ELSEVIER

Agricultural Economics 19 (1998) 219–229

AGRICULTURAL ECONOMICS

Market access by smallholder farmers in Malawi: implications for technology adoption, agricultural productivity and crop income

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Abstract

In Malawi, maize is the major crop and food staple. Given limited off-farm employment opportunities, much-needed increases in household income for improving food security must come from gains in agricultural productivity through better technology and more profitable crops. In the past, hybrid maize and more recently, tobacco were promoted by policy for increasing smallholder income. An analysis of determinants of adoption of these two crops and related income effects is presented. Apart from factor endowment and exposure to agroecological risks, differences in the household's access to financial and commodity markets significantly influence its cropping shares and farm income.

Keywords: Technology adoption; Market access; Credit; Maize; Malawi

1. Introduction

In Malawi, about three quarters of smallholders' acreage is planted to maize, mostly with low-yielding local varieties that may not even yield a ton per hectare. In the past decade, hybrid maize as a capital-intensive, high-yielding technology and more recently, tobacco as a labour- and capital-intensive cash crop have been emphasised as potential options for improving income and food security of rural households in Malawi. This paper presents an analysis of determinants of adoption of these two crops while focusing on access to commodity and financial markets and on related income effects. Next, recent policy changes in the agricultural sector in Malawi are described, followed by the formulation of hypotheses about determinants of adoption of hybrid maize and tobacco. Section 3 presents the sampling procedure and data. The remaining sections discuss the model, its results and policy conclusions.

2. Recent agricultural policy changes

Past policies in Malawi, by and large, favoured the production of high-value cash crops in the estate sector, while the smallholder sector was encouraged to produce and sell the country's food staple through official market channels (Mtwali, 1993). During the 1980s and the early 1990s, agricultural credit, input, and extension policy focused on the dissemination of a fixed input package of hybrid maize and fertilizer that was delivered at subsidised interest rates and input prices to smallholders. The policy of massive distribu-

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0169-5150/98/$19.00
PII S0169-5150(98)00027-9

tion of maize credit to smallholders was successful in increasing the share of higher-yielding hybrid maize in total smallholder hectarage planted to maize from about 8% in 1985 to a record high of 25% in 1992, while the overall share of maize in smallholder acreage increased from 73% to 80%. However, the concentration of the loan portfolio to one drought-sensitive crop, combined with the droughts in 1992 and 1994 and political promises for writing-off loan debt during the election year, led to widespread loan default and eventually to the collapse of the parastatal Smallholder Agricultural Credit Administration (SACA) in 1994. While 400,000 farmers received credit in 1992, 34,000 did so in 1994.

Following the major drought in 1992, the share of smallholder hectarage planted to nonmaize crops, in particular cassava and pulses, temporarily increased. Farmer's response to the perceived advantages of drought-resistant crops, the sudden collapse of the public system for distributing credit for maize production, and the recent policy orientation towards diversifying smallholder crop production may all have played a role in this. Following a second drought in 1993/1994, large-scale distribution of free fertilizer and hybrid maize seeds to drought-affected areas during 1994/1995 and 1995/1996 seems to have contributed to the recent revival of hybrid maize in smallholder farms despite the unfavourable price policy for fertilized maize. While subsidies on credit and fertilizer were removed in 1994 and 1995, the output markets for maize and tobacco remain controlled. The government of Malawi sets producer prices for maize below import parity level, and aims to stabilize consumer prices within a price band through open-market sales of domestic or imported maize.

Tobacco is the major export crop in Malawi, accounting for over 70% of the total value of commodity exports. In 1996, 141,662 metric tons of tobacco were exported, earning foreign exchange of US$238 million. In view of the importance of tobacco, the government of Malawi has traditionally regulated the tobacco subsector. Prior to 1990, tobacco could be legally produced only on estates under leasehold or freehold land tenure systems, effectively excluding smallholders from growing tobacco under customary land tenure. To enforce this system, a national tobacco production quota was allocated among estates which then also received the right to market their quota at the auction floors. For decades, rent-seeking behaviour by the powerful estate sector has thus excluded Malawian smallholders from growing this profitable crop. However, since tobacco is a labour-intensive crop with negligible economies of scale in production, the majority of estates found it more economical to contract-out their tobacco production to tenants farming between half to 1 ha. In addition, tobacco was also illegally produced by smallholders who then sold their produce to estates.

