malawi. This paper aims to test this hypothesis and to contribute to better understanding of strategies to revitalize the agricultural extension system in Malawi. Specifically, it examines the interplay between the fertilizer subsidy and access to extension services, and their impact on farm productivity and food security in Malawi. Results show that the fertilizer subsidy has inconsistent impact on farm productivity and food security; at the same time, access to agricultural advice was consistently insignificant in explaining farm productivity and food security. Further analysis, however, shows that when access to extension services is unpacked to include indicators of usefulness and farmers' satisfaction, these indicators were statistically significant. Households who reported that they received very useful agricultural advice had greater productivity and greater food security than those who reported receiving advice that they considered not useful. This result implies the need to ensure the provision of relevant and useful agricultural advice to increase the likelihood of achieving agricultural development outcomes.

Keywords: extension services, fertilizer subsidy, agricultural productivity, food security, impact assessment, Africa south of the Sahara

JEL code: Q16, Q12

ACKNOWLEDGMENTS

The study was implemented with the financial support of the United States Agency for International Development (USAID) through the Malawi Country Strategy Support Program (MSSP) and the CGIAR Research Program on Policies, Institutions and Markets (PIM). The authors are thankful for discussions with Gershon Feder and Karl Pauw and reviews by Jacob Ricker-Gilbert, Todd Benson, Athur Mabiso, and Flora Nankhuni. This paper has not gone through IFPRI's standard peer-review procedure. The opinions expressed here belong to the authors, and do not necessarily reflect those of PIM, IFPRI, or CGIAR. Any remaining errors are solely the responsibilities of the authors.

1. INTRODUCTION

Africa south of the Sahara (SSA) is confronted with persistently low levels of agricultural productivity and persistent food insecurity. Governments and donors have initiated many programs to improve the agricultural productivity and food security of many poor SSA countries, but there are mixed results on their effectiveness. Among such efforts, agricultural extension was heavily promoted in the 1970s and 1980s through implementation of large-scale training and visit programs. Due to concerns of the high cost and limited impact of these programs, there have been major declines in investments in agricultural extension in many countries in more recent years. Fertilizer and other farm input subsidy programs have also been popular. Such programs started up in the 1980s and declined in the 1990s during the structural adjustment period, but they have recently been reintroduced, triggered by concerns of food price crises and growing food insecurity in SSA. Malawi's Farm Input Subsidy Program (FISP) has been the most cited national subsidy program in recent years, popularly supported and recognized by many as an effective program in bringing about an African Green Revolution (Denning et al. 2009; Javdani 2012). However, many observers also have pointed out its high, possibly unsustainable costs and inconsistent farm-level impact and development outcomes (Chibwana et al. 2014; Holden and Lunduka 2010a, 2010b; Ricker-Gilbert and Jayne 2011).

Malawi spent an annual average of 9.8 percent of its national budget subsidizing fertilizer and seed between 2005/2006 and 2008/2009, and these subsidies accounted for a large share of agricultural spending (Dorward and Chirwa 2011). In more recent years, FISP accounted for 44 percent of agricultural spending in 2013/14, down from 58 percent in 2012/2013 (raw data from Malawi Ministry of Agriculture, Irrigation and Water Development [MoAIWD]). The large allocation of funding to FISP leaves minimal funding for other services and roles in the public agriculture sector. For instance, investment in agricultural extension made up only 1.6 percent of agricultural spending in 2012/2013 (raw data from MoAIWD).

This sharply unequal funding against agricultural extension raises concerns among experts, who have suggested that inadequate provision of information for farmers might account for some of the inconsistent farm-level impact of FISP among others (Lunduka, Ricker-Gilbert, and Fisher 2013). Snapp and colleagues (2014) suggested that untimely delivery of inputs coupled with lack of sound advice and extension services may have been one of the contributing factors in the observed low nutrient use efficiency observed among FISP beneficiaries, limiting the productivity and development impact of this flagship agricultural development program of the government of Malawi.

This paper aims to test this hypothesis in order to understand the interplay of agricultural extension services and the fertilizer subsidy in affecting the productivity and food security of Malawian smallholder farmers. It aims to contribute to the literature in three ways.

First, this paper will assess whether access to relevant extension services enhances the effectiveness of the fertilizer subsidy in enhancing agricultural productivity and food security by modeling both factors and their interaction as direct inputs into the standard agricultural production model. To do this, we use a panel dataset from a nationally representative survey of farming households. Conceptually, knowledge on good crop management practices and optimal input use are necessary for increasing crop productivity. Knowledge of agricultural production and marketing can contribute to the food security of farm households. Gaining knowledge on food and nutrition through participating in agricultural extension activities can also contribute directly to improving food security in farm households. Even with fertilizer that is more affordable and more accessible, productivity will not be increased if complementary inputs and good agricultural and management practices are not present. Therefore, access to relevant extension services is expected to positively affect the effectiveness of subsidies on fertilizer.

Second, this paper will model the effect of access to extension services, controlling for a farm household's receiving the FISP input subsidy, on farm productivity and food security. Existing research has focused on measuring the marginal product or direct effect of access to extension services on farm productivity by using production models in which production output is expressed as a function of land, capital, inputs, and other factors (see review by Birkhaeuser, Evenson, and Feder 1991, and more recent studies by Owens, Hoddinott, and Kinsey 2003 and Peterman et al. 2011); or by using frontier models, in which extension services are used as a factor to explain differences in technical efficiency levels rather than as an input in the production function (for example, Kalirajan and Shand 1985; Seyoum, Battese, and Fleming 1998; Young and Deng 1999); or by using a combination of these models (see Dinar, Karagiannis, and Tzouvelekas 2007). However, in a country with heavy government subsidies on farm production inputs, measuring the contribution of agricultural extension services in explaining productivity levels may not be as straightforward as the literature implies. Extension services may seem to be effective in promoting the adoption of a new crop or a new technology, when in reality such adoption is profitable only as a result of the government subsidy. This situation could possibly lead to artificial model results that suggest extension services are effective in increasing productivity and profitability.

Therefore, estimates of the marginal product or direct effect of extension services on output from the standard production models will be biased if input subsidy receipt is not controlled for. To our knowledge, these inquiries have not been dealt with in the literature, even though they can have major implications on whether greater attention to and investments in complementary agricultural extension services are needed alongside the fertilizer subsidy. Whether or not the fertilizer subsidy is taken into account will also have implications on minimizing measurement errors and bias in evaluating the impact of agricultural extension services in the presence of input market distortions, such as those caused by a fertilizer subsidy. Many studies have looked at the effects of the FISP input subsidy in Malawi (see review by Lunduka, Ricker-Gilbert, and Fisher 2013). However, none have examined the role of extension and advisory services in accounting for these effects. Similarly, several authors have examined the effects of access to extension services or agriculture advice on technology adoption and yield in various countries (see Ragasa et al. 2013), but not within the context of heavily subsidized input markets, which may make the technologies that the extension services promote seem more profitable and the extension services themselves seem artificially more effective than they actually are.

Third, this paper will test various indicators of access to extension services and the different types and modes of delivery, complementing and extending past studies that employed a simple dummy variable on whether the household was visited by an extension agent or the frequency of visits by extension agents as their variable for extension service access. This paper unpacks the "access to extension services" factor and explores other measures of agricultural extension service delivery in order to provide insights as to what source, type, or form of extension services delivery matters in affecting agricultural productivity and food security. In particular, we will test the following six hypotheses:

1. Whether households who meet more frequently with extension agents or receive advice from any source have greater productivity and food security.
2. Whether households who find the advice received useful and satisfactory have greater productivity and food security than those who find the advice received not useful. Some studies have shown that farmers' satisfaction and reported usefulness have an impact on productivity (Ragasa et al. 2013).
3. Whether households receiving agricultural advice directly from government extension agents or through information and communication technology (ICT), compared with other sources, and whether households receiving agricultural advice from a combination of sources, rather than only a single source, have greater productivity levels and indicators of food security.
4. Whether households who have more than one member receiving advice directly from various sources have greater productivity and food security than households with only one member receiving advice directly. Such family-based approaches to training involve

training or teaching several members of a household. The successful management of most agriculture and aquaculture enterprises relies on household members' working together, yet the need for a family-based approach to training is often overlooked as an explicit strategy. World Bank, FAO, and IFAD (2008) showed several case studies of a family-based approach that was instrumental in achieving successful agriculture and aquaculture enterprises.

5. Whether households with both female and male members receiving advice directly from various sources have greater productivity and food security than households with either only female or only male members receiving advice directly. Some studies have shown that when both female and male members of the household receive extension services, the likelihood of technology adoption is substantially increased (Lambrecht, Vanlauwe, and Maertens 2016).
6. Whether households who receive marketing advice, in addition to production-related advice, have greater productivity and food security than those who do not receive marketing advice.

This paper utilizes the 2010 and 2013 Integrated Household Panel Survey (IHPS) implemented by the government of Malawi through its National Statistical Office with the support of the Living Standards Measurement Survey–Integrated Surveys of Agriculture project. The models developed using these data pay close attention to differentiated impacts across regions, zones, and socioeconomic strata. The rest of the paper is structured as follows. Section 2 describes the conceptual framework and empirical model. Section 3 describes the sources of data. Section 4 summarizes the factors explaining access to and satisfaction with different types and sources of extension services, and Section 5 discusses the factors explaining access to the FISP input subsidy. Section 6 summarizes the impact of extension services, the FISP input subsidy, and their interaction on agricultural productivity and food security. Section 7 discusses policy implications and offers conclusions.

2. CONCEPTUAL FRAMEWORK AND EMPIRICAL MODEL

The theory of the agricultural household (Singh, Squire, and Strauss 1986; de Janvry, Fafchamps, and Sadoulet 1991) provides the conceptual framework for our empirical strategy. According to this framework, the household combines farm resources and family labor to maximize utility over leisure and consumption goods produced on the farm or purchased on the market. Farm decisions are constrained by a production technology, conditioned on the farm's physical environment; family labor time allocated to labor and leisure; and a full income constraint. The theory of the agricultural household is suitable for analyzing the decisions of farmers who are not fully commercialized or who operate with missing or imperfect markets. Our study area is rural Malawi, where financial markets are weak and villages often isolated, with limited access to various input and output markets. In this environment characterized by market failures, market prices do not reflect the full opportunity cost of various goods, particularly inputs and services such as agricultural knowledge and fertilizer. Consequently, we model production and food security outcomes as the result of a constrained utility maximization problem for a household (de Janvry and Sadoulet 2006).

Following the agricultural household theory and constrained utility maximization model of Singh, Squire, and Strauss (1986) and later by Van Dusen and Taylor (2005), the household chooses a vector of consumption levels (*X*, *Z*) such that the general solution to the maximization of household utility under the binding constraints is a set of constrained optimal production and consumption levels (*X*, *Z*):

$$X = f(p, Y_c, \Phi_{hh}, \Phi_{farm}, \Phi_{market}) \text{ and} \quad (1)$$

$$Z = f(p, Y_c, \Phi_{hh}, \Phi_{farm}, \Phi_{market}), \quad (2)$$

where *p* represents prices; *Y* represents the full income constraint (which stipulates that a season's expenditure of time and cash cannot exceed the sum of the net farm earnings and income that is exogenous to farm choices); *X* represents consumption of goods produced on the farm; *Z* represents all other purchased goods, given a vector of exogenous socioeconomic and household characteristics, Φ_{hh}, a vector of exogenous farm physical characteristics, Φ_{farm}, and a vector of market characteristics, Φ_{market}. The household's constrained production levels and food security outcomes can be expressed in reduced form as an indirect function of price, income, household, farm, and market parameters:

$$Outcome = f\left(p, Y_c, \Phi_{hh}, \Phi_{farm}, \Phi_{market}\right). \quad (3)$$

Embedded in the production technology, Φ_{farm}, are the variables *K*, access to extension services, and *S*, quantity of FISP input subsidy. Under FISP, beneficiary households are entitled to vouchers for two 50-kg bags of fertilizer and two 5-kg bags of improved maize seed that may be redeemed at designated outlets countrywide. As in other studies (Birkhaeuser, Evenson, and Feder 1991; Owens, Hoddinott, and Kinsey 2003; Peterman et al. 2011; Dinar, Karagiannis, and Tzouvelekas 2007), access to extension services (*K*), quantity of subsidized fertilizer (*S*), and unsubsidized fertilizer purchased and used (*F*) enter the models as factors of production.

