World Development Vol. 40, No. 1, pp. 124–133, 2012

0305-750X/$ - see front matter
ELSEVIER
www.elsevier.com/locate/worlddev
doi:10.1016/j.worlddev.2011.04.022

Cropland Allocation Effects of Agricultural Input Subsidies in Malawi

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Summary. — We measure the impacts of Malawi's Farm Input Subsidy Program on the cropland allocation decisions of farmers in Kasungu and Machinga districts in central and southern Malawi. Using a two-step regression strategy to control for endogenous selection into the program, we find positive correlations between participation in the program and the amount of land planted with maize and tobacco. Furthermore, results suggest that participating households simplified crop production by allocating less land to other crops (e.g., groundnuts, soybeans, and dry beans). Our findings have implications for policies aimed at promoting both food self-sufficiency and crop diversification in low income settings.

Key words — Africa, farm input subsidy program, land allocation, crop diversification, Malawi

1. INTRODUCTION

The land allocation decisions of smallholder farmers, including decisions to adopt improved crop varieties, have interested researchers and policy makers for decades (Feder, 1980; Just & Zilberman, 1983). This paper examines the cropland allocation effects of a widely administered agricultural input subsidy program – Malawi's Farm Input Subsidy Program (FISP). Malawi, like several other countries in sub-Saharan Africa, phased out agricultural input subsidy programs in the 1990s, but reintroduced them in recent years to boost grain yields, enhance rural incomes, and promote food self-sufficiency. Malawi's return to large-scale input subsidies for maize and tobacco occurred in the 2005–06 agricultural season when the country first implemented the FISP.

To date, the FISP has been administered through a series of vouchers that enable households to purchase fertilizer, hybrid seed, and/or pesticides at greatly reduced prices (Dorward & Chirwa, 2009). In the 2008–09 growing season – the period covered by this study – the Ministry of Agriculture distributed coupons to districts, and traditional authorities (TAs) then allocated them to villages. Village heads, in collaboration with Village Development Committees (VDCs), were tasked with identifying beneficiary households within their jurisdictions that would receive a maize voucher and, in some cases, a tobacco voucher. To be eligible, households had to be bona fide residents of the village and own land that would be cultivated during the agricultural season. Priority was to be given to vulnerable households, especially those headed by children and women. In practice, there appears to have been great variation in the selection criteria applied at the local level, the number of beneficiaries, and the number of coupons that were received by each household (Dorward *et al.*, 2008).

In 2008–09, each voucher entitled a beneficiary household to 50 kg of maize fertilizer at 8% of the prevailing market price, and 2 kg of hybrid maize seed (or 4 kg of open pollinated maize) for free. Some households also received coupons entitling them to 50 kg of tobacco fertilizer, again at a subsidized price. A total of 150,000 tons of maize fertilizer and 20,000 tons of tobacco fertilizer were acquired by the government for distribution to smallholder farmers. The program cost around MK31 billion (MK140 = US$1), 95% of which was financed through the government budget and 5% by Malawi's development partners.

Despite widespread agreement that improved inputs are essential for the growth of agricultural productivity and poverty reduction, input subsidies such as Malawi's remain controversial, largely due to their high financial and opportunity costs (Dorward *et al.*, 2008; Minot & Benson, 2009). Concerns that they displace purchases of commercial inputs have also been raised (see Ricker-Gilbert, Jayne, & Chirwa, 2011; Xu, Burke, Jayne, & Govereh, 2009). A further concern is that input subsidies might encourage farmers to concentrate on a few crops, which is at cross-purposes with the objective of many governments and international development agencies to promote diversification of crop production. As Harrigan (2008) points out, previous input subsidy programs in Malawi have been criticized for creating and perpetuating widespread dependency on maize (although this specific issue has not been investigated empirically). On a more positive note, Fisher and Shively (2005) report evidence that such subsidies may have unintended benefits, such as reducing forest pressure by encouraging agricultural intensification.

* This research was made possible, in part, through support provided by the Norman E. Borlaug International Agricultural Science and Technology Fellows Program and the Bureau of Economic Growth, Agriculture and Trade, US Agency for International Development through the BASIS Assets and Market Access Collaborative Research Support Program. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the sponsoring agency. We thank Stein Holden, Charles Jumbe, Rodney Lunduka, Will Masters, John Mazunda and Sieglinde Snapp for helpful comments, suggestions, and support. Final revision accepted: March 18, 2011.

The dominant trend among commercial and smallholder farm sectors in sub-Saharan Africa has been a shift toward a few crops that meet caloric needs and take advantage of market opportunities (Akinnifesi, Makumba, Sileshi, Ajayi, & Mweta, 2007; Byerlee & Eicher, 1997). For example, Snapp, Kanyama-Phiri, Kamanga, Gilbert, and Wellard (2002) indicate that smallholders in Malawi have moved somewhat in recent years toward monoculture maize systems. Although cereal specialization can help a farm household to increase its calorie availability and income, it can also introduce tradeoffs between maintaining soil fertility and managing weather-related agricultural risks. Simplified cereal-based cropping systems with minimal inputs (average fertilizer use in sub-Saharan Africa is 13 kg/ha, compared to 94 kg/ha in the developing world, overall; Food and Agriculture Organization, 2010) are associated with severe reductions in soil nutrients (Snapp, Rohrbach, Simtowe, & Freeman, 2002). Moreover, monoculture cropping systems may increase the vulnerability of farmers to climate variability and change. Farmers in Africa have historically diversified their cropping systems to self-insure against effects of adverse weather, as different crops are affected differently by weather events (Adger, Huq, Brown, Conway, & Hulme, 2003; Di Falco, Bezabih, & Yesuf, 2010; Di Falco & Chavas, 2009). Cultivating several crop species can help smallholders to manage price and production risk (Baumgärtner & Quaas, 2008; Di Falco & Chavas, 2009), and in moisture-stressed, ecologically-fragile agricultural systems, crop diversification also can be a viable strategy to increase farm-level productivity (Di Falco *et al.*, 2010).