For the 1990/1991 cropping season, and first on a pilot basis, 7600 smallholders were registered to legally grow tobacco with a total quota of 3.0 million kg. However, smallholders were required to sell their tobacco to ADMARC which paid lower prices than the auction floors. Irrespective of this initial marketing restriction, demand for tobacco production quota by smallholders was very strong. In response to this, the government of Malawi rapidly increased the quota allocated to smallholders during the next 5 years until 1995/1996. Since the cropping season 1996/1997, the quota system has been abolished. It has been replaced by a system in which smallholders are only required to register their chosen production at the beginning of the growing season. Furthermore, the government introduced over the years two additional marketing channels for smallholder tobacco. First, smallholders were allowed to organise themselves in farmer clubs. A club receives the right to directly market its production to the auction floors. The second option, introduced in 1993 but operational on a sizable scale only since 1994, is the licensing of intermediate buyers who can buy tobacco from estate or smallholder producers and then sell it to the auction floors. For a number of reasons, smallholders have made much use of this marketing channel during the past 3 years. First, the high unit transactions costs in marketing small quantities produced by smallholders can outweigh the price premium received when selling directly to action floors compared to an intermediate buyer. Second, for liquidity-constrained farmers, a cash sale to an intermediate buyer is likely to be more attractive than payments received from the auction floors which are staggered over a period of about 5 months after the sale. The share of smallholder burley tobacco sold by clubs directly to auction floors compared to their allocated quota was 48% in 1994, 30% in 1995, and 46% in 1996. In 1996, despite an estimated

smallholder production of 50 million, of which 29 million was formally registered to clubs, only 12.8 million was sold on auction floors by clubs (MoALD, 1996 crop estimates).

To summarize, the reforms in Malawi's tobacco subsector over the past 6 years have been substantial. Basically, smallholders can now benefit from the same marketing channels than estates, and are no longer limited by a production quota. These market and institutional reforms resulted in a rapid adoption of tobacco production by smallholders. For 1996/1997, it is estimated that over 100,000 smallholders have grown tobacco. Since tobacco is a labour-intensive crop, with negligible economies of scale in production but sizable ones in marketing, it is expected that most of tobacco production will eventually switch to smallholder family farms, while the role of the estate-cum-tenant sector in tobacco production will decline, while at the same time increasing the pressure for estates to offer more favourable terms to their tobacco tenants.

3. Sampling design and data

The data used are from 401 rural households in five districts of Malawi. The survey was conducted in 1995 by the International Food Policy Research Institute (IFPRI) in collaboration with the Department of Rural Development (DRD) of the Bunda College of Agriculture, University of Malawi. The survey was designed for analysis of access to and participation in four selected credit programs. The sample was therefore stratified along present and past program participation (Diagne et al., 1996). Two of the programs provide seasonal agricultural credit, mostly for tobacco and maize, with one of them on a national scale. These are administered by the Malawi Rural Finance (MRFC) and the Malawi Union of Savings and Credit Cooperatives (MUSCO). The other two specialise in credit for off-farm enterprises, but operate only in a few districts. All programs work with member-based institutions at the village level, either groups or cooperative societies. MRFC members gain improved access to agricultural extension (mostly for hybrid maize and tobacco), and both agricultural credit programs give credit as agricultural inputs in kind. We use mainly data from the agricultural module for the production years 1993/1994 and 1994/1995. The stratification of the households along participation in credit programs implies that simple descriptive means are not representative of the total population in the survey areas. To correct for this, the subsequent descriptive analysis uses sampling weights. We note, however, that the econometric analysis presented does not account for the potential estimation bias that can arise from the choice-based sampling procedure.

4. Factors influencing the adoption of technological innovations

Feder et al. (1985) conducted a comprehensive literature survey on adoption of agricultural innovations. They list factors that have been frequently identified as being influential in determining the adoption of an agricultural innovation. These include: (i) farm size, (ii) risk exposure and capacity to bear risks, (iii) human capital, (iv) labour availability, (v) credit constraint, (vi) tenure, and (vii) access to commodity markets. These factors are discussed next, in view of Malawi's specific context.