Following equation (3), our regression model is a reduced-form equation that relates the FISP input subsidy, extension services, and other explanatory variables to farm productivity and food security outcomes, shown as

$$Outcome_{ijt} = \alpha + \beta_1 K_{ijt} + \beta_2 lnS_{ijt} + \beta_3 lnF_{ijt} + \beta_4 V_{ijt} + \varepsilon_{ijt} \text{ and} \quad (4)$$

$$\varepsilon_{ijt} = c_{ij} + \mu_{ijt}, \quad (5)$$

where $Outcome_{ijt}$ is the outcome variable—farm productivity and food security indicators—for household *i*, situated in locality *j* at time *t*, and V_{ijt} represents all other exogenous factors $(\Phi_{hh}, \Phi_{farm}, \Phi_{market})$.

The error term ε_{ijt} in equation (4) is a function of two components presented in equation (5). The first component, c_{ij}, is unobserved time-constant factors that affect household *i*'s productivity and food security, also called unobserved heterogeneity. These factors might include soil quality and the farmer's management ability and degree of risk aversion. The second component of the error term, represented by μ_{ijt}, is unobserved time-varying shocks affecting farm productivity and food security. These factors might include political turmoil and health shocks or some selection criteria that are time-varying unobserved household characteristics, such as fertilizer subsidy vouchers provided by village leaders or extension agents' working with lead farmers and other farmers.

Econometric Considerations

The estimation considers and addresses several issues. First, the allocation of extension efforts is not random across and within localities. For example, governments may decide to concentrate extension resources in areas that have high agricultural potential—a placement effect. If this effect is not taken into account, estimates of impact will be biased upward. Comparing results reported in Bindlish and Evenson (1993) with those found by Gautam and Anderson (1999) affords a vivid demonstration of this potential bias. Bindlish and Evenson (1993) found that access to extension services, as measured by the log of the ratio of extension staff to farms, has a positive and statistically significant impact on the value of farm production in Kenya. Gautam and Anderson (1999), using the same data, argued that when district fixed effects are incorporated, this positive impact disappears. This paper addresses the potential bias by using district fixed effects. We also control for agroecological zones and the year of the panel (2010 or 2013). Any remaining selection bias was also addressed by employing propensity score matching (PSM) methods, specifying nearest neighbor and kernel matching, in which the results were consistent with the main models used.

Second, measuring the impact of extension services is not straightforward. Various challenges arise, including (1) issues of attribution, because of the diversity of service providers and their delivery methods; (2) difficulty in determining the incremental contribution of additional advice, given that several instances of receiving advice contribute to a stock of knowledge over time; and (3) difficulty in measuring the contribution and impact of extension services where services and inputs are usually bundled into a package or program. This paper addresses these difficulties in various ways. We use receipt of any agricultural advice, regardless of the source or method and independent of any program, to avoid the issue of attribution between providers and bundles of services. Because the overwhelming majority of households reported direct contact with government extension agents and ICT as their main source of advice and only 6 percent cited the private sector or nongovernmental organizations (NGOs), we include three variables that reflect the significance of source of advice in the models: (1) direct contact with government extension agents versus no direct contact, (2) access to information via ICT versus no access via ICT, and (3) a single source of advice versus more than one source of advice. While the dataset used in this paper has information on advice received in a particular year, it does not include access to advice in previous years by an individual household. We used village-level information on access to extension services from previous years. The specific question is "Compared with five years ago, are the agricultural extension services which assistant agricultural extension development officers and the Ministry of Agriculture provide farmers in your community [choices: worse, better, the same, or did not receive extension services]?"

Third, our study includes two important unobserved individual effects: managerial skill and heterogeneity in soil characteristics within a broad soil group. If households are optimizers and recognize the individual differences in their production functions, farms with positive effects from fertilizer use will use more fertilizer per hectare, all else equal, and there will be correlation between the unobserved individual effect in the error term and the rate of application of fertilizer, resulting in a bias in ordinary least squares estimators. The Mundlak-Chamberlain (MC) device (Mundlak 1978; Chamberlain 1984), also known as correlated random effects, provides an approach to allow for correlation between the unobserved individual omitted variable c_{ij} and variables of interest (K_{ijt}, S_{ijt}), provided the unobserved effect is time-invariant. The MC device allows for modeling the distribution of the omitted variable conditional on the means of the strictly exogenous variables, instead of treating the omitted variable as a parameter to estimate. To implement the MC device, we include the means of all time-varying covariates for household i. This cluster of means of time-varying covariates captures the correlation between K_{ijt}, S_{ijt}, and c_{ij}. These averages have the same value for a given household in every year but vary across households. In general, the MC device unifies the fixed-effects and the random-effects estimation approaches. By including the vector of time-averaged variables, we still control for time-constant unobserved heterogeneity, as with fixed effects, while avoiding the problem of incidental parameters in nonlinear models. At the same time, the MC device allows measurement of the effects of time-constant independent variables, just as in a traditional random-effects environment (Wooldridge 2002). However, MC does not capture possible correlation of covariates and unobserved time-varying shocks, μ_{ijt}. If these factors are not controlled for, the estimate of productivity and food security impacts still will be inconsistent.

The fourth econometric consideration, therefore, pertains to the assumption of independence between K_{ijt} , S_{ijt}, and μ_{ijt} in many panel studies. This may be a strong assumption, particularly when the covariates of interest are not determined randomly. In this study, the subsidized fertilizer and advice received are likely to be correlated with unobserved time-varying factors or selection criteria that affect the productivity and food security outcomes. For example, government and local leaders allocate subsidized fertilizer vouchers to households according to specific household characteristics, which may be unobservable to us as researchers. Similarly, extension agents work with lead farmers, who in turn work with other farmers, based on some selection criteria that may be unobservable to us. This study uses the control function (CF) method to deal with correlation between K_{ijt} , S_{ijt}, *and* μ_{ijt} (Imbens and Wooldridge 2007; Wooldridge 2008).

The CF method entails taking the residuals from a reduced-form model of subsidized fertilizer allocation and access to extension, and including them as a covariate in the structural model of productivity and food security (equation [4]). The significance of the coefficient on the residual both tests and controls for correlation between K_{ijt} , S_{ijt}, and μ_{ijt}. We derived the generalized residual from a first-stage probit model for FISP input subsidy receipt and access to extension services using the following formula (Imbens and Wooldridge 2007; Wooldridge 2008):

$$gr_{i2} = y_{i2}\lambda(\boldsymbol{Z_i\beta_2}) - (1 - y_{i2})\lambda(-\boldsymbol{Z_i\beta_2}),$$

where gr_{i2} is the generalized residual; y_{i2} represents receipt of the FISP input subsidy or extension service; and $\lambda(.)$ is the inverse Mills ratio, expressed as the ratio of the standard normal density function and the cumulative standard normal distribution.

We derived the generalized residuals from the first-stage Tobit model for quantity of subsidized fertilizer received and frequency of accessing extension services, using the following formula (Greene 1997, 972):

$$e_i = \left(\frac{1}{\sigma^2}\right)\left[z_i(y_i - \boldsymbol{\beta}'\boldsymbol{X_i}) + (1 - z_i)\sigma\left(\frac{\phi_i}{1 - \Phi_i}\right)\right],$$

where σ and $\boldsymbol{\beta}$ are estimates from the Tobit model; z_i = 1 if the quantity of subsidized fertilizer or frequency of extension services > 0, and z_i = 0 if zero; y_i is the quantity of subsidized fertilizer or frequency of extension services; ϕ_i indicates the standard normal density function; and Φ_i is the cumulative standard normal distribution.

The CF approach requires that an instrumental variable (IV) be used in the reduced-form model (first stage) that is not in the structural model (second stage); the IV should be correlated with the potentially endogenous variables K_{ijt} and S_{ijt} but not correlated with μ_{ijt} in the structural model when conditioned on other covariates. The instrument for the FISP input subsidy is the number of years the household has been living in the village. The instrument for access to extension services is the distance from the household's house to the nearest agricultural extension officer. The tests performed suggest that the instrument for the FISP subsidy is valid and strong.[1] However, various tests show the instrument for access to extension services to be weak; moreover, it is weakly correlated to other variables that directly affect agricultural productivity and food security, such as distance to a road, to markets, and to input dealers. Despite not being able to control for possible unobserved time-varying factors or selection criteria related to access to extension services, we are confident that the estimates of impact of access to extension services are valid and robust, given that nonrandom place effects and other sources of selection bias are adequately addressed and results remain consistent and stable across the various models estimated.

We also performed sensitivity analyses and robustness checks using alternative estimation methods, namely, an IV approach using the predicted probabilities in the first-stage regression models as the instruments in the second stage (following the approach proposed by Adams, Almeida, and Ferreira 2009) and pooled ordinary least squares (POLS), in addition to the PSM methods mentioned above. Results of models using MC and CF and models using MC and IV are presented in detail in this paper, while results of the POLS and PSM are briefly discussed, given that they yield similar results.

[1] Intuitively, there is no reason to believe that the number of years living in the village can directly affect productivity and food security outcomes, beyond its indirect effect through fertilizer use. The minimum condition for instruments to be valid is that they be sufficiently correlated with the endogenous variables (Verbeek 2004, 148). This can be tested by estimating the first-stage regression of each endogenous variable on the instruments used and performing an F-statistic test (Verbeek 2004, 145). Stock and Watson (2003), cited in Verbeek (2004, 148), suggested that a minimum F-statistic of 10 is sufficient for validity. The chi-square statistic in the probit model for years that the household has lived in the village (the dummy for FISP input subsidy receipt) is 11, and the F-statistic in the Tobit model (for quantity of subsidized fertilizer) is 17. These statistics confirm that the instrument used is strongly correlated with the endogenous variable instrumented (in the first stage) and not correlated with the outcome variables (in the second stage).

3. DATA AND METHODS

Data used in this paper are from two waves of the Integrated Household Panel Survey (IHPS) (2010 and 2013) implemented by the government of Malawi through its National Statistical Office. A multi-topic survey, the IHPS is nationally representative and designed to provide information on various aspects of household welfare and socioeconomic status in Malawi. The IHPS collected detailed information on household behavior, income distribution, agriculture productivity, employment, health, and education, among other topics (Malawi, NSO 2014a). The first wave of the panel is based on the Third Integrated Household Survey (IHS3), which utilized listing information and cartography from the 2008 Malawi Housing and Population Census (HPC). This study uses a stratified two-stage sample design in which enumeration areas (EAs) defined for the 2008 HPC were selected as the primary sampling units. A total of 768 EAs were selected from across the country, with a minimum of 24 EAs interviewed in each district. Following the selection of IHS3 sample EAs, we compiled a list of households in each sample EA to provide the sampling frame for the second-stage selection of households. A total of 12,271 households were selected for the IHS3 survey. The second wave of the panel is based on a subsample of the IHS3 EAs (204 out of the 768 EAs) selected prior to IHS3 fieldwork. A total of 3,246 households (2,400 agricultural and 846 nonagricultural) were selected for tracking in 2013 in line with the IHS3 fieldwork timeline as part of the IHPS. The final IHPS sample included 4,000 households that can be traced to the original baseline households. The new sample size takes into account split-off individuals that had formed new households by 2013 (Malawi, NSO 2014a).

Our analysis is based on a balanced panel of 1,823 agricultural households.[2] We use household-level data to analyze the effect of the FISP input subsidy, agricultural advice, and other factors on total value of production per hectare and on measures of dietary diversity as indicators for household food security; we use plot-level analysis to assess the factors affecting maize yield (production per hectare). The key variables are defined and measured below.

Productivity

Following Owens, Hoddinott, and Kinsey (2003) and Peterman et al. (2011), we use the value of yield per hectare of various crops as the measure of farm productivity.[3] Productivity value is calculated by multiplying the quantity of each crop produced per hectare by the farmgate or market price for the produce at household or village level (whichever is available in the datasets). The value of production is used because the majority of the plots were intercropped, making area estimates for each crop difficult to calculate. Overall productivity is estimated for the full sample as well as for crop-specific production models.