We investigate whether farm input subsidies influence smallholder farmers' decisions to simplify or diversify their cropping patterns using data from a 2009 household survey in Malawi. A total of 380 households were randomly selected from 35 villages in Kasungu District (in the central region of Malawi) and Machinga District (in the southern region). These villages, with an average population of 118 households, were purposively selected as a follow-up to a 2002 survey designed to measure the impacts of a forest co-management project (see Jumbe, 2005). Our 2009 survey revisited these villages and households. The original villages were selected at random within a larger population of villages adjacent to forest reserves and the sample frame was developed in conjunction with senior staff from the Forest Department, District Forestry Offices, and the Forestry and Research Institute of Malawi (FRIM). Given the goals of the original sample selection process, and, therefore, the selection criteria for the data used here, this sample should not be considered fully representative of smallholder farmers in Malawi. Nevertheless, the sample households do possess a broad range of characteristics that are broadly shared in rural areas of Malawi, and, therefore, provide important insights regarding the Farm Input Subsidy Program, which was rolled-out nationwide. Households were interviewed in Chichewa, Malawi's national language, by trained local enumerators using a structured questionnaire.

Although similar in many respects, the two districts covered by our survey do differ in several important ways. For example, Malawi's National Statistics Office estimates that, in 2005, 66% of households in Kasungu were employed in agriculture compared to 33% in Machinga. And while the primary occupation in both study sites is agriculture, Machinga's closer proximity to major trading centers provides households with a somewhat wider range of livelihood activities (e.g., selling firewood, charcoal and curios). In contrast, burley tobacco production and the production of legumes (soybean and groundnuts) are the major sources of cash income for households in Kasungu. Agricultural production is also more diversified in Kasungu where farmers reported allocating 40% of their land to other crops (namely groundnuts, soybean, cassava, vegetables, and sweet potato). Only 20% of farmers' land was allocated to these other crops in Machinga, whereas 76% of the land on average was used to produce maize. These district level differences provide some scope, therefore, for studying the role of external market forces in shaping household response to the FISP.

We study the effect of the program using a two-stage, instrumental variables regression approach, because program participation cannot be interpreted as exogenously determined. Although conceived as a targeted program with exogenous selection criteria, Malawi's FISP has been criticized for uneven roll out and widespread leakage (Dorward *et al.,* 2008; Holden & Lunduka, 2010a; Ricker-Gilbert *et al.*, 2011). In some instances selection criteria appear to have been ignored or adjusted to meet local goals. Moreover, the subsidies received by beneficiaries have been heterogeneous, consisting of either seed or fertilizer, or a combination of the two. The two-stage regression approach accounts for the latent characteristics of participants, and provides a clear perspective on the pathway by which the FISP changed cropland allocation. Our results suggest that the program induced participating households to allocate more land to tobacco and maize. On average, households that received coupons for maize or tobacco inputs allocated 16% and 46% more land to maize and tobacco, respectively, than households that did not receive a coupon. Furthermore, participating households simplified their crop mosaic by allocating 21% less land to other crops.

2. EMPIRICAL APPROACH

We use a two-step approach to examine impacts of the FISP on cropland allocation. In step one, selection into the program is treated as endogenous and conditional on household- and village-specific factors. A multinomial logistic (MNL) regression is used to predict the probability of participation in mutually exclusive categories of the program for maize. [1] A separate probit regression is used to predict the probability of participation in the tobacco program. The same explanatory variables are used in both regression models, which take the form:

$$C_{ijk} = \beta_0 + \beta_1 Z_i + \beta_2 S_i + \beta_3 P_i + \beta_4 V_j + \beta_5 D_k + \varepsilon_{ijk}. \quad (1)$$

In Eqn. (1), the dependent variable C is, alternately, participation in the maize program or participation in the tobacco program by household i in village j and region k. Vector $\boldsymbol{Z}$ represents household socio-demographic and economic factors that could influence coupon receipt, including the age, gender, and education of the household head; the number of household residents; the size of the household's landholding; and the wealth position of the household. The maize subsidy program was intended to benefit the most vulnerable farm households in each community, as well as those having sufficient land to make use of the subsidized seed and fertilizer. The model, therefore, includes variables for farm size and farm size squared, because households with very small landholdings would not be eligible, and those with very large landholdings would be considered too well off to be eligible.

Variable S represents the household's social capital, measured as the number of years the household head had resided in the village. We assume that the longer the householder was a village resident, the more likely he or she would have been recognized by the village chief and the Village Development Committee during coupon distribution. Vector $\boldsymbol{P}$ represents participation in the subsidy program during the previous season, which could increase or decrease a household's chances of receiving coupons in the current season. V is a variable for the population of the village. Since the inception of the FISP in 2005, a number of new, small villages have arisen, many as breakaways from larger villages. While some natural growth in the number of villages is to be expected, the recent rate of village formation has been much higher than before the subsidy program. Some of these new villages consist entirely of family members of the new village heads, who seek to control coupon distribution to benefit their own extended families. Some of the new villages were not recognized by the local District Assembly and were less likely to receive coupons. We hypothesize that residents of old, larger villages had a higher probability of receiving coupons than residents of small, newly established villages. D is a binary variable, indicating whether the household resided in Kasungu District. Finally, ε is an error term, representing random and unobservable factors at the household, village, and district level.