In Table 1, we compare the mean and coefficient of variation for yields, gross revenue, input expenditures and gross margins per hectare by crop. The yield is valued at the quantity-weighed sample sales price. The table excludes the data from the district of Mangochi where many households in both years experienced a complete maize crop failure. Despite having a mean yield of only 658 kg/ha that is 49% below the yield of hybrid maize, the local maize varieties are grown in about half of the households. Several factors could explain this. The first factor is yield or income risk. In Table 1, the coefficients of variation for yield, as well as for gross margins of hybrid maize, are lower than that for local maize. However, when the data from the Mangochi district are included, the picture completely changes. On the average for the whole sample, hybrid maize has lower yields and gross margins but higher risk than local maize. This suggests that hybrid maize does well in some agroclimatic regions but exhibits negligible or no risk-adjusted advantages in less favourable areas for maize cultivation. The lower the risk-bearing ability of the household, the higher, therefore, could be its preference for local maize. As the ability to bear risks largely depends on the household's equity capital and access to credit, we hypothe-

Table 1
Means and coefficient of variation for indicators of productivity and input intensity by crop

Variable	Local maize, n=43		Hybrid maize, n=522		Tobacco, n=121	
	Mean	CV	Mean	CV	Mean	CV
Yield (kg/ha)	658	58	1289	54	746	112
Gross revenue (MK)	746	100	1217	67	5326	148
Input expenditure(MK)	101		339		595	
Gross margin (MK)	645	113	877	96	4732	161
Gross margin per unit of working capital	6.4		2.6		8.0	

Source: DRD/IFPRI Rural Finance Survey in Malawi.
CV stands for coefficient of variation, expressed in percent. All monetary values are in Malawi Kwacha (MK) and relate to 1 ha, if not specified otherwise. The data have been weighed using the strata population from the village census. The data show means for two production years combined: 1993/1994 and 1994/1995. For most of the 100 surveyed households in the district of Mangochi, the maize crop which consisted mostly of hybrid maize varieties failed in both production years. In this district, 168 yield observations for hybrid maize and 25 yield observations for local maize were reported by the sample households, of which 70% and 52% were below 500 kg/ha, respectively. The table shows means excluding the data for Mangochi. If included, the average gross margin per hectare of local maize is MK 627, and for hybrid maize MK 491 for all households as an average, with coefficients of variation of 116% for local maize and 158% for hybrid maize.

sise that the share of hybrid maize in total area planted increases with the access to credit and landholding of the household. Another reason for growing local maize varieties is their favourable food processing and on-farm storage characteristics compared to most, but not all, hybrid maize varieties (Smale et al., 1995). Maize breeding research has led to the release of new varieties that focus on improved drought resistance, on-farm processing and storage characteristics.

The expenditures for inputs shown in Table 1 comprise direct costs arising from the acquisition of seed, organic and mineral fertilizer, pesticides, hired labour, transport and marketing services. The expenditures per hectare are the lowest for local maize and highest for tobacco. Tobacco is not only the most labour-intensive crop, but also the most capital-intensive one. When capital is a binding constraint, the productivity of crops with respect to capital will influence the crop mix. As an average for both years, hybrid maize had, by far, the lowest capital productivity among the three crops. The gross margins in Table 1 indicate considerable comparative advantage of tobacco vs. hybrid and local maize in utilizing the scarce factor of land and capital. On the average, hybrid maize has a comparative advantage over local maize when land is the binding constraint, but loses out when access to capital is restricted. Capital constraints may also induce labour constraints, especially during the peak planting season when family labour is not sufficient but households lack the liquidity to pay for hired labour.