Food Security

We use indicators of dietary diversity to measure food security. Research implemented by the International Food Policy Research Institute (for example, Hoddinott and Yohannes 2002) confirmed that a more diversified diet is associated with improvement in nutritional parameters, including birth weight, child anthropometric status, improved hemoglobin concentrations, caloric and protein adequacy, percentage of protein from animal sources (high-quality protein), and per capita consumption (a proxy for household income). Studies validating dietary diversity against nutrient adequacy in developing countries have confirmed a positive relationship and a consistently positive association between dietary diversity

---

[2] Although there were 2,400 agricultural households in the panel, we ended up using 1,800 households. Households that reported not having cultivated in a survey period were dropped from the sample. At the plot level, some households gave different plot information over the two survey periods—that is, some households had a plot in round one but not in round two, and some identified their plot(s) inconsistently in the two survey rounds. After controlling for these anomalies, we are left with 1,800 agricultural households.

[3] We focus here on crop productivity, excluding that of livestock.

and child growth (Ruel 2002; Arimond and Ruel 2002; Working Group on Infant and Young Child Feeding Indicators 2006; Smale, Moursi, and Birol 2015). Several dietary diversity indicators are used. First, following a widely used approach documented by Swindale and Bilinsky (2006), we use the household dietary diversity score (HDDS) in our analysis. HDDS is a count of food groups, out of 12, that household members have consumed over a seven-day reference period. HDDS food groups used that are relevant for Malawi are cereals, roots and tubers, vegetables, fruits, meat, eggs, fish and seafood, pulses and legumes, milk and milk products, oils and fats, sugar and honey, and others. Second, the food variety score (FVS) considers food items consumed within a household (food items and meals eaten outside of the home are excluded). The FVS is calculated based on Ecker and Qaim (2011) and the Ministry of Agriculture and Irrigation (2000, 25).

Table 3.1 Descriptive statistics of variables used in the estimation, pooled 2010 and 2013

Variable	Mean	Std. dev.	Min.	Max.
Dependent variable				
Log(value of production per hectare)	12.06	1.04	6.54	14.50
Household dietary diversity	8.25	2.05	3.00	12.00
Food variety score	15.65	6.54	3.00	64.00
Food consumption score	52.04	17.81	8.00	124.00
Explanatory variables				
Received input subsidy (= 1)	0.58	0.49	0.00	1.00
Quantity of subsidized fertilizer received (kg/ha)	83.96	101.91	0.00	500.00
Quantity of unsubsidized fertilizer purchased and used (kg/ha)	86.55	158.87	0.00	600.00
Used modern seed varieties (= 1)	0.56	0.50	0.00	1.00
Used hybrid seed varieties (= 1)	0.49	0.50	0.00	1.00
Used herbicide or pesticide (= 1)	0.05	0.21	0.00	1.00
Used mechanization (= 1)	0.04	0.20	0.00	1.00
Practiced intercropping (= 1)	0.48	0.50	0.00	1.00
Hired labor (= 1)	0.13	0.33	0.00	1.00
Number of plots	2.11	1.05	1.00	9.00
Land owned (acres)	3.62	47.47	0.00	2,247.20
Accessed credit (= 1)	0.14	0.35	0.00	1.00
Child dependency ratio	1.61	1.08	0.00	10.00
Household size	5.14	2.25	1.00	17.00
Years of education of household head	4.87	3.75	0.00	16.00
Age of household head	44.95	16.46	15.00	104.00
Male household head (= 1)	0.76	0.43	0.00	1.00
Annual rainfall (mm)	1,067.78	237.92	755.00	2,013.67
Distance to nearest paved road (km)	9.78	9.57	0.00	58.00
Distance to nearest daily/weekly market (km)	14.83	23.07	0.00	400.00
Distance to nearest ADMARC outlet (km)	8.07	5.37	0.00	35.00
Asset index	9.05	1.46	0.00	10.87

Table 3.1 Continued

Variable	Mean	Std. dev.	Min.	Max.
Extension-related variables				
Received agricultural advice (= 1)	0.54	0.50	0.00	1.00
Frequency of advice received (number) (those receiving advice)	4.00	4..00	1.00	52.00
Usefulness of advice				
Not useful (= 1)	0.12	0.24	0.00	1.00
Useful (= 1)	0.24	0.34	0.00	1.00
Very useful (= 1)	0.64	0.47	0.00	1.00
Source of advice				
Any direct contact with government extension agents (= 1)	0.54	0.45	0.00	1.00
Advice from electronic media (= 1)	0.43	0.42	0.00	1.00
Direct contact with government agents only (= 1)	0.34	0.39	0.00	1.00
Government agents plus other sources (= 1)	0.21	0.32	0.00	1.00
Number of recipients of advice within household				
Only one member received advice (= 1)	0.85	0.50	0.00	1.00
More than one members received advice (= 1)	0.15	0.29	0.00	1.00
Gender of recipient(s) of advice within household				
Female member(s) only (= 1)	0.19	0.31	0.00	1.00
Male member(s) only (= 1)	0.66	0.48	0.00	1.00
Both female and male members (= 1)	0.15	0.29	0.00	1.00
Topic of advice				
Received marketing advice in addition to production advice (= 1)	0.37	0.40	0.00	1.00
Received production advice only, no marketing advice (= 1)	0.63	0.48	0.00	1.00
Village-level access to extension in previous 5 years (= 1)	0.05	0.21	0.00	1.00
Instrument for receipt of agricultural advice and frequency				
Distance to nearest extension officer (km)	7.18	12.50	0.00	96.00
Instrument for receipt of fertilizer subsidy and quantity				
Years the household has lived in the village	35.12	20.43	0.00	104.00

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).
Note: ADMARC = Agricultural Development and Marketing Corporation.

We identified various factors that help explain who is likely to have access to agricultural advice (Table 4.2). Years of education of the household head is statistically significant in explaining access to agricultural advice, and the relationship is nonlinear. Those without formal education and those with advanced degrees are less likely to access agricultural advice. This result is expected because a certain minimum level of education may be required to participate in extension programs, while at the same time household heads with higher degrees may have the means and access to other knowledge sources to manage their farms without relying on advice from local agricultural advisory services. Age of household head is a significant determinant of receipt of agricultural advice, and the relationship is nonlinear. Very young and very old heads of household are less likely to receive advice than others.[4]

Male household heads are more likely to receive agricultural advice than female heads in some models, but gender of the household head is insignificant when combined with district fixed effects and when used to explain frequency of access to extension services. The household wealth index is a significant determinant of access to agricultural advice, and its relationship to such access is nonlinear. Very poor and very wealthy households are less likely to receive agricultural advice than others. Weak access to agricultural advice by the poorest segments of the farming population may have implications on

[4] Ten percent of household heads are 26 years old or younger, and another 10 percent are more than 70 years old.

the ability of the extension system to be pro-poor. Households nearer an agricultural extension officer are more likely to obtain agricultural advice.

The same factors explain the frequency of obtaining advice. In addition, households in different regions, agroecological zones, and districts show different probabilities and frequencies of receiving agricultural advice. A larger percentage of households in the Central Region reported having access to agricultural advice from government and other sources than was found in the Northern and Southern Regions. A larger percentage of households in the warm semiarid areas reported having greater access to agricultural advice than those from other agroecological zones. District fixed effects are jointly significant, indicating that some districts have systematically greater access to agricultural advice than do other districts, suggesting strong placement effects for access to agricultural advice.

To summarize, households with limited formal education are less likely than other households to access agricultural advice from government extension agents and other sources. The poorest segment of households are less likely to access agricultural advice from government extension agents and other sources. Very young and very old household heads are less likely to access agricultural advice from government extension agents and other sources. There seems to be no strong evidence of bias against female-headed households compared with male-headed households after controlling for location, which contrasts with the case in other countries (Ragasa et al. 2013). While the dataset does not include a category of people with and without disabilities, this paper shows strong evidence that youth and the poorest segment of farming households are less likely to access extension services, which may lead to their being left out in the development processes that agricultural advisory services support. Location is strongly significant in most models explaining access to agricultural advice, indicating a strong placement effect of agricultural advice.

4. DETERMINANTS OF ACCESS TO EXTENSION SERVICE

Several times in the past Malawi has reformed its agricultural extension system—from the Master Farmer Scheme and the *Achikumbi* or "Progressive Farmer" approach in the 1950s and 1960s, to the group approach in 1970s, to the training and visit system in the 1980s, to the more recent passage of the national extension policy in 2000, emphasizing farmers' demand, stakeholder accountability, pluralism, and coordination. Despite the emphasis on and promotion of pluralism, the government extension system remains the main provider of extension and advisory services in Malawi, while various international NGOs and other international development agencies, such as the CGIAR international agricultural research centers and the FAO, and some local NGOs and community-based organizations also provide some extension services as part of integrated development projects, either by hiring public extension workers, by having their own agents work with farmers, or by working directly with leader farmers or contact farmers. In 2013, 28 percent of farming households reported accessing extension services mainly from direct contact with government extension agents, while 6 percent of households reported accessing extension services from NGOs, and only 2 percent said they received advice from private-sector providers (Table 4.1). The rest of the households surveyed reported sourcing their agricultural information from other modes, including electronic media (particularly radio), lead farmers or other farmers, village meetings, field days, and farm demonstrations, all of which are delivery methods used alone or in combination by government extension services, NGOs, and the private sector. The most popular is electronic media, from which one-third of households reported obtaining agricultural advice. Twelve percent of households reported receiving advice mainly from lead farmers and other farmers, 6 percent from village meetings or farmer field days.

The main topics of the advice sample households reported receiving were composting, new seed varieties, fertilizer use, irrigation, pest control, pit planting, and forestry. Households reported access to more types of advice in 2013 than in 2010. In particular, advice on pest control, pit planting, forestry, marketing, animal care and diseases, tobacco production and marketing, and access to credit have become more popular, being reported by about three times as many households in 2013 as in 2010. Though indicating that more diversified advice is being offered, the expanded set of topics still indicates that the focus of most extension messages remains on production rather than on marketing and other issues.

Households tend also combine their sources of information. For example, 10 percent of households obtained advice from both government extension agents and electronic media. Thirteen percent received advice from both government agents and other sources.

Most households reported that only one household member received advice directly—mainly the head of the household, usually male. About one-third of households reported that two or more household members received advice directly from government extension agents and NGOs; about half of reported two or more members attending village meetings for agricultural advice.

In 2013, 71 percent of those receiving advice found it to be very useful, 21 percent found it useful, and 8 percent found it not useful (Table 4.1). This is an improvement from 2010, in which 52 percent of those obtaining advice found it to be very useful, 30 percent found it useful, and 19 percent found it not useful. The ratings by source are hard to compare statistically because only a few households reported receiving advice from many of the sources, except for government extension agents and electronic media. Some patterns, however, are worth mentioning: advice from electric media received a high rating for both years; advice from the private sector got the most "very useful" ratings; and advice from lead farmers received a relatively low rating in 2010 but improved in 2013.

In 2013, 62 percent of households received agricultural advice, an increase from 43 percent in 2010 (Table 4.1). Although this shows some improvement, it still leaves about 38 percent of farming households without access to any agricultural advice. Moreover, there are indications that access to extension services many be biased against some segments of the farming population. The national extension policy clearly states that "the public sector must make sure that the poorest segments of the population, women, youth, and people with disabilities are not left out of the development process for purposes of equity and equality" (Malawi, MoAI 2000, 25).

We identified various factors that help explain who is likely to have access to agricultural advice (Table 4.2). Years of education of the household head is statistically significant in explaining access to agricultural advice, and the relationship is nonlinear. Those without formal education and those with advanced degrees are less likely to access agricultural advice. This result is expected because a certain minimum level of education may be required to participate in extension programs, while at the same time household heads with higher degrees may have the means and access to other knowledge sources to manage their farms without relying on advice from local agricultural advisory services. Age of household head is a significant determinant of receipt of agricultural advice, and the relationship is nonlinear. Very young and very old heads of household are less likely to receive advice than others.[5]

Male household heads are more likely to receive agricultural advice than female heads in some models, but gender of the household head is insignificant when combined with district fixed effects and when used to explain frequency of access to extension services. The household wealth index is a significant determinant of access to agricultural advice, and its relationship to such access is nonlinear. Very poor and very wealthy households are less likely to receive agricultural advice than others. Weak access to agricultural advice by the poorest segments of the farming population may have implications on the ability of the extension system to be pro-poor. Households nearer an agricultural extension officer are more likely to obtain agricultural advice.