Identifying the cropland allocation equations requires including at least one variable in the participation equations that does not enter the cropland allocation equations. For identification, we use several variables which we hypothesize affect participation in the FISP, but which do not directly affect the household's decision on cropland allocation: participation in the subsidy program during the previous season and tenure of residence in the village. To test for the validity of the identifying variables, we included them as regressors in the land share regressions and found that their estimated coefficients were not statistically different from zero.

Step two of the analysis relies on a series of follow-on regressions for land use. The dependent variables are the shares of land allocated (L) to maize (traditional, improved, or a combination), tobacco, and other crops (groundnuts, beans, and all other annual crops).[2] Tobit models are used to account for the fact that some households had zero land shares for some crops. The regressions take the form:

$$L_{ij} = \gamma_0 + \gamma_1 H_i + \gamma_2 p_{ij} + \gamma_3 \theta_i + \gamma_4 W_i + \gamma_5 S_i + \gamma_6 F_i + \gamma_7 C_i^* + \gamma_8 D_k + v_{ij}. \quad (2)$$

Vector $\boldsymbol{H}$ in Eqn. (2) represents household characteristics, including age, gender, and education of the household head; labor availability; farm size; the household's wealth position; and household food security status. Age is assumed to be an indicator of farming experience. Labor availability is estimated as the number of adults, age 15 years and older, residing in the household. A household food security indicator is included. This binary variable equals one if the household purchased more maize than it sold in the previous agricultural season. If all other factors remained the same, one would expect that households which faced a maize deficit in 2008 would allocate a greater share of land to maize in 2009, that is, during the subsequent planting season that serves as our unit of analysis.

In Eqn. (2), $\boldsymbol{p}$ is a vector of household-specific crop prices. We use observed household-level prices (in MK/kg) for maize, tobacco, and other crops from the 2008 agricultural season, observed immediately prior to cropland allocation decisions. The reported selling price of maize is used for households classified as net sellers of maize. We follow the World Food Programme (2009) definition and identify a household as a net buyer of maize if in 2008 it purchased more maize than it sold. In this case we use as our value the reported purchase price of maize during the most recent calorie shortfall period. Village average prices are used for self-sufficient households, that is, those that reported no purchases or sales of maize and, therefore, no maize price. The prices of other crops are computed as village-level, value-weighted averages of sale prices of ten crops marketed by households (groundnuts, soybean, cowpea, dry beans, cassava, sweet potato, sunflower, sorghum, millet, and pigeon peas).

We use observed prices to test the widely-held conjecture that smallholder farmers in Malawi do not respond to market prices when making land allocation decisions. Conclusions of previous studies of responses of smallholder farmers to output price signals have been inconsistent. Arslan (2008) concluded that subsistence farmers do not respond to market prices in making land allocation decisions, because they attach nonmarket values to traditional maize varieties. Arslan's model indicates that shadow prices for maize explain land allocation decisions better than market prices. Although some studies have found a positive relationship between crop choice and crop prices, others have attributed unexpected responses to nonmarket values of maize (Berthaud & Gepts, 2004; Dyer-Leal & Yunez-Naude, 2003). De Janvry, Sadoulet, and De Anda (1995) argue that net sellers of maize respond to market prices for maize, and that such households respond to falling maize prices by diversifying to other high-value crops.

Since maize dominates in the diets of most Malawians, our model includes a variable representing the household's relative subsistence maize requirement (θ), which we compute based on the number and ages of household members, using calorie requirement estimates from the Malawi Government. The relative subsistence requirement is calculated as the ratio of the household subsistence requirement (kg) to total farm size (hectares). Households with a higher relative subsistence requirement might be expected to allocate a larger proportion of land to maize production. Holden and Lunduka (2010b) show that the land-poor in Malawi have larger maize area shares. However, Smale, Just, and Leathers (1994) found that Malawian households with higher relative subsistence requirements allocated a smaller proportion of their land to maize.

Variable W in Eqn. (2) represents the proportion of households in household i's village that have off-farm income. This variable indicates the local availability of off-farm income opportunities that could compete with crop production for labor. We exclude household i when computing this index to purge it of correlation with the household error term.

Vector $\boldsymbol{S}$ represents idiosyncratic shocks experienced by the household during the 12 months immediately prior to the start of the current agricultural season. Three binary shock variables are included. The first corresponds to shocks that affected labor supply in the household: sickness, injury, or death of an adult member, or any combination of those shocks. Labor-reducing shocks are expected to affect cropland allocation directly because some crops – tobacco in particular – are labor intensive. The second variable signals shocks that directly impact crop output: crop losses resulting from pests or diseases, theft of output, or a combination of those shocks. Although the output-related shocks might impact the allocation of cropland in the subsequent season, the expected effect is indeterminate. The third variable indicates financial loss, for example, through theft or other means. Financial losses dampen a household's ability to purchase inputs, but might also act as incentives to produce more high-value crops, such as tobacco.