Are there discernible patterns in factor endowment and other characteristics between households that specialise in local or hybrid maize or tobacco? Table 2 shows that mean gross margins per farm and per hectare are highest in the tobacco-growing households, and are generally lower in those households which grow local maize. A second pattern is that the shares of land planted with local maize or hybrid maize are lowest in the tobacco-growing households and highest in those households that grow both hybrid and local maize. Except for tobacco households, the shares of land planted to maize exceed 70%. Third, land possessed under formal title or customary usufruct right is highest in the tobacco-growing households, and lowest in those households that only grow local maize. It is hypothesized that with higher land endowment, the relative importance of producing local maize for home consumption in case of remote or unreliable maize markets decreases. A fourth pattern in Table 2 is that tobacco-growing households seem to be better endowed in human capital, as reflected by the size of the household and the level of education of its head. This pattern remains unchanged when including those sample households in the descriptive analysis which only began growing tobacco in 1994/1995. Of the 404 sample households, only 42 grew tobacco in 1993/1994, but 86 among them grew tobacco in 1994/1995. In contrast, local maize-only producers score lowest in these indicators. Fifth, households in the latter group are headed more

Table 2
Means of socio–economic characteristics of households, by cropping pattern

Variable	Local maize only	Hybrid maize only	Hybrid and local maize	Tobacco	Mean	SD
	n=201	n=254	n=164	n=121	n=790	n=790
Gross margin (GMGTOT)	837	1378	1171	3664	1283	2785
Gross margin per hectare of cultivated land (GMGTOTKA)	748	1193	721	1764	935	1158
Share of area planted (%) to						
local maize (SHCRLOCM)	85.0	0	48.6	30.1	56.0	39.0
hybrid maize (SHCRHYBM)	0	71.1	38.5	38.4	24.6	33.1
tobacco (SHCRTOBA)	0	0	0	23.4	2.3	8.5
Total land possessed (hectare) (LANDAREH)	1.45	1.94	2.16	2.55	1.77	1.14
Squared term of land possessed (SQLAND)	2.61	6.22	5.90	8.30	4.45	12.91
Unit value of agricultural land (MK per hectare) (PAGLAND)	3109	4000	7059	3197	3990	9569
Household size (HHSIZE)	4.51	5.40	5.70	5.73	5.01	2.36
Dependency ratio (DEPCHOLD)	0.25	0.22	0.21	0.24	0.24	0.22
Member of agricultural credit program (0=no, 1=yes) (MEMA)	0.03	0.08	0.17	0.23	0.08	0.27
Member of non-agricultural credit program (MEMN)	0.02	0.04	0.03	0.07	0.27	0.16
Characteristics of head						
Gender (0=female, 1=male) (MALEHEAD)	0.56	0.74	0.69	0.92	0.66	0.48
Age in years (AGEH)	46	40	46	43	44	15
Years of formal schooling (YYEDUCH)	2.4	4.0	3.1	3.8	3.0	2.7
Distance to parents' home (km)(PHVKM)	8.5	11.8	8.0	7.1	9.0	39.3
Squared term of PHVKM (SQPHVKM)	1700	3040	444	280	1625	19,350
Number of cattle possessed (NCATTL)	0.2	0.5	0.6	0.8	0.4	1.7
Number of small animals possessed (SMALANIM)	2.5	7.5	5.6	6.3	4.4	6.5

Table 2
(*Continued*)

Variable	Local maize only	Hybrid maize only	Hybrid and local maize	Tobacco	Mean	SD
	n=201	*n*=254	*n*=164	*n*=121	*n*=790	*n*=790
Dummy if household received hybrid maize seed as gift (1=yes,0=no) (GSEEDHMZ)	0	0.25	0.16	0.19	0.15	0.35
Fertilizer price (MK/kg) (PCFERT)	1.7	2.5	1.7	1.9	1.9	0.7
Producer price for hybrid maize (MK/kg) (PPHMZ)	0.9	1.0	0.9	1.0	1.0	0.3
Producer price for tobacco (MK/kg) (PPTOB)	6.9	8.6	6.5	7.8	7.2	5.2
Consumer price for cassava (MK/kg) (PHCASVA)	3.2	2.8	2.8	2.4	2.4	1.8
Village-level characteristics						
Index of storage risks for grains (1=low, 3=high) (RISKSTOR)	1.75	2.28	1.76	1.53	1.98	0.59
Index of crop production risks (from 5 to 15) (CROPRISK)	7.59	7.69	7.39	6.97	7.57	1.62
Dummy, if poorer than neighbouring villages (1=yes) (VPOORER)	0.47	0.10	0.38	0.48	0.29	0.45
Time and other costs for travelling to parastatal agricultural market outlet (MK) (OPPCOST)	10.9	2.8	4.9	0.8	5.8	11.8
Coefficient of variation of rainfall (CVRYY)	0.27	0.32	0.28	0.28	0.29	0.07
District dummy Mangochi (MANGOCHI)	0.03	0.72	0.09	0	0.35	0.48
District dummy Nkota (NKOTA)	0.04	0.13	0.05	0.16	0.09	0.29
District dummy Rumphi (RUMPHI)	0.03	0.01	0.20	0.28	0.06	0.23
District dummy Dedza (DEDZA)	0.64	0.04	0.36	0.09	0.29	0.46
Dummy for production year (=1 if 1994/1995) (YEAR95)	0.49	0.51	0.39	0.67	0.50	0.50