The same factors explain the frequency of obtaining advice. In addition, households in different regions, agroecological zones, and districts show different probabilities and frequencies of receiving agricultural advice. A larger percentage of households in the Central Region reported having access to agricultural advice from government and other sources than was found in the Northern and Southern Regions. A larger percentage of households in the warm semiarid areas reported having greater access to agricultural advice than those from other agroecological zones. District fixed effects are jointly significant, indicating that some districts have systematically greater access to agricultural advice than do other districts, suggesting strong placement effects for access to agricultural advice.

To summarize, households with limited formal education are less likely than other households to access agricultural advice from government extension agents and other sources. The poorest segment of households are less likely to access agricultural advice from government extension agents and other sources. Very young and very old household heads are less likely to access agricultural advice from government extension agents and other sources. There seems to be no strong evidence of bias against female-headed households compared with male-headed households after controlling for location, which contrasts with the case in other countries (Ragasa et al. 2013). While the dataset does not include a category of people with and without disabilities, this paper shows strong evidence that youth and the poorest segment of farming households are less likely to access extension services, which may lead to their being left out in the development processes that agricultural advisory services support. Location is strongly significant in most models explaining access to agricultural advice, indicating a strong placement effect of agricultural advice.

[5] Ten percent of household heads are 26 years old or younger, and another 10 percent are more than 70 years old.

Table 4.1 Percentage of farming households receiving agricultural advice, and source, type, and usefulness of advice

Agricultural advice	2013								2010							
	Received advice	Source							Received advice	Source						
		Govt.	Media	Other farmer	Lead farmer	NGO	Priv.	Village meeting		Govt.	Media	Other farmer	Lead farmer	NGO	Priv.	Village meeting
Any advice^	**62**	**27**	**33**	**12**	**2**	**6**	**2**	**6**	**43**	**20**	**18**	**5**	**1**	**2**	**1**	**4**
Type of advice^																
Composting	**48**	15	19	6	1	2	0	4	**22**	12	6	1	0	1	0	1
New seed varieties	**46**	18	20	5	1	2	0	2	**25**	9	8	2	1	0	0	2
Fertilizer use	**46**	18	19	6	2	1	1	2	**24**	10	7	2	1	0	0	2
Irrigation	**42**	14	24	5	1	2	0	1	**19**	9	9	2	0	0	0	1
Pest control	**39**	17	21	5	1	1	1	2	**12**	11	8	1	1	0	0	1
Pit planting	**33**	15	19	5	1	2	0	5	**10**	12	7	1	0	0	0	1
Forestry	**33**	13	25	4	1	2	0	2	**11**	7	12	1	1	1	0	0
Marketing	**30**	11	27	5	1	2	1	1	**8**	7	12	1	1	0	0	1
Livestock	**30**	14	24	4	1	2	0	2	**8**	10	10	1	1	0	0	1
Tobacco	**28**	10	28	4	1	2	1	1	**10**	6	11	2	0	0	1	2
Credit	**28**	9	26	5	1	4	1	2	**8**	6	12	2	1	1	0	0
Fisheries	**19**	8	33	3	0	1	0	0	**8**	5	12	2	0	0	0	0
Others	**2**	10	12	2	2	4	2	0	**0**	8	13	0	1	0	0	0
Usefulness of advice^																
Not useful	**8**	7	5	8	9	10	15	6	**19**	11	2	8	21	30	2	10
Useful	**21**	27	26	22	26	21	12	43	**30**	39	33	49	79	32	8	44
Very useful	**71**	66	69	67	66	68	73	51	**52**	50	65	42	0	38	90	46

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).
Note: ^Percent of all households surveyed.

Table 4.2 Results of the probit and Tobit models explaining access to agricultural advice

Variable	Received advice	Received advice (with district fixed effects)	By source						Number of visits and meetings[a]
			Government agents	Electronic media	Other farmers	Other sources	Government and others	Government and media	
Years of education of	0.017**	0.019**	0.010	0.005	0.008*	0.005	0.007*	0.007**	0.183
household head	(0.007)	(0.008)	(0.007)	(0.006)	(0.005)	(0.006)	(0.004)	(0.003)	(0.115)
Years of education of	-0.001	-0.001	-0.000	-0.000	-0.001*	-0.000	-0.000	-0.000	-0.004
household head squared	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.010)
Age of household head	0.006*	0.007*	0.007**	0.005*	-0.004*	-0.001	0.001	0.000	0.180***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.054)
Age of household head	-0.000*	-0.000**	-0.000**	-0.000**	0.000*	0.000	-0.000	-0.000	-0.002***
squared	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Male (= 1)	0.042*	0.032	0.023	0.059***	-0.019	0.024	0.004	-0.000	0.234
	(0.022)	(0.023)	(0.019)	(0.017)	(0.012)	(0.017)	(0.012)	(0.010)	(0.347)
Asset index	0.145***	0.141***	0.077**	0.096***	0.010	0.065**	0.071**	0.076**	1.417**
	(0.036)	(0.037)	(0.034)	(0.030)	(0.020)	(0.031)	(0.028)	(0.029)	(0.582)
Asset index squared	-0.010***	-0.010***	-0.005**	-0.008***	-0.000	-0.004**	-0.005**	-0.005***	-0.101***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.038)
Land owned (acres)	-0.002	-0.002*	-0.002	-0.000	0.005**	0.019***	-0.000	-0.000	-0.008
	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.004)	(0.001)	(0.000)	(0.010)
Land owned squared	0.000	0.000*	0.000	0.000	-0.000	-0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Child dependency	-0.010	-0.006	0.008	-0.010	-0.000	-0.014*	0.005	0.001	0.161
	(0.010)	(0.011)	(0.009)	(0.009)	(0.004)	(0.008)	(0.006)	(0.005)	(0.161)
Household size	0.013***	0.010**	0.004	0.005	0.002	0.004	0.004	0.003	0.092
	(0.005)	(0.005)	(0.004)	(0.004)	(0.002)	(0.004)	(0.003)	(0.002)	(0.072)
Number of plots	0.035***	0.038***	0.031***	0.009	-0.004	-0.012*	0.012**	0.009**	0.718***
	(0.009)	(0.009)	(0.008)	(0.007)	(0.004)	(0.007)	(0.005)	(0.004)	(0.131)
Annual rainfall (mm)	0.000**	0.000	0.000***	0.000	-0.000	0.000	0.000***	0.000***	0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Distance to nearest paved road	0.001	-0.003**	0.001	0.000	0.000	-0.000	0.001	0.000	0.005
(km)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.015)

Table 4.2 Continued

Variable	Received advice	Received advice (with district fixed effects)	By source						Number of visits and meetings[a]
			Government agents	Electronic media	Other farmers	Other sources	Government and others	Government and media	
Agroecological zone (control = cool subhumid zone)									
Warm semiarid zone (= 1)	0.036	-0.028	0.013	0.011	0.027	0.043	0.013	-0.003	-0.062
	(0.036)	(0.049)	(0.032)	(0.030)	(0.019)	(0.028)	(0.020)	(0.016)	(0.551)
Warm subhumid zone (= 1)	0.014	0.098**	-0.039	0.023	0.059**	0.060**	0.012	-0.011	-0.613
	(0.034)	(0.048)	(0.029)	(0.029)	(0.029)	(0.028)	(0.020)	(0.015)	(0.517)
Cool semiarid zone (= 1)	-0.080**	-0.009	-0.025	0.002	0.013	-0.011	0.016	0.013	-2.014***
	(0.040)	(0.050)	(0.034)	(0.033)	(0.020)	(0.029)	(0.024)	(0.020)	(0.628)
Region (control = Central)									
North (= 1)	-0.152***	1.000***	-0.049*	-0.194***	-0.028*	-0.069***	-0.076***	-0.066***	-1.743***
	(0.030)	(0.000)	(0.026)	(0.017)	(0.015)	(0.023)	(0.012)	(0.009)	(0.481)
South (=)	-0.118***	0.024	-0.018	-0.150***	-0.039**	-0.076***	-0.055***	-0.045***	-1.006**
	(0.026)	(0.422)	(0.022)	(0.019)	(0.018)	(0.021)	(0.013)	(0.011)	(0.391)
2010 (= 1)	-0.192***	-0.177***	-0.065**	-0.117***	-0.084**	-0.124***	-0.076***	-0.041***	-1.070**
	(0.030)	(0.031)	(0.027)	(0.025)	(0.035)	(0.029)	(0.018)	(0.015)	(0.481)
Distance to nearest	-0.002***	0.000	-0.002***	0.000	-0.000	-0.000	-0.001**	-0.001	-0.025**
agricultural extension officer	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.012)
Constant	-3.139***	-2.273***	-3.403***	-2.916***	-1.141	-1.998***	-4.340***	-6.783***	-19.401***
	(0.661)	(0.741)	(0.717)	(0.755)	(1.130)	(0.722)	(1.036)	(1.588)	(4.150)
Observations	***3,656***	***3,656***	***3,656***	***3,656***	***3,656***	***3,656***	***3,656***	***3,656***	***3,656***
Pseudo R^2	***0.09***	***0.13***	***0.04***	***0.14***	***0.08***	***0.06***	***0.10***	***0.12***	***0.04***
% correctly predicted by model	***69%***	***75%***	***72%***	***75%***	***72%***	***73%***	***69%***	***72%***	***72%***

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).
Notes: Figures are the marginal effects; standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; [a] estimated via Tobit model; all other models were estimated via probit model.

5. DETERMINANTS OF FISP INPUT SUBSIDY RECEIPT

The analysis of the IHPS panel survey data showed that several factors explain (1) the probability of a farm household's receiving the FISP subsidy and (2) the quantity of subsidized fertilizer received (Table 5.1). As expected, the number of years the household has resided in the village is significant. The longer the household has lived in the village, the more likely it is to have received the subsidy and to have received a greater quantity of subsidized fertilizer than other households received. The household head's years of education is statistically significant in explaining access to the subsidy and the quantity of subsidized fertilizer obtained, with the relationship being nonlinear. Those without formal education and those with advanced degrees are less likely to receive the subsidy and, if they do receive it, more likely to obtain a smaller quantity of subsidized fertilizer than others received. Age of household head is a significant determinant of receipt of the subsidy and of the quantity of subsidized fertilizer received, with the relationship being nonlinear. Very young and very old household heads are less likely to receive the subsidy, but if they do, they receive smaller quantities of subsidized fertilizer. Male household heads are more likely to receive the subsidy than female heads. Wealth, as proxied by a household asset index, is not statistically significant in explaining the probability of input subsidy receipt and the quantity of subsidized fertilizer received. Also, amount of land owned is not a statistically significant correlate of input subsidy receipt, which indicates that amount of land or area cultivated is not a factor in the receipt of the FISP input subsidy—it seems that small, medium, and large farms have similar likelihoods of accessing the input subsidy.

Households with a larger number of plots are more likely to receive the input subsidy and receive subsidized fertilizer in a greater quantity. Households in different regions, districts, and agroecological zones also show different probabilities of receiving the subsidy and different quantities of subsidized fertilizer received.

The MoAIWD distributes input subsidy vouchers through its extension system at the district level. The coupons are then allocated to villages through traditional authorities. At the village level, village heads and village development committees are responsible for beneficiary selection (Chibwana et al. 2014). The criteria for household selection into the FISP include the following: (1) beneficiaries must own land that is cultivated during the relevant season; (2) the household must be bona fide residents of the village; (3) only one member per household is eligible for the program; and (4) priority is given to vulnerable groups, particularly households headed by children and women (Chibwana et al. 2014). Our results suggest that households that had lived in a village longer were more likely to receive the FISP subsidy and more likely to receive increased amounts of subsidized fertilizer, which supports the residency objective. Unlike the stated objective, however, male-headed households were more likely to receive the subsidy than female-headed households. This finding is similar to that of Chibwana, Fisher, and Shively (2012), who found that female-headed households were less likely to receive input subsidies. There is also evidence that younger household heads are less likely to receive the FISP subsidy, which is in contrast to the stated program priority of households headed by children or youth.