Fertilizer is an important input in the production of improved varieties of both maize and tobacco, and the second stage analysis includes price variables (MK/kg) for maize and tobacco fertilizers $\boldsymbol{F}$. Farmers could be expected to shift away from a crop in response to a rise in the price of a required input, such as fertilizer. An average village-level purchase price was assumed for the 4% of households that did not report any price for fertilizer. Only 32% of households in the sample planted tobacco and applied tobacco fertilizer during the current season; average village-level prices are used for households that did not grow tobacco.

Vector C^{*} represents the variables affecting participation in the FISP, based on the predicted participation variables for maize and tobacco, derived from the first-stage MNL and probit regressions. Because the FISP targeted maize and tobacco, receipt of coupons in 2009 can be expected to increase the proportions of land allocated to these crops. [3] Variable D is a binary location variable that controls for broad agronomic and economic features of the landscape. Table 1 presents descriptive statistics for all variables used in the two-stage regression model.

3. MODEL RESULTS AND DISCUSSION

(a) *Results for FISP participation*

Results of the MNL and probit regression models suggest that the most vulnerable people in the Malawian communities were not the main recipients of FISP coupons (Table 2). For example, households with female heads were intended to be targeted, but in actuality, were less likely than male-headed households to benefit from the program. Furthermore, asset-poor households were more likely to receive no coupon than better-off households, which is consistent with reports by Ricker-Gilbert *et al.* (2011) and Xu *et al.* (2009) regarding subsidy beneficiaries in Malawi and Zambia, respectively.

The participation regression results reveal district-level differences in administration of the subsidy program: farmers in Kasungu District were more likely to receive coupons than

Table 1. *Values of variables used in the regression analyses*

Variable	Description	Mean	SD
Age	Age of household head (years)	46.84	14.88
Female-headed	Female headed household (1 = yes; 0 = no)	0.15	0.35
Education	Education level of household head (1 = some education; 0 = no education)	0.85	0.35
Household size	Number of residents in the household	6.33	2.77
Farm size	Total land owned by household (hectares)	1.63	1.46
Farm size squared	Square of total land owned by household (hectares^2)	11.82	31.34
Adults	Number of adults (aged 15 years and over)	3.34	1.67
Net buyer of maize	Household was a net buyer of maize in 2008 (0 = no, 1 = yes)	0.57	0.50
Poorest	Asset-poor household (0 = no, 1 = yes)	0.47	0.50
Residency	Number of years the household head has been resident in the village	35.70	17.17
Received tobacco fertilizer coupon in 2008	Household received tobacco fertilizer coupon in 2008 (0 = no, 1 = yes)	0.04	0.19
Received maize seed coupon in 2008	Household received maize seed coupon in 2008 (0 = no, 1 = yes)	0.05	0.21
Received maize fertilizer coupon in 2008	Household received maize fertilizer coupon in 2008 (0 = no, 1 = yes)	0.26	0.44
Received maize seed and fertilizer coupons in 2008	Received maize seed and fertilizer coupons in 2008 (0 = no, 1 = yes)	0.51	0.50
Kasungu	Household resides in Kasungu District (0 = no, 1 = yes)	0.56	0.50
Village size	Number of households in the village	117	79
Traditional maize share	Share of total land planted with traditional maize	0.38	0.29
Improved maize share	Share of total land planted with improved maize	0.25	0.27
All maize share	Share of total land planted with all maize	0.63	0.27
Tobacco share	Share of total land planted with tobacco	0.06	0.11
Other crops share	Share of total land planted with other crops	0.31	0.28
Maize price	Price of maize grain (MK/kg)	46.29	18.11
Tobacco price	Price of tobacco leaf (MK/kg)	227.98	42.83
Price of other crops	Weighted price of other crops (MK/kg)	54.82	11.39
Subsistence requirement	Household's maize subsistence requirement relative to farm size (kg/hectare)	1655	1578
Proportion with off-farm income	Proportion of households with off-farm income in household's village excluding farmer himself	0.47	0.15
Labor loss	Household experienced a labor loss in 2008 (1 = yes; 0 = no)	0.17	0.37
Crop loss	Household suffered crop loss in 2008 (1 = yes; 0 = no)	0.40	0.49
Financial loss	Household suffered financial loss in 2008 (1 = yes; 0 = no)	0.29	0.45
Maize seed coupon	Predicted probability of receiving a maize seed coupon only	0.06	0.09
Maize fertilizer coupon	Predicted probability of receiving a maize fertilizer coupon only	0.19	0.14
Maize seed and fertilizer coupons	Predicted probability of receiving both a maize seed coupon and a maize fertilizer coupon	0.62	0.20
Maize fertilizer price	Price of maize fertilizer (MK/kg)	53.32	54.53
Tobacco fertilizer price	Price of tobacco fertilizer (MK/kg)	106.60	57.70
No. of observations		380	