Source: DRD/IFPRI Rural Finance Survey.

SD stands for standard deviation. Of the 790 observations from 401 households in both production years, 50 observations are from households which do not farm or do not grow neither tobacco nor maize. For 12 of the 401 households, no crop production data are available for the production year 1994/1995. The first three columns in the table refer to households that do not grow tobacco in a particular production year, but only maize besides other food crops. All monetary values are in Malawi Kwacha. The measure for area is hectare (ha). The dependency ratio DEPCHOLD is computed as the sum of household members younger than 8 years or older than 64 years divided by household size. The effects of the drought during production year 1993/1994 varied considerably by district. The mean shares of area affected by maize crop failure are the following in each of the districts: Mangochi 84%, Rumphi 69%, Dedza 64%, Nkhotakota 56%, and Dowa 38%.

frequently by women. This suggests that female-headed households are less likely to adopt cash crops, an outcome that can be affected by a host of factors such as the lack of access to credit or extension services, and the time constraints resulting from farm and home production (Kumar, 1994). Sixth, membership in an agricultural or nonagricultural credit program is lowest in the group of households that grow only local maize, and highest for tobacco growers. We hypothesise that program membership is important for the adoption of capital-intensive hybrid maize and tobacco. Finally, the costs of accessing agricultural input and output markets also seem to matter. As a measure of transaction costs in accessing markets, information was obtained about the time and transportation costs from the village to the nearest market outlet of the ADMARC, the parastatal marketing institution. Those households growing only local maize incur the highest costs.

5. Model specification

Several authors have used recursive econometric models to explain the adoption of agricultural technology and cash crops and related income effects (Kumar, 1994; von Braun et al., 1989). A similar framework is applied in this paper. We conceptualise the adoption of hybrid maize and tobacco and the resulting income generation as a sequential decision-making process whereby previous cropping decisions predetermine income.

When crop technologies are divisible, as it is the case for hybrid maize and tobacco, Feder et al. (1985) suggest that the extent of adoption is best measured by the hectarage share of the crop under consideration. While the participation in a credit program has been hypothesised to influence the adoption of hybrid maize (Kumar, 1994; Smale et al., 1995), past research rarely considered the potential simultaneity bias that arises from using the endogenous credit participation as a regressor in the adoption equation (Zeller et al., 1996). It is hypothesised that the share, S, allocated to a particular crop is a function of a vector, $\boldsymbol{x}$, of exogenous variables and the endogenous credit program participation, A, such that

$$S = \alpha_2 \boldsymbol{x} + \gamma A + E_2 \quad (1)$$

The problem arises because unmeasured household-level variables affect both program participation, A and the adoption of technology, S. With the resulting endogeneity, OLS regression of S on participation in a credit program, A is likely to result in inconsistent estimates. For consistent estimation, a variant of the standard sample selection model is applied:

$$A^* = \alpha_1 \nu + E_1 \quad (2)$$

$$S = \alpha_2 \boldsymbol{x} + \gamma A + E_2 \quad (3)$$

$A=1$ if $A^*>0$ and $A=0$, otherwise.