Table 5.1 Correlates of input subsidy receipt

Variable	(1) Received input subsidy (= 1)[a]	(2) Quantity of subsidized fertilizer received (kg)[b]
Years living in the village	0.002***	0.741***
	(0.001)	(0.192)
Years of education of household head	0.018**	6.968***
	(0.007)	(2.383)
Years of education of household head squared	-0.002**	-0.468**
	(0.001)	(0.205)
Age of household head	0.015***	5.333***
	(0.003)	(1.051)
Age of household head squared	-0.000***	-0.044***
	(0.000)	(0.010)
Male household head (= 1) (d)	0.080***	27.785***
	(0.023)	(7.154)
Asset index	0.022	-1.860
	(0.036)	(11.388)
Asset index squared	-0.001	-0.065
	(0.002)	(0.756)
Land owned (acre)	0.000	0.085
	(0.000)	(0.055)
Child dependency ratio	-0.008	-5.378
	(0.010)	(3.396)
Household size	0.009*	6.689***
	(0.005)	(1.485)
Annual rainfall	0.000	0.008
	(0.000)	(0.029)
Tropic-warm/semiarid (= 1) (d)	0.121***	50.685***
	(0.045)	(14.404)
Tropic-warm/subhumid (= 1) (d)	0.047	22.141
	(0.047)	(14.528)
Tropic-cool/semiarid (= 1) (d)	0.068	36.919**
	(0.045)	(15.015)
Distance to nearest paved road (km)	-0.001	0.282
	(0.001)	(0.412)

Table 5.1 Continued

Variable	(1) Received input subsidy (= 1)[a]	(2) Quantity of subsidized fertilizer received (kg)[b]
Year 2010 (= 1) (d)	0.065**	25.392**
	(0.031)	(9.917)
District fixed effects	YES	YES
Constant		-180.564***
		(65.551)
sigma		
Constant		149.744***
		(2.592)
Observations	***3,622***	***3,640***
Pseudo R^2	***0.10***	***0.02***
% correctly predicted	***74%***	***71%***
Log lik.	***-2,207.856***	***-14,149.454***
Chi-squared	***501.539***	***566.371***

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).
Notes: Marginal effects; standard errors in parentheses; (d) for discrete change of dummy variable from 0 to 1; * p < 0.10, ** p < 0.05, *** p < 0.01; a estimated via probit model; b estimated via Tobit model.

6. IMPACT OF ACCESS TO ADVICE AND SUBSIDIZED INPUTS ON FARM PRODUCTIVITY AND FOOD SECURITY

Impact of Access to Advice and Subsidized Inputs on Farm Productivity

Table 6.1 shows the results of the estimation explaining farm productivity. The quantity of subsidized fertilizer received does not show consistent impact on farm productivity across the different models estimated. Model 1, using the MC device and the CF approach, shows no significant impact, while Model 2, using the MC device and the IV approach, shows a positive impact on farm productivity, although the magnitude is small—that is, for every 1 kg of additional fertilizer, the value of production is expected to increase by 0.4 percent, or for every 100 kg of additional fertilizer, the value of production is expected to increase by 40 percent. Other models estimated, POLS and PSM, show no significant impact. These results on the farm-level productivity impact of FISP are consistent with the mixed findings seen elsewhere in the literature (Chibwana et al. 2014; Holden and Lunduka 2010a, 2010b; Ricker-Gilbert and Jayne 2011).

Table 6.1 Results of estimation of the impact of access to agricultural advice and input subsidy on farm productivity

Dependent variable: Log(value of production per hectare)	Model 1 (MC CF)	Model 2 (MC IV)
Quantity of fertilizer subsidy received (kg/ha)	-0.001 (0.001)	0.004* (0.003)
Received advice (= 1)	0.074 (0.049)	0.047 (0.047)
Unsubsidized fertilizer quantity (kg/ha)	0.001*** (0.000)	0.001*** (0.000)
Received advice x quantity of subsidized fertilizer (= 1)	-0.000 (0.000)	0.000 (0.000)
Used modern varieties (= 1)	0.101 (0.088)	0.109 (0.088)
Used hybrid varieties (=1)	-0.040 (0.084)	-0.119 (0.103)
Used herbicide/pesticide (= 1)	0.180* (0.108)	0.182* (0.109)
Used mechanization (= 1)	0.071 (0.150)	0.120 (0.150)
Used intercropping (= 1)	-0.007 (0.043)	-0.038 (0.048)
Hired labor (= 1)	-0.041 (0.065)	-0.141 (0.090)
Number of plots	-0.002 (0.028)	-0.120 (0.079)
Land owned (acres)	-0.003** (0.001)	-0.003*** (0.001)

Table 6.1 Continued

Dependent variable: Log(value of production per hectare)	Model 1 (MC CF)	Model 2 (MC IV)
Land owned squared	0.000**	0.000**
	(0.000)	(0.000)
Asset index	-0.015	-0.010
	(0.066)	(0.066)
Asset index squared	-0.004	-0.003
	(0.004)	(0.004)
Access to credit (= 1)	-0.013	-0.025
	(0.058)	(0.058)
Child dependency ratio	-0.014	0.006
	(0.030)	(0.031)
Household size	0.016	-0.002
	(0.017)	(0.019)
Years of education of household head	0.006	0.006
	(0.005)	(0.005)
Age of household head	-0.003***	-0.006***
	(0.001)	(0.002)
Male household head (= 1)	0.047	0.024
	(0.039)	(0.041)
Annual rainfall (mm)	0.001**	0.001*
	(0.001)	(0.001)
Distance to nearest paved road (km)	-0.007***	-0.008***
	(0.002)	(0.002)
Distance to nearest market (km)	0.000	0.000
	(0.001)	(0.001)
Distance to nearest ADMARC outlet (km)	-0.003	0.001
	(0.004)	(0.004)
Village received advice in previous 5 years (= 1)	-0.209**	-0.227**
	(0.098)	(0.099)
Year 2010 (= 1)	-0.589***	-0.648***
	(0.076)	(0.084)
District fixed effects	YES	YES
Agroecological zones fixed effects	YES	YES
Constant	12.049***	12.267***
	(0.367)	(0.398)
Observations	***3,525***	***3,525***
Overall R^2	***0.34***	***0.33***

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).

Notes: Standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01; ADMARC = Agricultural Development and Marketing Corporation; MC CF = Mundlak-Chamberlain device and control function approach; MC IV = Mundlak-Chamberlain device and instrumental variable approach.

Access to agricultural extension advice is consistently insignificant in all models. The interaction terms between access to advice and receipt of the FISP input subsidy also are not statistically significant.

The insignificance of access to extension services is consistent with findings of most studies assessing the impact on farm productivity of the extension system in Malawi. Fifteen years after the introduction of the national extension policy, only a few of the actions laid out in the policy have been taken; many elements remain largely unimplemented (Ragasa, Mazunda, and Kadzamira 2015). In recent years, an increasing diversity of sources and types of agricultural advisory services has emerged to provide Malawi's farmers with information to enhance their farming. However, as the system has grown more complex, increasing inefficiencies, redundancies, and confusion due to conflicting messages to farmers on a specific issue or technology, as well as major challenges in coordination, have emerged (Chowa, Garforth, and Cardey 2013; Knorr, Benyata, and Hoffmann 2007; Masangano and Mthinda 2012; MEAS 2012). The low contributions to on-farm productivity of the extension system in Malawi observed here are not wholly unexpected.

At the microeconomic level, our results are consistent with the studies of Chirwa (2005), Kampani (2011), and Tchale (2012). Chirwa (2005) found that contact with extension services was insignificant in explaining smallholder farmer adoption of inorganic fertilizers and hybrid maize seed in Machinga district. Kampani (2011) found that extension service was not significant in explaining smallholder farmer knowledge and use of soybean production practices in Lilongwe district. Tchale (2012) showed that access to extension services did not significantly encourage farmers to grow orphan crops. On the other hand, Kilic, Palacios-Lopez, and Goldstein (2013) showed that access to extension services was significant in explaining productivity levels of both female- and male-headed households, and Maguza-Tembo (2010) showed that extension services and frequency of extension visits to farmers significantly influenced adoption of recommended maize production technologies, in a study of the effectiveness of farmer-to-farmer extension compared with the conventional extension system in Dedza district. However, these studies did not address any nonrandom placement effect and did not control for the interplay of access to extension with FISP and any endogeneity issues.

In addition to testing different model specifications, we estimated different models to capture the heterogeneity of households. First, we tested for the significance of advice on productivity levels for those with and those without the FISP input subsidy. Results show that advice is insignificant in those two general types of households. Second, we tested the significance of the input subsidy on productivity levels for those with and those without advice. Results show little difference in terms of the coefficient of the input subsidy between the two models, indicating little effect of advice on the impact of the input subsidy on productivity levels. Third, we tested the significance of advice and the input subsidy on productivity levels by region (Northern, Southern, and Central) and by agroecological zone. Again, results show that advice is insignificant in those general geographical categories and the input subsidy remains significant in all the geographical categories.

Finally, we tested the significance of advice and the input subsidy on productivity levels across different values of production (via quantile regression) and asset distributions (by grouping the asset index into quintiles). Households in the higher third and fourth asset quintiles experienced higher impacts of the input subsidy than those in the lower first quintile. But advice remains insignificant across asset quintiles. Based on value-of-production groupings, those between the 20th and 40th percentiles experienced the highest impact of the input subsidy on productivity, compared with the lowest and upper quintiles. Despite some inconsistency in the effect of the input subsidy on the upper quintiles, there seems to be a consistent story on its limited effect on the lowest decile, indicating some limitation of the subsidy as an engine for poverty reduction. This is consistent with findings by Lunduka, Ricker-Gilbert, and Fisher (2013) and Ricker-Gilbert and Jayne (2012).

Other factors seem to be significant in explaining productivity levels. The use of herbicide or pesticide is significant and positive. Quantity of purchased fertilizer is positive, although the magnitude of its effect on productivity and food security is small—that is, for every 100-kg increase in fertilizer use, the value of production is expected to increase by 10 percent.

Households with younger heads are more productive than those with older ones. There is no significant difference in productivity between male- and female-headed households, holding other factors constant. Annual rainfall is significant and positive in most models, indicating the relevance of rainfall levels in rainfed systems. Distance to the nearest road, indicating access to markets and services, is consistently significant in all models.

Impact of Access to Advice and the Input Subsidy on Food Security

Table 6.2 shows the results of the estimation explaining different indicators of food security. The quantity of subsidized fertilizer received shows inconsistent results. It is negative in some models and has no effect in others. This result is consistent with some findings that raise questions on the program's consistent ability to promote productivity growth and reduce food insecurity and poverty (Lunduka, Ricker-Gilbert, and Fisher 2013).