Table 2. *Regression results for participation*

Variable	Maize			Tobacco
	(1) Seed	(2) Fertilizer	(3) Both	(4) Fertilizer
Constant	0.159	−0.770	−0.816	−1.506**
	(0.194)	(−0.435)	(−0.543)	(−2.397)
Age (years)	−0.023***	0.0327**	0.0286**	−0.0124
	(−6.394)	(2.307)	(2.205)	(−0.695)
Female-headed (0 = no, 1 = yes)	−0.835	−0.588*	−0.970*	–
	(−0.660)	(−1.926)	(−1.875)	
Education (0 = none, 1 = some)	−0.188	−0.0554	0.294	0.468
	(−0.225)	(−0.972)	(0.947)	(1.515)
Household size (number)	−0.0311	−0.126***	−0.121*	−0.0244***
	(−0.231)	(−2.597)	(−1.684)	(−11.86)
Farm size (hectares)	−0.265***	−0.113	−0.0143	0.00579
	(−7.002)	(−0.332)	(−0.123)	(0.0997)
Farm size sq. (hectares^2)	0.0103***	−0.00438	−0.000919	0.00105
	(12.83)	(−0.244)	(−0.312)	(0.557)
Poorest (0 = no, 1 = yes)	−0.939***	−0.461	−0.562*	−0.456*
	(−3.752)	(−1.495)	(−1.673)	(−1.776)
Household resides in Kasungu (0 = no, 1 = yes)	1.034***	0.0781*	0.500***	0.746***
	(2.654)	(1.724)	(4.755)	(3.647)
Village size (# households)	−0.000285	0.00486	0.00583	0.000256
	(−0.0692)	(0.808)	(0.778)	(0.250)
Instrumenting variables				
Residency in village (years)	0.0141**	−0.00899	−0.00861***	0.00196
	(2.219)	(−0.604)	(−3.817)	(0.213)
Received tobacco fertilizer coupon in 2008 (0 = no, 1 = yes)	−0.848*	−15.53***	−0.597	1.454***
	(−1.904)	(−11.17)	(−1.278)	(3.124)
Received maize seed coupon in 2008 (0 = no, 1 = yes)	2.411***	1.179*	1.598	−1.048***
	(3.933)	(1.714)	(1.240)	(−11.34)
Received maize fertilizer coupon in 2008 (0 = no, 1 = yes)	1.015	2.298***	1.712	−0.266
	(0.826)	(16.44)	(1.454)	(−1.067)
Received maize seed and fertilizer coupons in 2008 (0 = no, 1 = yes)	0.768*	0.986	2.342***	−0.209***
	(1.689)	(1.444)	(8.940)	(−4.270)
No. of observations	23	71	235	30
Pseudo R^2		0.17		0.19

Note: Received no coupon is the base outcome, $n = 51$.
t statistics in parentheses.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

those in Machinga (Table 2). Despite the two districts receiving proportionately equal amounts of fertilizer, it is possible that more coupons were given to fewer people in Machinga during distribution at the village level.[4]

There appears to be continuity in the receipt of maize and tobacco coupons – households that received coupons during the previous agricultural season were more likely to receive the same coupons during the current season (Table 2). However, receipt of a tobacco coupon in the previous year is negatively correlated with a household's chances of receiving coupons for maize seed and fertilizer in the current year. A plausible explanation is that village chiefs broadly classified households as either maize producers or tobacco producers, and avoided distributing maize coupons to tobacco farmers and *vice-versa*.

(b) *Individual share regressions*

Results of the Tobit regressions for land shares are reported in Table 3. Results indicate that older household heads allocated more land to traditional maize than younger household heads. Conversely, educated household heads allocated less land to traditional maize than uneducated heads. Opposite patterns were found for improved varieties of maize, but the correlations are not significant. Households in which the head had some level of education allocated less land to maize and more to other crops than households where the head had no education. This finding might suggest that education improves understanding of the higher nutritional and agronomic value of some other crops, such as groundnuts and soybeans. Another conceivable explanation for the observed association between education and cropland allocation is that maize self-sufficiency is less important for households with an educated head because education increases opportunities to earn income from nonagricultural sources.

Regressions indicate that the proportion of land planted with improved maize is positively correlated with the number of working age adults in the household, which reflects the fact that the use of improved maize technology (hybrid maize and chemical fertilizers) accentuates seasonal peaks in labor demand (Byerlee & Heisey, 1996). This analysis excludes gender, due to high collinearity with receipt of a tobacco