Eq. (1) states that, A, access to a credit program depends on a set of variables represented in ν. Eq. (2) states that adoption, S, depends on another set of variables, $\boldsymbol{x}$, and access to credit program, A. The problem of simultaneity bias arises when Eq. (3) is estimated by OLS. This is because the random error terms E_1 and E_2 are likely to be correlated, since unobserved household variables affect both A and S. A two-stage procedure can be used to produce unbiased and consistent estimates of adoption, given that participation in a credit program is an endogenous variable (Maddala, 1983). In the first stage, an estimate A^* of A is obtained by probit maximum likelihood method for Eq. (2). The predicted probability is then used in the second stage to obtain estimates of the cropping shares, S, for local and hybrid maize and tobacco. In the second step of the recursive model, the effect of adoption of technology and new crops on farm gross margin is estimated, controlling for other factors, such as endowment in production factors, prices, predicted participation in credit programs, and transaction costs in accessing agricultural input and output markets. The dependent variable is the gross margin from the household's crop production in either of the two production years. Means and standard deviations for the variables used in the regression models are listed in Table 2.

6. Interpretation of model results

In order to differentiate between the effects of nonagricultural credit programs and agricultural credit programs, two separate PROBIT models have been estimated (see first two columns of Table 3). It is assumed that the choices of participating in either of the programs are mutually independent. The regres-

Table 3
Determinants of technology adoption and effects on smallholder crop income in Malawi

Regressand	Household participates in credit program		Cropping shares			Income
	Nonagricultural	Agricultural	Hybrid maize	Tobacco	Local maize	Farm crop income
Constant	−3.418	−3.309***	70.74***	−1.71	34.4*	−2814.2***
LANDAREH	0.178**	0.251***	0.19	1.21*	−2.44	995.8***
SQLAND	−0.127*	−0.163*	0.05	−0.06*	0.12	−23.9
PAGLAND	0.109*	0.478	−0.000015	−0.00003	0.00005	0.0063
HHSIZE	0.103***	0.276	0.76	0.59**	−1.35*	10.0
DEPCHOLD	−0.611**	0.766***	−9.62	−1.95	18.3***	433.1
MALEHEAD	−0.549***	0.369***	−1.57	−0.11	5.79*	
AGEH	0.170	0.516				
YYEDUCH	0.209	−0.381	0.35	0.15	−0.715*	75.9
PHVKM	0.375**	−0.524***				
SQPHVKM	−0.618**	0.107***				
NCATTL	0.034	0.695				
SMALANIM	0.006	0.146				
GSEEDHMZ			9.92***	1.32	−8.45***	
PCFERT			−4.26***	−1.61***	−7.00***	−173.8
PPHMZ			0.85	−4.37**	5.54	953.9*
PPTOB			0.03	0.393**	−0.38	382.1
PHCASVA			0.21	−0.55***	0.84	112.0
RISKSTOR	−0.456	1.436***	−35.3**	11.27***	13.95	
CROPRISK	−0.693	0.189***	−10.9***	2.05***	7.52**	
VPOORER	−2.298	−0.315	35.0	−22.88***	6.91	
OPPCOST			−1.17**	0.69	−0.52	−4.4
MANGOCHI	4.706	−3.850***	186.6***	−51.31***	−96.3	−4126**
NKOTA	4.335	−3.558***	133.6**	−38.73***	−81.6	−2877*
RUMPHI	4.048	3.248***	118.5**	−35.56***	−50.3	−1375
DEDZA	1.810	1.950***	89.8*	−47.13***	−6.48	783
CVRYY	0.132	−1.428**	47.88***	7.84	−48.3	
YEAR95			4.25	2.82	−2.09	−2132*
PCMEMA[a]			38.25**	9.75*	−56.9**	−470
PCMEMN[a]			−23.90	2.73	32.19**	2155
PSHYBM[a]						6.21
PSTOBA[a]						191.55**
PSLOCM[a]						−25.78*
Adjusted R^2	36.9	38.7	43.6	18.9	32.6	26.2

[a]Predicted values of MEMA, MEMN, SHCRHYBM, SHCRTOBA, and SHCRLOCM. *, ** and *** significant at the 10, 5 and 1% levels, respectively.

sion results for cropping shares of hybrid maize, tobacco and local maize, and those for crop income, are listed in the subsequent four columns of Table 3. Major results are highlighted next.