Table 6.2 Results of estimation of impact of access to agricultural advice and input subsidy on food security indicators

Variable	(1) HDDS	(2) HDDS	(3) FCS	(4) FCS	(5) FVS	(6) FVS
Quantity of fertilizer subsidy received (kg/ha)	-0.004***	-0.000	-0.030***	-0.018	-0.017***	-0.014
	(0.001)	(0.005)	(0.011)	(0.045)	(0.004)	(0.016)
Received advice (= 1)	0.086	0.091	-1.356	-1.268	-0.010	0.111
	(0.096)	(0.093)	(0.890)	(0.862)	(0.305)	(0.295)
Unsubsidized fertilizer quantity (kg/ha)	0.002***	0.002***	0.010***	0.010***	0.003***	0.003**
	(0.000)	(0.000)	(0.003)	(0.003)	(0.001)	(0.001)
Received advice x quantity of subsidized fertilizer (= 1)	0.001	0.001	0.010*	0.009**	0.002	0.001
	(0.001)	(0.000)	(0.005)	(0.004)	(0.002)	(0.002)
Used modern varieties (= 1)	-0.276	-0.281	-1.932	-2.005	-0.860	-0.904*
	(0.172)	(0.172)	(1.603)	(1.609)	(0.545)	(0.548)
Used hybrid varieties (= 1)	0.303*	0.337*	2.322	2.942	1.068**	1.482**
	(0.164)	(0.204)	(1.535)	(1.867)	(0.522)	(0.647)
Used herbicide/pesticide (= 1)	-0.123	-0.138	-2.264	-2.422	-0.591	-0.681
	(0.210)	(0.211)	(1.957)	(1.963)	(0.666)	(0.670)
Used mechanization (= 1)	-0.110	-0.111	-2.012	-2.148	-0.816	-0.974
	(0.295)	(0.297)	(2.756)	(2.765)	(0.938)	(0.944)
Used intercropping (= 1)	0.004	0.011	-0.856	-0.675	0.169	0.296
	(0.084)	(0.096)	(0.786)	(0.881)	(0.267)	(0.304)
Hired labor (= 1)	0.306**	0.309*	0.984	1.385	1.374***	1.690***
	(0.127)	(0.180)	(1.180)	(1.635)	(0.402)	(0.571)
Number of plots	0.182***	0.196	1.026**	1.585	0.775***	1.201**
	(0.055)	(0.161)	(0.516)	(1.432)	(0.175)	(0.510)
Land owned (acres)	-0.000	-0.000	-0.008	-0.007	-0.005	-0.005
	(0.002)	(0.002)	(0.019)	(0.019)	(0.007)	(0.007)
Land owned squared	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 6.2 Continued

Variable	(1) HDDS	(2) HDDS	(3) FCS	(4) FCS	(5) FVS	(6) FVS
Asset index	-0.024	-0.017	-1.062	-1.020	-0.594	-0.577
	(0.133)	(0.134)	(1.203)	(1.205)	(0.422)	(0.424)
Asset index squared	-0.011	-0.011	-0.063	-0.065	0.006	0.005
	(0.008)	(0.008)	(0.075)	(0.075)	(0.026)	(0.027)
Access to credit (= 1)	0.276**	0.287**	0.911	1.038	0.962***	1.051***
	(0.114)	(0.115)	(1.062)	(1.068)	(0.361)	(0.364)
Child dependency ratio	-0.026	-0.017	-0.082	-0.067	-0.191	-0.200
	(0.057)	(0.061)	(0.536)	(0.562)	(0.182)	(0.193)
Household size	0.042	0.030	-0.167	-0.207	0.305***	0.295**
	(0.033)	(0.038)	(0.312)	(0.354)	(0.106)	(0.122)
Years of education of household head	0.080***	0.080***	0.500***	0.495***	0.208***	0.206***
	(0.010)	(0.010)	(0.091)	(0.091)	(0.033)	(0.033)
Age of household head	-0.011***	-0.012***	-0.045**	-0.039	-0.035***	-0.029**
	(0.002)	(0.004)	(0.020)	(0.035)	(0.007)	(0.012)
Male household head (= 1)	0.132	0.129	1.138	1.196	0.102	0.155
	(0.080)	(0.085)	(0.705)	(0.747)	(0.254)	(0.269)
Annual rainfall (millimeters)	0.001	0.001	-0.007	-0.007	-0.005	-0.005
	(0.001)	(0.001)	(0.011)	(0.011)	(0.004)	(0.004)
Distance to nearest paved road (km)	-0.024***	-0.025***	-0.191***	-0.195***	-0.053***	-0.055***
	(0.005)	(0.005)	(0.043)	(0.043)	(0.016)	(0.016)
Distance to nearest market (km)	-0.001	-0.001	0.009	0.010	-0.009**	-0.009*
	(0.001)	(0.001)	(0.013)	(0.013)	(0.004)	(0.005)
Distance to nearest ADMARC outlet (km)	-0.023***	-0.023***	-0.133**	-0.146*	-0.077***	-0.087***
	(0.008)	(0.009)	(0.067)	(0.078)	(0.024)	(0.028)
Village received advice in previous 5 years (= 1)	-0.144	-0.166	0.262	0.133	0.510	0.456
	(0.206)	(0.207)	(1.783)	(1.789)	(0.652)	(0.654)
Year 2010 (= 1)	0.211	0.213	1.252	1.496	-0.308	-0.119
	(0.149)	(0.168)	(1.384)	(1.540)	(0.474)	(0.533)
District fixed effects	YES	YES	YES	YES	YES	YES
Agroecological zones fixed effects	YES	YES	YES	YES	YES	YES
Constant	10.051***	9.885***	78.771***	76.499***	23.325***	21.803***
	(0.763)	(0.822)	(6.688)	(7.217)	(2.416)	(2.604)
Observations	***3,591***	***3,591***	***3,591***	***3,591***	***3,591***	***3,591***
Overall R^2	***0.28***	***0.28***	***0.24***	***0.24***	***0.29***	***0.29***

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).

Notes: Standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01; Models 1, 3, and 5 are estimated based on Mundlak-Chamberlain device and control function approach, and Models 2, 4, and 6 are estimated based on Mundlak-Chamberlain device and instrumental variable approach. ADMARC = Agricultural Development and Marketing Corporation; FCS = food consumption score; FVS = food variety score; HDDS = household dietary diversity score.

Access to extension advice is consistently insignificant in all models. The interaction terms between access to advice and receipt of the input subsidy are also not statistically significant, except for the FCS models, in which there is less negative impact of quantity of fertilizer subsidy if advice is received.

Similar to the productivity models above, we tested different model specifications to capture the heterogeneity of households. First, we tested for the significance of advice on food security measures for those with the input subsidy and those without it. Results show that advice is insignificant in those two general types of households. Second, we tested the significance of the input subsidy on food security measures for those with and those without advice. Results show that the input subsidy is insignificant in those two general types of households. Third, we tested the significance of advice and the input subsidy on food security levels by region (Northern, Southern, and Central) and by agroecological zone. Again, results show that advice and the input subsidy are insignificant in those general geographical categories. Finally, we tested the significance of advice and the input subsidy on food security measures across different values of production (via quantile regression) and asset distributions (by grouping the asset index into quintiles). Again, advice and the input subsidy remain insignificant across the value-of-production groupings and the asset quintiles.

The use of hybrid seed, hired labor, and credit are statistically significant and positive in explaining HDDS and FVS, but not FCS. The years of education and age of the household head are statistically significant in explaining three indicators of food security. Household heads with more education have higher food security, and households with younger heads have more food security. Gender of household head is not significant. Distance to a road and to an ADMARC (Agricultural Development and Marketing Corporation) outlet are significant in explaining all three indicators of food security, while distance to the nearest daily or weekly market is significant in explaining FVS, indicating the importance of access to markets in improving food security.

Impact of Frequency and Quality of Advice on Farm Productivity and Food Security

We unpacked the dummy variable on access to advice that we used in the earlier models to capture information on the frequency and usefulness to the farmer of the advice received. The results of the models that include these additional explanatory variables on agricultural extension services received are presented in Table 6.3. First, instead of a dummy variable for access or no access to extension advice, we used frequency of advice received in a year. The frequency of advice received in a year is consistently insignificant in explaining farm productivity and food security levels.[6]

Second, the usefulness of advice as reported by the sample households is statistically significant in explaining productivity and food security in most models. In the restricted sample (only those who received advice), households who received "not useful" advice have significantly lower productivity, HDDS, and FVS than those who received "very useful" advice and those who received "useful" advice. The statistical significance of the reported usefulness of advice is consistent with the findings of Ragasa and others (2013) in the context of Ethiopian agriculture.

[6] As shown in Table 3.1, the frequency of receiving advice ranges from 1 to 52 counts for those who reported having received advice. Seventy-six percent of these households reported receiving advice once or up to four times per year, but 1 percent of these households received advice more than 20 times, even up to 52 times, which may be unrealistically frequent. We ran a separate model excluding these few outliers, but this approach did not change the results.

Table 6.3 Impact of frequency and quality of advice and different delivery modes on farm productivity and food security indicators

	(1) Prod. value	(2) Prod. value	(3) HDDS	(4) HDDS	(5) FCS	(6) FCS	(7) FVS	(8) FVS
Frequency of receiving advice								
Number of visits and meetings	0.003	0.004	-0.010	-0.009	0.092	0.098	-0.012	-0.014
	(0.008)	(0.008)	(0.016)	(0.016)	(0.154)	(0.154)	(0.057)	(0.057)
Usefulness of advice (control: received "not useful" advice)								
Received "useful" advice (= 1)	0.324***	0.323***	0.009	-0.006	-0.660	-0.727	-0.490	-0.574
	(0.096)	(0.096)	(0.187)	(0.187)	(1.730)	(1.731)	(0.636)	(0.636)
Received "very useful" advice (= 1)	0.335***	0.338***	0.420***	0.410***	0.499	0.425	1.007*	0.947*
	(0.081)	(0.081)	(0.158)	(0.159)	(1.453)	(1.456)	(0.537)	(0.539)
Source of advice								
Direct contact with gov. agent (control: no	0.035	0.035	-0.086	-0.089	-1.203	-1.207	-0.546	-0.564
direct contact)	(0.057)	(0.057)	(0.112)	(0.112)	(1.041)	(1.040)	(0.385)	(0.385)
Received advice from electronic media	-0.022	-0.019	0.022	0.025	0.233	0.246	0.082	0.101
(control: no advice from electronic media)	(0.063)	(0.063)	(0.123)	(0.123)	(1.144)	(1.144)	(0.423)	(0.423)
Received advice from gov. agents only	0.040	0.042	-0.143	-0.144	-1.821	-1.808	-0.642	-0.664
(control: no advice from gov. agent)	(0.064)	(0.064)	(0.124)	(0.124)	(1.161)	(1.160)	(0.429)	(0.429)
Received advice from gov. agent + other source	0.030	0.026	0.121	0.114	0.488	0.450	-0.012	-0.019
(control: no advice from gov. agent)	(0.082)	(0.082)	(0.161)	(0.161)	(1.502)	(1.502)	(0.555)	(0.556)
Number of recipients of advice within household								
One household member received advice	0.000	0.004	0.096	0.094	-1.516	-1.546	-0.524	-0.557
(control: > 1 members received advice)	(0.070)	(0.071)	(0.139)	(0.139)	(1.263)	(1.267)	(0.471)	(0.472)
Gender of recipient(s) of advice within household (control: both female and male received advice)								
Female member only received advice	-0.237	-0.237	-0.062	-0.077	-0.680	-0.791	-1.423	-1.579
	(0.201)	(0.202)	(0.397)	(0.398)	(3.551)	(3.553)	(1.333)	(1.332)
Male member only received advice	0.026	0.030	0.128	0.128	-1.626	-1.646	-0.438	-0.456
	(0.074)	(0.074)	(0.146)	(0.146)	(1.330)	(1.334)	(0.495)	(0.496)
Topic of advice								
Received marketing advice in addition to	0.139**	0.142**	-0.114	-0.111	-0.008	-0.002	-0.468	-0.437
production advice (control: no marketing advice)	(0.070)	(0.070)	(0.137)	(0.137)	(1.279)	(1.278)	(0.472)	(0.473)

Source: Malawi Integrated Household Panel Survey 2010, 2013 (Malawi, NSO 2014b).

Notes: Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table used the subset of households that received any agricultural advice. Dependent variables: Prod. value = Log(value of production per hectare); HDDS = household dietary diversity score; FCS = food consumption score; FVS = food variety score. Models 1, 3, 5, and 7 are estimated based on Mundlak-Chamberlain device and control function approach, and Models 2, 4, 6, and 8 are estimated based on Mundlak-Chamberlain device and instrumental variable approach.

Since there is no follow-up question in the IHPS questionnaire on why households were very satisfied, satisfied, or not satisfied with the extension advice they received, we looked at the characteristics and demographics of the reporting households. We hypothesized farmers' satisfaction with extension services to be correlated with education, previous experience, location, and number of children. However, most of these variables were not systematically correlated with the reported satisfaction of farmers on the service or advice received, except location. The dummy variables for village and for district are jointly significant, suggesting that the same provider or the same message may have caused farmers in some villages and districts to be dissatisfied with the agricultural advice. Another possible explanation is that some services, facilities, or equipment necessary for effectively applying the extension advice may have been absent from those villages or districts, resulting in dissatisfaction with the advice received.