Table 3. *Regression results for land shares*

Variables	Maize			Tobacco	Other crops
	Traditional (1)	Improved (2)	All maize (3)	(4)	(5)
Constant	0.466**	−0.289	0.481***	−0.0662	0.444***
	(2.054)	(−0.521)	(5.091)	(−0.150)	(22.31)
Age (years)	0.00291**	−0.00463	4.51e−06	−0.00243**	0.000806
	(2.472)	(−1.512)	(0.00355)	(−2.293)	(0.385)
Education (0 = none, 1 = some)	−0.0669*	0.0529	−0.0265	−0.00997	0.0505***
	(−1.965)	(0.722)	(−1.637)	(−0.262)	(62.44)
Number of adults	−0.00836	0.0294***	0.0111	0.0118	−0.0110
	(−0.422)	(162.7)	(1.041)	(0.610)	(−0.616)
Farm size (hectares)	−0.0122*	0.000243	−0.0171***	−0.0125***	0.0248***
	(−1.741)	(0.173)	(−2.700)	(−13.02)	(5.094)
Poorest (0 = no, 1 = yes)	0.0296	−0.0804***	−0.0206	−0.0618***	0.0572***
	(0.636)	(−4.619)	(−1.422)	(−3.518)	(3.502)
Net buyer of maize (0 = no, 1 = yes)	−0.0126	−0.0325***	−0.0463**	−0.0116	0.0789**
	(−0.801)	(−3.438)	(−2.582)	(−0.159)	(2.421)
Maize price (MK/kg)	0.00118***	−0.000359	0.000570*	−0.000104	−0.000903
	(4.773)	(−1.257)	(1.792)	(−0.0471)	(−1.436)
Tobacco price (MK/kg)	0.000127	0.000427***	0.000453***	−3.26e−05	−0.000591
	(1.204)	(9.125)	(9.726)	(−0.349)	(−1.643)
Price of other crops (MK/kg)	−0.00166	0.000929	−0.000635	0.00244	−0.000491
	(−0.239)	(0.116)	(−0.257)	(0.528)	(−0.192)
Subsistence requirement (kg/hectare)	8.32e−05	1.03e−06	8.69e−05***	−4.59e−05***	−2.34e−04***
	(1.611)	(0.0268)	(35.14)	(−4.270)	(−6.130)
Proportion with off farm income	−0.100	0.174	0.0628***	−0.322***	0.0329***
	(−0.617)	(0.818)	(2.976)	(−3.227)	(31.10)
Labor loss (0 = no, 1 = yes)	−0.00953	0.0512	0.00843	−0.0808***	0.0436
	(−0.131)	(0.688)	(0.453)	(−23.87)	(1.400)
Crop loss (0 = no, 1 = yes)	−0.0287***	0.0411***	0.0136	0.0111**	−0.0210
	(−3.619)	(2.640)	(0.804)	(2.463)	(−0.630)
Financial loss (0 = no, 1 = yes)	−0.0197	0.0420	0.00215	0.0431***	−0.0120
	(−0.377)	(0.780)	(0.285)	(6.276)	(−0.586)
Maize fertilizer price (MK/kg)	3.17e−05	3.40e−05	0.000133***	0.000483***	−0.000416***
	(0.146)	(0.158)	(36.60)	(4.856)	(−15.37)
Tobacco fertilizer price (MK/kg)	−0.000435	0.000440	−0.000288**	−0.000124***	0.000326**
	(−0.715)	(0.969)	(−2.501)	(−2.613)	(2.227)
Kasungu (0 = no, 1 = yes)	−0.0235	−0.125	−0.163***	0.0849***	0.206***
	(−0.236)	(−0.935)	(−5.142)	(5.379)	(6.534)
Participation variables					
Maize seed coupon	−0.302	0.989***	0.556***	−0.0625***	−0.650***
	(−1.233)	(8.779)	(3.167)	(−3.146)	(−2.858)
Maize fertilizer coupon	0.243	0.163	0.312**	−0.00326	−0.486
	(1.200)	(1.152)	(2.273)	(−0.0108)	(−1.282)
Maize seed and fertilizer coupons	−0.0923	0.454***	0.164***	0.119	−0.213***
	(−1.314)	(8.390)	(5.682)	(1.233)	(−9.573)
Tobacco fertilizer coupon	0.289	−0.357**	0.0581	0.464***	−0.307
	(0.675)	(−2.327)	(0.329)	(3.689)	(−1.125)
No. of observations	378	378	378	378	378
Log pseudolikelihood	−158.85	−191.00	4.22	−102.30	−161.31

Robust *t*-statistics in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

coupon. When the gender variable is included in the analysis, female-headed households appear to allocate more land to traditional maize than male-headed households, possibly because they have less capital to purchase the improved maize technology and participated in the FISP at relatively lower rates than male-headed households. Female-headed household heads might also attach nonmarket values to traditional maize. For example, some female farmers reported that the flint kernel on traditional maize makes it easier to process into flour than the dent kernel on improved maize, and produces a higher flour-to-grain ratio. Traditional maize is also less susceptible to storage pests, especially the large grain borer (Orr, 1998). Smale, Bellon, and Aguirre Gomez (2001) found that such varietal characteristics are of overriding importance in determining the proportions of maize varieties planted.

Households that were net buyers of maize in 2008 allocated less land to maize in the 2009 agricultural season. If those households chose to meet their maize consumption requirements from the market, their allocation of a larger fraction of land to other crops could be a strategy for optimizing income. Not surprisingly, the proportion of land allocated to improved maize is found to be negatively correlated with net buyer status. Since improved maize varieties are high yielding, households that allocate less land to such varieties and more land to traditional varieties are at greater risk of producing insufficient amounts and are more likely to be net buyers. Net buyer households also planted less tobacco and more other crops than net seller or self-sufficient households, suggesting that they used income derived from selling other crops to meet their maize subsistence requirements. Asset-poor households allocated a smaller proportion of their land to improved maize and tobacco, and a larger proportion to other crops, possibly because such households may lack the financial capital required to produce improved maize and tobacco, while the other crops, such as cassava and sweet potato, are less capital intensive.

The proportions of land allocated to maize and tobacco are negatively correlated with farm size. Alwang and Siegel (1999) found that farmers in Malawi aim for subsistence in maize, in part because the supply of maize is unreliable during periods of calorie shortfall. However, owning more land does not appear to induce the household to plant more maize. The area of land planted with tobacco might be constrained by the high cash cost associated with tobacco production. If so, households with large farms would be expected to allocate more land to less input-intensive crops, such as cassava, sweet potatoes, and soybeans. In fact, the proportion of land planted with other crops is positively correlated with farm size in our sample.

Results of the Tobit regressions indicate that the proportions of land allocated to traditional maize and all maize are positively correlated with the lagged price of maize. However, the same correlation for improved maize is not statistically significant. Given that the majority of the households surveyed were net buyers of maize, this result could indicate risk aversion by farmers who pursue self-sufficiency despite higher maize prices. As expected, farmers allocated less land to maize when the price of other crops was high, indicating that other food and cash crops are used as substitutes for maize. The price of tobacco is positively correlated with the shares of land allocated to improved maize and to all maize, suggesting that maize is grown as a food crop, and tobacco is grown as a complimentary cash crop. Orr (1998) observed that cash income from sales of burley tobacco was used to purchase fertilizer for improved maize, and concluded that these two crops represent a synergistic technology package that can improve household food security and generate additional cash income.