Participation in either of the two credit programs is modelled in a reduced form as an outcome of variables that either affect the supply side with the placement of programs or the demand side by asking for membership in such a program. The model seeks to account for endowment in physical, human and social capital of households as well as agroecological risks. The probability of participation in both program types rises with increasing land possession (LANDAREH), but at a decreasing margin (SQLAND). The two coefficients for the indicators of the household's liquidity, the number of cattle (NCATTL) and that of small animals (SMALANIM) have the expected positive sign. Third, the coefficients for the indicators of human capital (i.e., AGEH for age and YYEDUCH for education of household head) and indicators of risk-bearing capacity (i.e., MALEHEAD for gender of household head and DEPCHOLD for dependency ratio) have the

expected signs, except for education affecting participation in agricultural credit programs. The distance in kilometers to the home of the head's parents (PHVKM), and its squared term (SQPHVKM), are used as indicators of possession of social capital. It is hypothesised that individuals who live in the same village as their parents or close to their parents have more friends and relatives who can help them get accepted into a group or help them in retaining program membership in times of difficulties to repay the loan. For the agricultural credit programs, the coefficients for the distance and the squared term carry the expected signs, and are highly significant. However, lower social capital implies a higher probability for joining a nonagricultural credit program. This result is explained by the fact that the nonagricultural programs explicitly target poorer, often female-headed households which engage in trading activities in or near rural towns. Finally, the households' exposure to agroecological risks is expected to affect participation in credit programs. Three variables capture different risk types. The index variable RISKSTOR indicates the degree of risk in obtaining losses while storing food. The index variable CROPRISK reflects the degree of exposure to five different types of crop risks (flooding, drought, hail, insects and other pests, and river bank erosion). The variable CVRYY measures the coefficient of variation in rainfall for the area in which the household resides. We hypothesise that an increase in both storage and crop production risks increases the probability of households applying for membership in a credit program. On the other hand, credit programs may be less inclined to accept members in risk-prone communities because of higher probability of loan default. As a result of the hypothesised divergent demand and supply effects, the expected signs are undetermined. The regression finds that more of storage and crop production risks significantly increase the probability of being a member of an agricultural credit program. Furthermore, an increasing interannual variation in rainfall significantly reduces the probability of participation in an agricultural credit program. While the first two effects seem to be driven by demand, the latter appears to be a supply-sided one. The agricultural credit program may shy away from areas with known rainfall risk.

With respect to determinants of cropping shares, we highlight major similarities and differences for the three crops. A first robust result is that larger farms will have a higher cropping share of hybrid maize and tobacco and less of local maize. Moreover, households with more members, with less dependents, or with better-educated heads, will grow more of hybrid maize and tobacco and less of local maize. Concerning participation in formal credit markets, the coefficients for predicted membership in agricultural credit programs (PCMEMA) carry an expected and significant sign for all three crops. Increasing the probability of participation by an absolute 10% raises the cropping share of tobacco by an absolute amount of 0.97% and that for hybrid maize by 3.82%, while it reduces that of local maize by 5.69%. The effect of nonagricultural programs (PCMEMN) on cropping shares for hybrid and local maize is opposite to that of agricultural credit programs. Here, members significantly increase their share of local maize, and grow less of hybrid maize. We explain this as follows. First, the in-kind delivery of loans in agricultural credit programs induces transaction costs for households for converting the loan to other uses as they have to sell their maize inputs. Hence, a bias towards hybrid maize production is created. Second, agricultural credit programs focus their extension and other activities on hybrid maize and tobacco. Nonagricultural credit programs, on the other hand, disburse the credit in cash, but lend for off-farm enterprise development. Third, households have a limited risk-bearing capacity. Members in nonagricultural credit programs already take additional risks in their off-farm enterprises, thus, they seek to reduce their risk exposure in the on-farm enterprises by substituting hybrid for local maize and other crops. This interpretation is further supported by results related to the variables measuring on-farm food storage and crop production risks. Households who live in villages with high food (i.e., maize) storage and high crop production risks are predicted to plant considerably less of hybrid maize. Furthermore, transaction costs (OPPCOST) in accessing agricultural markets significantly matter for the cropping decision. The model shows that with higher travel costs to the nearest parastatal agricultural market outlet of ADMARC, the share of hybrid maize declines.