Key informants have offered some possible explanations for why farmers may not be satisfied with extension advice. First, some communities complained that the extension messages provided are not what they need and that extension workers often preach a particular technology package without first hearing what the community wants and needs. Some communities reported that they had not been consulted about their demands and preferences. Second, some communities complained that different extension workers from different organizations give conflicting messages, and in some cases, farmers just do not trust the knowledge and expertise of some of the extension workers. Third, in some communities, lead farmers have been equated with the progressive farmers who obtain privileges, such as free inputs or services from the government or NGOs. Therefore, farmers in some villages feel envious toward them rather than seeing them as models for their own use of improved technology and farming methods. Because of this negative feeling, surrounding farmers may view as not good or not useful any technology promoted by or in partnership with lead farmers. This attitude may be linked to previous reforms, from the Master Farmer Scheme in the 1950s to the *Achikumbi,* or "Progressive Farmer," approach in the 1960s, which are said to have created negative perceptions of these lead/contact/model farmers and to have largely failed to show productivity and development impacts (Knorr, Benyata, and Hoffmann 2007).[7] This is in contrast to a more favorable assessment of lead farmers by Khalia and colleagues (2015).

Finally, even when farmers receive advice on technologies, if complementary inputs, services, or equipment are not provided or locally available, the whole extension service delivery will not be useful to many farmers. Several examples came out of the key informant interviews. First, communities have been trained on contour plowing, a very useful technology in erosion-prone areas. However, spare parts are not available for the animal-traction implements required. Second, mother-baby trials and training on legume-maize rotation have been provided, but bean seed is not readily available. Similarly, farmers have been trained on postharvest processing techniques, but communities cannot implement the training due to lack of storage facilities. Therefore, in some cases, dissatisfaction with or low usefulness ratings of extension services may not be about the service per se but because of preformed opinions of the service providers or because other inputs, services, or facilities needed to follow the recommendations are not available. Whether it is the weak quality of extension services or a lack of complementary inputs and services that limits the impact of agricultural advice on farm productivity and food security is a research question that can be further explored.

[7] Given that only a few households in the IHPS (2010, 2013) reported having received advice from lead farmers, we could not statistically test whether advice from lead farmers was rated more or less favorably than advice from other sources. A glance at the percentages and ratings in Table 4.1 shows a relatively poor rating for advice from lead farmers in 2010 but an improvement in 2013.

Impact of Different Extension Delivery Methods on Farm Productivity and Food Security

We also tested the impact over time on farm productivity and rural households' dietary diversity of different dimensions of how and to whom extension messages were delivered—the source of advice (in particular, the government, electronic media, or multiple sources), the number of household members receiving advice from outsiders, the gender of household members receiving advice, and the delivery of marketing advice in addition to production-related advice. The results of these investigations are also shown in Table 6.3. The coefficient in the models for the dummy variable for government extension service is not significant. Therefore, households receiving advice from the government extension service do not have statistically different farm productivity and food security indicators than those not accessing the government extension service. The dummy variable for electronic media also is not significant, indicating that households that received agricultural advice through electronic media (particularly radio) do not have statistically different farm productivity and food security indicators than households not receiving advice from this source. The dummy variable for receipt of advice from more than one source is not significant, which means that households receiving advice from more than one source do not have statistically different productivity and food security than households receiving advice from only a single source or none at all.

The coefficient for the dummy variable for only one household member's receiving extension advice is not significantly different from that of more than one household member's receiving the advice. Households with more than one member receiving advice directly have similar levels of farm productivity and food security to those with only one member directly receiving advice. This finding is in contrast to successful cases of enterprises relying on family-based training presented in World Bank, FAO, and IFAD (2008). Still, the success of these ventures is not solely attributed to the family-based training because other factors may have contributed.

The coefficient for the dummy variable for only a female household member's receiving advice, and that for only a male, are not significantly different from the coefficient for both female and male members' receiving advice. Households with only female members or only male members directly receiving advice had similar levels of farm productivity and food security to those with both genders directly receiving advice. This finding does not support results from the study in eastern Democratic Republic of Congo by Lambrecht, Vanlauwe, and Maertens (2016) using fertilizer adoption as the outcome variable. The divergence may be due to the different outcome variables being explained. Advice (through any form of delivery) may have emphasized fertilizer and thereby had an effect on fertilizer adoption, but may not necessarily have had an effect on productivity and food security.

Last, the coefficient for the dummy variable for a household's receiving marketing advice in addition to production-related advice is significant and positive in the farm productivity models but not in the food security models.

7. CONCLUSIONS

The input subsidy (measured as the quantity of subsidized fertilizer received) shows mixed results, indicating its inconsistent impact on crop productivity and food security indicators. Access to extension services (measured in terms of reported receipt of agricultural advice from any source, modeled both as a binary response and as a measure of frequency of advice, as in hypothesis 1 above) in a particular year has no effect on productivity and food security in that same year, consistently across all models. However, when we further disaggregate access to agricultural advice into its perceived usefulness (as in hypothesis 2 above), we find that households that rated advice received as "not useful" had consistently lower productivity and food security measures than those that rated the advice they received as "very useful." This is consistent with the findings of earlier studies elsewhere (Ragasa et al. 2013) and has major implications for the need to provide relevant and useful agricultural extension services for a better chance of achieving agricultural development outcomes.

Analyses were also done to account for different types of households—between those that received the input subsidy and those that did not; between those with advice and without; and across regions, agroecological zones, asset quintiles, and the distribution of value of production. In all these different disaggregated models, access to advice was consistently not a significant factor in explaining productivity and food security measures. The positive effect of the input subsidy on productivity seems to be weakest among the poorest segments of the population (in the lowest decile of households by assets), indicating some limitation of the input subsidy as a tool for greater equality and poverty reduction.

In addition to testing hypothesis 1 on the frequency of receiving advice and hypothesis 2 on the quality of advice, this study did not find consistent evidence on the other four hypotheses (3–6) on modes of delivering agricultural advice. It seems that it is the quality or relevance of the advice and the satisfaction of farmers with the advice received that is important, not so much the type and method of delivery of the advice.

1. We did not find evidence that households accessing government extension services have greater productivity and food security than households not accessing government extension services. We did not find evidence that households that received agricultural advice through electronic media (particularly radio) have greater productivity and food security than households not receiving advice from electronic media. We did not find evidence that households receiving advice from more than one source have greater productivity and food security than households receiving advice from a single source or none at all.
2. We did not find evidence that households who have more than one member receiving advice directly from various sources have greater productivity and food security than households with only one member receiving advice directly.
3. We did not find evidence that households with both female and male members receiving advice directly from various sources have greater productivity and food security than households with either only a female or only a male receiving advice directly.
4. There is some evidence that households who received marketing advice in addition to production-related advice have greater crop productivity than those who did not receive marketing advice, but the effect does not extend to food security levels. This outcome may be consistent with promoting greater attention to extension services on nutrition, in addition to advice on agricultural production and marketing, to achieve a greater impact on food and nutrition security.

Other factors that consistently show significance in our models are the distances to the nearest road, market, and ADMARC outlet, indicating the importance of access to markets in improving agricultural productivity and food security. These findings support the argument for establishing rural growth centers and rural farmer service centers, because these institutions potentially contribute toward bringing much-needed services to remote rural communities. Herbicides are significant factors in increasing farm productivity. Hybrid seed varieties, hired labor, and credit significantly contribute to food security. Smallholder farmers may need to be organized into collective groups, such as cooperatives, in order to have better access to services and credit for sourcing hybrid seeds, chemicals, and hired labor. Education of the household head is consistently significant in explaining food security levels, indicating the importance of formal education or longer-term training, rather than short-term, ad hoc training.

From a data collection and research perspective, questions in surveys can be further improved to better capture farmers' satisfaction or their rating of the usefulness of the agricultural advice they receive. For example, follow-up open-ended questions can be asked to elicit more information on which aspects of the extension advice received were useful and which ones were not. For those who indicate they received advice, follow-up questions can include whether they acted upon it or not, and what specific aspect of the advice was followed. More in-depth qualitative interviews can also be useful in better understanding which advice or aspects of advice were useful and which ones were not, from the perspective of different types of rural households. Moreover, additional questions can be used to understand whether dissatisfaction with or a low opinion of the usefulness of extension services may be about the extension service per se; about a preformed opinion of the service provider; or about the unavailability of complementary inputs, services, or facilities needed to follow the recommendations. Any one or a combination of these constraints will have different policy implications.

REFERENCES

Adams, R., H. Almeida, and D. Ferreira. 2009. "Understanding the Relationship between Founder-CEOs and Firm Performance." *Journal of Empirical Finance* 16: 136–150.

Arimond, M., and M. T. Ruel. 2002. "Dietary Diversity Is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys." *Journal of Nutrition* 134 (10): 2579–2585.

Bindlish, V., and R. Evenson. 1993. *Evaluation of the Performance of T&V Extension in Kenya.* Technical Paper 208, Africa Technical Department Series. Washington, DC: World Bank.

Birkhaeuser, D., R. E. Evenson, and G. Feder. 1991. "The Economic Impact of Agricultural Extension: A Review." *Economic Development and Cultural Change* 39: 610–650.

Chamberlain, G., 1984. "Panel Data." In *Handbook of Econometrics.* Vol. 2, edited by *Z.* Grilliches and M. D. Intriligator, 1247–1318. Amsterdam: North Holland.

Chibwana, C., M. Fisher, and G. Shively. 2012. "Cropland Allocation Effects of Agricultural Input Subsidies in Malawi." *World Development* 40 (1): 124–133.

Chibwana, C., G. Shively, M. Fisher, C. Jumbe, and W. Masters. 2014. "Measuring the Impacts of Malawi's Farm Input Subsidy Program." *African Journal of Agricultural and Resource Economics* 9 (2): 132–147.

Chirwa, E. W. 2005. "Adoption of Fertiliser and Hybrid Seeds by Smallholder Maize Farmers in Southern Malawi." *Development Southern Africa* 22 (1): 1–12.

Chowa, C., C. Garforth, and C. Cardey. 2013. "Farmer Experience of Pluralistic Agricultural Extension, Malawi." *The Journal of Agricultural Education and Extension* 19 (2): 147–166.

de Janvry, A., M. Fafchamps, and E. Sadoulet. 1991. "Peasant Household Behavior with Missing Markets: Some Paradoxes Explained." *Economic Journal* 101: 1400–1417.

de Janvry, A., and E. Sadoulet. 2006. "Progress in Modeling of Rural Households' Behavior under Market Failures." In *Poverty, Inequality and Development*. Vol. 2, edited by A. de Janvry and R. Kanbur, 155–181. New York: Springer.

Denning, G., P. Kabambe, P. Sanchez, A. Malik, R. Flor, R. Harawa, P. Nkhoma, C. Zamba, C. Banda, C. Magombo, M. Keating, and J. Wangila. 2009. "Input Subsidies to Improve Smallholder Maize Productivity in Malawi: Toward an African Green Revolution." *PLoS Biology* 7 (1): e1000023.

Dinar, A., G. Karagiannis, and V. Tzouvelekas. 2007. "Evaluating the Impact of Agricultural Extension on Farms' Performance in Crete: A Nonneutral Stochastic Frontier Approach." *Agricultural Economics* 36: 135–146.

Dorward, A., and E. Chirwa. 2011. "The Malawi Agricultural Input Subsidy Program: 2005–6 to 2008–9." *International Journal of Agricultural Sustainability* 9: 232–247.

Ecker, O., and M. Qaim. 2011. Analyzing Nutritional Impacts of Policies: An Empirical Study for Malawi. *World Development* 39: 412–428.

Gautam, M., and J. R. Anderson. 1999. *Reconsidering the Evidence on Returns to T&V Extension in Kenya*. Policy Research Working Paper 2098. Washington, DC: World Bank.

Greene, W. 1997. *Econometric Analysis,* 3rd ed. Upper Saddle River, NJ, US: Prentice-Hall.

Hoddinott, J., and Y. Yohannes. 2002. *Dietary Diversity as a Household Food Security Indicator.* Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Holden, S. T., and R. Lunduka. 2010a. *Impacts of the Fertilizer Subsidy Program in Malawi: Targeting, Household Perceptions and Preferences.* Noragric Report 54. Ås, Norway: Department of Economics and Resource Management, Norwegian University of Life Sciences.

———. 2010b. *Too Poor to Be Efficient? Impacts of the Targeted Fertilizer Subsidy Program in Malawi on Farm Plot Level Input Use, Crop Choice and Land Productivity.* Noragric Report 55. Ås, Norway: Department of Economics and Resource Management, Norwegian University of Life Sciences.