The results underscore a positive relationship between the share of land allocated to maize and the maize household subsistence requirement. Farmers are seen to allocate more land to maize if the total amount of maize required per year is high relative to their farm size, supporting Alwang and Siegel's (1999) observation that smallholder farmers in Malawi are subsistence-oriented. As expected, the share of land allocated to tobacco and other crops is negatively correlated with the subsistence requirement.

Farmers living in villages with more off-farm income opportunities planted a larger proportion of their land with maize. On the other hand, the amount of land allocated to tobacco is negatively correlated with off-farm opportunities. This is not surprising, as tobacco is a cash crop and, therefore, off-farm activity and tobacco production serve the same purpose. Farmers do not produce maize to generate cash income, but may use income from other sources to plant more maize. Alwang and Siegel (1999) found that off-farm income helps smallholders in Malawi to finance on-farm operations, although Fisher, Shively, and Buccola (2005) found evidence of labor substitution between crop and noncrop activities.

Households that experienced crop losses during the 12 months prior to the current cropping season allocated more land to improved maize and less land to traditional maize. The logic behind this finding is that losses due to drought, crop pests, or disease promote the use of improved maize varieties, most of which perform better under these conditions than traditional maize. A loss of labor in the 12 months prior to the current cropping season is found to be negatively correlated with the share of land planted with tobacco. A smallholder farm in Malawi requires 3053 h of labor to produce 1 hectare of burley tobacco (Orr, 1999). However, the proportion of land in tobacco is positively correlated with either a financial loss or a crop loss. This suggests that farmers may use high-value tobacco production to cope with short-term financial and physical crop losses.

The share of land planted with maize is positively correlated with the price of maize fertilizer. Since subsistence in maize is the main goal of smallholder farmers, they allocate land to maize, irrespective of the price of fertilizer. However, the share of land allocated to tobacco is also positively correlated with the price of maize fertilizer, and the share of land allocated to other crops is negatively correlated with maize fertilizer price.

Turning to the key policy variable of interest, participation in the FISP, in general we find that the proportions of land planted with maize and tobacco are positively correlated with participation in the program. Receipt of any maize coupon is significantly correlated with the share of land planted with maize. On average, farmers who received coupons for seed and fertilizer allocated 16% more land to maize than those who did not. Households receiving coupons also simplified crop production by allocating 21% less land to other crops. The share of land planted with improved maize shows a strong positive correlation with participation in the FISP. Farmers that received coupons for improved maize seed and maize fertilizer allocated 45% more land to improved maize than farmers that did not receive any coupons. The proportion of land planted with traditional maize is negatively (although not significantly) correlated with receipt of FISP coupons for maize. The share of land planted with tobacco is strongly and positively correlated with receipt of a coupon for tobacco fertilizer. Conversely, the share of land allocated to other crops is negatively correlated with receipt of coupons for maize inputs or tobacco fertilizer. These patterns are broadly consistent with those found by Holden and Lunduka (2010b), who argue that a rise in the number of plots under tobacco production during 2006–09 reflects the incentive effects of fertilizer subsidies for tobacco.

The regression results show that households in Kasungu District allocated more land to tobacco and other crops than households in Machinga District. They also allocated less land to maize, overall. On average, households in the Kasungu sample own 2.1 hectares of land compared with 1 hectare in Machinga District. Thus the proportion of maize in total land for households in Kasungu would be less if farmers in Kasungu pursue subsistence in maize as an objective. The differences in the cropping patterns between the two districts could also be indicative of differences in the livelihood options available to residents of the two districts, as highlighted above.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Political imperatives in Malawi, and many other African countries, indicate that agricultural input subsidies will continue for the foreseeable future, despite their high fiscal burden. The FISP in Malawi has attracted widespread international attention as a success story, an example of a "smart subsidy" program.[5] Since the FISP was introduced in 2005, increased use of improved maize seed and fertilizer, combined with favorable rains, has resulted in dramatic increases in maize output and subsequent improvements in national and household food security. Malawi has even begun limited exports of maize. Nevertheless, further research is needed to clarify how input subsidy programs can be made more effective at achieving food security and less prone to unintended adverse effects.

The present study investigated whether Malawi's FISP has influenced farmers to simplify or diversify their crop varieties and/or cropping patterns, that is, whether it has precipitated a shift toward specialization. The results show that farmers who received coupons for improved maize seed and maize fertilizer allocated 45% more land to improved maize and less land to traditional varieties than farmers that did not receive a coupon. Hybrid varieties have many advantages over traditional varieties. For example, in comparisons made over 3 years (including one of the worst drought years in Malawi's history), with and without fertilizer, at more than 100 sites in Malawi, hybrid varieties consistently out-performed traditional varieties in terms of yield (CIMMYT, 1994). Thus, the FISP may have assisted Malawian farm households in moving toward the goal of food self-sufficiency. A similar increase in cropland allocation to tobacco in households that received coupons for tobacco fertilizer could increase incomes of resource-poor farmers, another FISP goal. However, the increase in land allocated to improved maize and tobacco occurred at the expense of other crops (groundnuts, soybeans, cassava, and sweet potatoes), which were allocated 17% less land by farmers who received coupons for maize seed and fertilizer. Therefore, our results suggest that agricultural input subsidies are associated with crop simplification, but future research using nationally representative data (our study covers two districts only) is needed to better assess this relationship.