For the cropping shares of all three crops, rising fertilizer prices have a negative effect. Compared to other major crops grown by smallholders, such as cassava and beans, not only hybrid maize and tobacco, but also local maize can be fertilizer-intensive. On the average for the sample as a whole and for the production years 1993/1994 and 1994/1995, the farm-gate price ratio of maize to fertilizer is roughly 0.5 (as can be seen from Table 2). The recent policy changes have considerably worsened this ratio. An evaluation of national fertilizer trials for maize found that at 1996/1997 price levels, it is not profitable to apply fertilizer on hybrid maize in most areas of the country (Benson, 1997). Finally, the government's distribution of free maize seed during 1994/1995 (GSEEDHMZ) had a significant positive effect in increasing the share planted to hybrid maize.

In column 6 of Table 3, we show the results for the income effects of changing cropping shares. The regression function controls the household's endowment in land and its quality (PAGLAND) and in human capital, and measures the income effects of predicted cropping shares for hybrid and local maize, as well as tobacco. Crop income significantly increases with higher land endowment, but with a decreasing effect at the margin, and with higher household size and education of the household head. Both the cropping share for hybrid maize and tobacco increase the crop income, with tobacco having a relatively large, and hybrid maize a very small positive effect. Expanding local maize has a negative effect. Yet, the estimated income gains from expanding the cropping share of hybrid maize at the expense of local maize are negligible when compared to the gains that can be realised when growing tobacco. The recent rapid expansion of tobacco production among smallholders in those areas where tobacco can be grown is, therefore, explained by the results. Increasing the probability of membership in an agricultural credit program by an absolute 10% increases crop income by MK 311 despite a negative direct effect of MK 47, which is presumably caused by opportunity costs of time and other cost of participating in a credit club that requires regular meetings. The large indirect income effect of MK 358 is caused through increased shares of more profitable hybrid maize (+MK 24) and tobacco (+MK 187) and the reduction of local maize (+MK 147).

7. Policy conclusions

Several conclusions regarding the impact of alternative food policy instruments are deduced from this paper. First, the granting of tobacco production quota to smallholders has provided smallholders with the opportunity to grow a new profitable cash crop. The resulting rapid adoption of tobacco is not the outcome of technology innovation, but of policy reform and related institutional changes in the tobacco subsector. Second, we find that households with small farm sizes and low risk-bearing ability are able to adopt capital-intensive crops, such as hybrid maize and tobacco, if policies improve their access to credit, extension, input and output markets. Participation in an agricultural credit program has been found to substantially raise the cropping share for hybrid maize and tobacco, and membership in both credit program types has sizable effects on crop income. We, therefore, conclude that an expansion of the existing credit programs could have beneficial effects on agricultural production of smallholders and rural incomes, but that its public costs must be weighed against these benefits. Third, participation in agricultural credit programs is found to be lower for households which live in areas with higher variation in rainfall. This is likely to be caused by supply side effects. Agricultural credit programs seem to shy away from these areas because of higher expected loan default. In order to better serve risk-prone areas, the credit programs may introduce member-financed emergency funds which are pooled across larger regions for covering covariate risks or, the programs may charge higher interest rates to cover the risk in drought-prone areas. Fourth, we find that the household's transaction costs in accessing the nearest parastatal market outlet for agricultural inputs and outputs have a negative influence on the share of area cropped with hybrid maize. This finding supports our conclusion that access to agricultural markets and related improvements in rural infrastructure and marketing institutions are essential for adoption of new technology and transformation of subsistence-oriented smallholder agriculture. Fifth, the speed and success of this transformation will also depend on getting prices right. The results show that cropping shares and, therefore, supply response are sensitive to changes in product and fertilizer prices. The current policy in favour of net buyers of maize is to be seen as

a hindrance to increased maize production. Combined with the removal of subsidies for fertilizer and credit, and the significant recent devaluation of the Malawi Kwacha, hybrid maize has lost much of its relative profitability over local maize and other calorie-rich food crops. In fact, maize, as such, has lost profitability, and the recent expansion in production in cassava, tobacco and other crops is an outcome of this development. Under the current policy setting and population growth, food imports are therefore likely to become an ever-increasing fiscal burden. Other policy instruments that have the potential to more efficiently provide a safety net for the urban and rural poor should be explored and tested in order to eventually be able to end the disincentives for smallholder maize production.

Acknowledgements

The authors are grateful for comments by Paul Héisey, Melinda Smale, Malcolm Blackie, and Benedicte de la Briere on an earlier version of the paper.

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