Imbens, G., and J. Wooldridge. 2007. “What’s New in Econometrics?” Paper presented at National Bureau of Economic Research Summer Institute, Cambridge, MA, US: July 30–August 1. Accessed January 5, 2012. www.nber.org/minicourse3.html.

Javdani, M. 2012. “Malawi's Agricultural Input Subsidy: Study of a Green Revolution–Style Strategy for Food Security.” *International Journal of Agricultural Sustainability* 10 (2): 150–163.

Kalirajan, K. P., and R. T. Shand. 1985. “Types of Education and Agricultural Productivity: A Quantitative Analysis of Tamil Nadu Rice Farming.” *Journal of Development Studies* 21: 232–243.

Kampani, A. A. 2011. “Assessing Smallholder Farmer Knowledge and Use of Soybean Production Practices and the Contributing Factors in Chitekwere EPA, Lilongwe, Malawi.” MS thesis, Bunda College, University of Malawi, Lilongwe.

Khaila, S., F. Tchuwa, S. Franzel, and S. Simpson. 2015. *The Farmer-to-Farmer Extension Approach in Malawi: A Survey of Lead Farmers.* ICRAF Working Paper No. 189. Nairobi: World Agroforestry Centre.

Kilic, T., A. Palacios-Lopez, and M. Goldstein. 2013. *Caught in a Productivity Trap: A Distributional Perspective on Gender Differences in Malawian Agriculture.* Policy Research Working Paper 638. Washington, DC: World Bank.

Knorr, J., M. G. Benyata, and V. Hoffmann. 2007. *The History of Agricultural Extension in Malawi*. Weikersheim, Germany: Margraf.

Lambrecht, I., B. Vanlauwe, and M. Maertens. 2016. “Agricultural Extension in Eastern DR Congo: Does Gender Matter?” *European Review of Agricultural Economics,* forthcoming.

Lunduka, R., J. Ricker-Gilbert, and M. Fisher. 2013. “What Are the Farm-Level Impacts of Malawi’s Farm Input Subsidy Program? A Critical Review.” *Agricultural Economics* 44: 563–579.

Maguza-Tembo, M. M. 2010. “The Effectiveness of Farmer-to-Farmer Extension: A Case Study of Lobi and Mlomba Extension Planning Areas in Dedza and Lilongwe Districts, Malawi.” MSc thesis, Bunda College, University of Malawi, Lilongwe.

Malawi, MoAI (Ministry of Agriculture and Irrigation [currently named as MoAIWD]). 2000. *Agricultural Extension in the New Millennium: Towards Pluralistic and Demand-driven Services in Malawi.* Policy Document. Lilongwe, Malawi

Malawi, NSO (National Statistical Office). 2014. *Integrated Household Panel Survey 2010–2013: Household Socio-economic Characteristics Report*. Zomba, Malawi.

———. 2014b. Integrated Household Panel Survey 2010–2013 data. http://www.nsomalawi.mw/component/content/article/3-reports/211-integrated-household-panel-survey-ihps-2013.html. Zomba, Malawi.

Masangano, C., and C. Mthinda. 2012. *Pluralistic Extension System in Malawi*. IFPRI Discussion Paper 01171. Washington, DC: International Food Policy Research Institute.

MEAS (Modernizing Extension and Advisory Services). 2012. *Strengthening Pluralistic Agricultural Extension in Malawi: Report on the MEAS Rapid Scoping Mission*. East Lansing, MI, US: Michigan State University.

Mundlak, Y., 1978. On the Pooling of Time Series and Cross Section Data. *Econometrica* 46: 69–85.

Owens, T., J. Hoddinott, and B. Kinsey. 2003. “The Impact of Agricultural Extension on Farm Production in Resettlement Areas of Zimbabwe.” *Economic Development and Cultural Change* 51 (2): 337–357.

Peterman, A., A. Quisumbing, J. Behrman, and E. Nkonya. 2011. “Understanding the Complexities Surrounding Gender Differences in Agricultural Productivity in Nigeria and Uganda.” *Journal of Development Studies* 47 (10): 1482–1509.

Ragasa, C., G. Berhane, F. Tadesse, and A. S. Taffesse. 2013. “Gender Differences in Access to Extension Services and Agricultural Productivity.” *The Journal of Agricultural Education and Extension* 19 (5): 437–468.

Ragasa, C., J. Mazunda, and M. Kadzamira. 2015. *The National Extension Policy of Malawi—Lessons from Implementation.* Malawi Strategy Support Program Policy Note 23. Washington, DC: International Food Policy Research Institute.

Ricker-Gilbert, J., T. S. Jayne. 2011. *What Are the Enduring Effects of Fertiliser Subsidy Programs on Recipient Farm Households? Evidence from Malawi.* Department of Agricultural, Food and Resource Economics Staff Paper 2011-09. East Lansing: Michigan State University.

———. 2012. "Do Fertilizer Subsidies Boost Staple Crop Production and Reduce Poverty across the Distribution of Smallholders in Africa? Quantile Regression Results from Malawi." Paper presented at International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, August 18–24. Accessed March 2013. http://iaae.confex.com/iaae/iaae28/webprogram/Paper16263.html.

Ruel, M. T. 2002. *Is Dietary Diversity an Indicator of Food Security or Dietary Quality? A Review of Measurement Issues and Research Needs.* Food Consumption and Nutrition Division Discussion Paper 140. Washington, DC: International Food Policy Research Institute.

Seyoum, E. T., G. E. Battese, and E. M. Fleming. 1998. "Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: A Study of Farmers within and outside the Sasakawa–Global 2000 Project." *Agricultural Economics* 19: 341–348.

Singh, I., L. Squire, and J. Strauss, eds. 1986. *Agricultural Household Models: Extensions, Applications and Policy*. Washington, DC: The World Bank; Baltimore, MD: Johns Hopkins University Press.

Smale, M., M. Moursi, and E. Birol. 2015. "How Does Adopting Hybrid Maize Affect Dietary Diversity on Family Farms? Micro-evidence from Zambia." *Food Policy* 52: 44–53.

Snapp, S. S., T. S. Jayne, W. Mhango, T. Benson, and J. Ricker-Gilbert. 2014. "Maize-Nitrogen Response in Malawi's Smallholder Production Systems." Paper presented at National Symposium on Eight Years of FISP—Impact and What Next? Lilongwe, Malawi, July 14–15.

Stock, J. H., and M. W. Watson. 2003. *Introduction to Econometrics*. Boston, MA: Addison-Wesley.

Swindale, A., and P. Bilinsky. 2006. *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*, version 2. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Tchale, M. S. C. 2012. "The Role of Orphan Crops in Smallholder Farming Systems in Simulemba, Malingunde and Chapananga in Malawi." MS thesis, Bunda College, University of Malawi, Lilongwe.

Van Dusen, M. E., and J. E. Taylor. 2005. "Missing Markets and Crop Biodiversity: Evidence from Mexico." *Environment and Developmental Economics* 10 (4): 513–531.

Verbeek, M. 2004. *A Guide to Modern Econometrics*, 2nd ed. West Sussex, UK: Wiley.

Wooldridge, J. 2002. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA, US: MIT Press.

———. 2008. "Quasi-maximum Likelihood Estimation and Testing for Nonlinear Models with Endogenous Explanatory Variables." Unpublished working paper, Michigan State University, East Lansing, MI, US.

Working Group on Infant and Young Child Feeding Indicators. 2006. *Developing and Validating Simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing Countries: Summary of Findings for Analysis of 10 Data Sets.* Washington, DC: Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development.

World Bank, FAO (Food and Agriculture Organization of the United Nations), and IFAD (International Fund for Agricultural Development). 2008. *Gender in Agriculture Sourcebook*. Washington, DC: World Bank.

Young, D., and H. Deng. 1999. "The Effects of Education in Early-Stage Agriculture: Some Evidence from China." *Applied Economics* 31: 1315–1323.

RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to www.ifpri.org/pubs/pubs.htm#dp.
All discussion papers can be downloaded free of charge.

1497. *Ghana's macroeconomic crisis: Causes, consequences, and policy responses.* Stephen D. Younger, 2016.

1496. *Temporary and permanent migrant selection: Theory and evidence of ability–search cost dynamics.* Joyce J. Chen, Katrina Kosec, and Valerie Mueller, 2015.

1495. *The effect of insurance enrollment on maternal and child healthcare use: The case of Ghana.* Gissele Gajate-Garrido and Clement Ahiadeke, 2015.

1494. *Stories of change in nutrition: A tool pool.* Stuart Gillespie and Mara van den Bold, 2015.

1493. *Optimal tariffs with smuggling: A spatial analysis of Nigerian rice policy options.* Michael Johnson and Paul Dorosh, 2015.

1492. *Smallholders and land tenure in Ghana: Aligning context, empirics, and policy.* Isabel Lambrecht and Sarah Asare, 2015.

1491. *Returns to agricultural public spending in Africa South of the Sahara*. Samuel Benin, 2015.

1490. *Lost in translation: The Fractured conversation about trade and food security*. Eugenio Díaz-Bonilla, 2015.

1489. G*ender roles and food safety in 20 informal livestock and fish value chains.* Delia Grace, Kristina Roesel, Erastus Kang'ethe, Bassirou Bonfoh, and Sophie Theis, 2015.

1488. *Farm household typologies and mechanization patterns in Nepal Terai: Descriptive analysis of the Nepal Living Standards Survey*. Hiroyuki Takeshima, Rajendra Prasad Adhikari, Mahendra Nath Poudel, and Anjani Kumar, 2015.

1487. *Public-private partnerships and the reduction of undernutrition in developing countries.* John Hoddinott, Stuart Gillespie, and Sivan Yosef, 2015.

1486. *How does women's time in reproductive work and agriculture affect maternal and child nutrition?: Evidence from Bangladesh, Cambodia, Ghana, Mozambique, and Nepal.* Hitomi Komatsu, Hazel Jean L. Malapit, and Sophie Theis, 2015.

1485. *US maize data reveals adaptation to heat and water stress*. Timothy S. Thomas, 2015.

1484. *Customary tenure and innovative measures of safeguarding land rights in Africa: The community land initiative (iniciativa de terras comunitárias) in Mozambique*. Hosaena Ghebru, Raul Pitoro, and Sileshi Woldeyohannes, 2015.

1483. *The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model description for version 3*. Sherman Robinson, Daniel Mason-D'Croz, Shahnila Islam, Timothy B. Sulser, Richard Robertson, Tingju Zhu, Arthur Gueneau, Gauthier Pitois, and Mark Rosegrant, 2015.

1482. *Enhancing food security in South Sudan: The role of public food stocks and cereal imports.* Paul A. Dorosh, Shahidur Rashid, Abigail Childs, and Joanna van Asselt, 2015.

1481. *Gender, headship, and the life cycle: Landownership in four Asian countries.* Kathryn Sproule, Caitlin Kieran, Agnes Quisumbing, and Cheryl Doss, 2015.

1480. *The food-energy-water security nexus: Definitions, policies, and methods in an application to Malawi and Mozambique.* Thea Nielsen, Franziska Schunemann, Emily McNulty, Manfred Zeller, Ephraim Nkonya, Edward Kato, Stefan Meyer, Weston Anderson, Tingju Zhu, Antonio Queface, and Lawrence Mapemba, 2015.

1479. *The making of public investments: Champions, coordination, and characteristics of nutrition interventions*, Tewodaj Mogues and Lucy Billings, 2015.

1478. *The dynamics of smallholder marketing behavior: Explorations using Ugandan and Mozambican panel data.* Bjorn Van Campenhout, 2015.

1477. *Adjusting to external shocks in small open economies: The case of Honduras.* Samuel Morley and Valeria Piñeiro, 2015.

1476. *Drivers of growth in agricultural returns to scale: The hiring in of tractor services in the Terai of Nepal.* Hiroyuki Takeshima, 2015.

1475. *The contribution of increased equity to the estimated social benefits from a transfer program: An illustration from PROGRESA.* Harold Alderman, Jere R. Behrman, and Afia Tasneem, 2015.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ABUJA OFFICE

No 6/Plot 1413 Ogbagi Street
Off Oro-Ago Crescent
Cadastral Zone II
Garki, Abuja
Nigeria
+08.03.587.0332
Email: ifpri-abuja@cgiar.org