If agricultural input subsidies do encourage farmers to concentrate on a smaller number of crops, and if this is viewed as detrimental, government policies might have to be redesigned to avoid this unintended effect. From one perspective, crop diversification is an important strategy for resourceful households. By growing a mixture of crops, farmers can reduce potentially negative impacts of labor shortages, seasonal production needs, and uncertain climate conditions (Tripp, 2006). In this sense, the movement toward a more simplified cropping system, dominated by improved varieties of maize, might make farm households particularly vulnerable to climate variability and change. Malawi has a highly variable climate: forty weather-related disasters occurred during 1970–2006, including 16 drought or flood events after 1990 (Action Aid, 2006). Crop diversification helps farmers to insure against such disasters, as different crops are affected differently by climatic events (Adger *et al.,* 2003). Furthermore, the increase in maize acreage at the expense of relatively drought-tolerant crops, notably cassava and sweet potato, could exacerbate the impact of drought on food security (Holden & Lunduka, 2010b).

Another effect of the FISP – reduced allocation of land to legume crops (e.g., groundnuts, soybeans, and pigeon peas) – has potentially negative consequences for soil fertility. When the subsidy program is eventually phased out, smallholder farmers might not be able to afford sufficient fertilizer to prevent a decline in soil fertility. Legumes help build soil carbon and nitrogen stocks that have been depleted by constant cultivation with nitrogen-demanding maize, and are an affordable soil-maintenance option for resource-poor farmers (Bezner-Kerr, Snapp, Chirwa, Shumba, & Msachi, 2007; Snapp *et al.*, 2002). The inorganic fertilizer provided by FISP coupons can help to increase nitrogen content of the soil, but synergistic effects of fertilizer application and legume cultivation achieve better soil maintenance (Akinnifesi, Makumba, & Kwesiga, 2006; Akinnifesi *et al.*, 2007, 2009).

Nevertheless, a move toward greater specialization in maize on the part of smallholders in Malawi is not intrinsically a bad thing, since maize provides labor savings and improved pest control as well as market opportunities, and flexibility in planting and harvesting times. But the current objectives of agricultural policy in Malawi include increased maize production *and* increased crop diversification, which our results suggest may be difficult to achieve under the current policy. A number of policies could be instituted to pursue these objectives concurrently. Researchers at national and international agricultural research organizations in Malawi have developed improved varieties of crops that are drought tolerant and/or have soil-building properties; however, investments are needed in production and distribution to ensure that these seeds are available to farm households. Improved crop varieties other than maize should be included in the FISP, to allow farmers to experiment and gain knowledge of new and diverse crops. In 2008–09, the FISP offered a flexible coupon that allowed farmers to choose between improved maize or legume seeds, but most farmers selected maize, largely due to a lack of legumes in the market.[6] In 2009–10, farmers were provided with both maize and legume coupons, and the availability of legumes in the market increased considerably. It is probable that land allocated to legumes was less impacted by increased allocation to maize during that year than during the year examined in the current study. Offering coupons for one or more drought-tolerant crops would also be a valuable policy since it would reduce the impact of drought on farm households. Finally, offering education to farmers would increase interest in diversifying cropping patterns. For example, the soil-building properties of legumes are well known by farmers, but not sufficient reason to increase adoption of leguminous crops. Bezner-Kerr *et al.* (2007) show that educating Malawian farmers about the nutritional benefits of legumes greatly enhanced their interest in growing them. Adoption of such complementary policies by the Malawi government could help the FISP to achieve the goals of food self-sufficiency and increased income, and at the same time reduce any unintended and counterproductive trends toward crop simplification and monoculture.

NOTES

1. By "mutually exclusive", we mean a household can be categorized into only one of four participation categories.

2. Because most farmers could not distinguish between hybrid and OPV maize, the term "improved maize" refers to any type that is not traditional maize.

3. In the analysis of cropland allocation one might argue forthe inclusion of one participation variable at a time, or an index that combines all four, to avoid problems of multicollinearity. However, we do not view multicollinearity among these participation variables as a problem, since several of the participation variables are statistically significant in the regressions. We tested for multicollinearity among these variables using the variance inflation factor. A rule-of-thumb is that numbers greater than 10 are taken as an indication of possible collinearity problems. We find values for the predicted participation variables that range from 1.28 to 2.36.

4. 13,012 metric tons of NPK fertilizer were planned for distribution to 101,109 farm families in Kasungu, or roughly 128 kg per household. In Machinga, 10,186 metric tons of NPK fertilizer were to benefit 74,447 registered farmers, an equivalent of 136 kg per farmer.

5. Minot and Benson (2009) define "smart subsidies" as mechanisms to provide subsidized goods and services designed both to promote market development and to enhance the welfare of the poor. Often the intent is to phase out such subsidies once the market infrastructure has been developed and markets for the supply of the relevant goods and services are functioning.

6. A key reason legume seeds have never been a significant part of the subsidy is their very slow seed multiplication ratio. It takes years to rebuild legume seed supplies. A government commitment of over 2 years is thus required to ensure sufficient quality legume seed is available for a subsidy program. In contrast, maize seed is fast to multiply up and, because maize is a staple crop, obtaining sufficient supplies of high quality maize seed is less of a problem. If the subsidy program is finalized at the last minute, which is often a political reality, it is possible for government to purchase maize seed, but large quantities of legume seed will not be available.

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