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DETERMINANTS OF HOUSEHOLD VULNERABILITY TO FOOD INSECURITY: A CASE STUDY OF SEMI-ARID DISTRICTS IN MALAWI

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Abstract: This paper looks at household vulnerability to food insecurity and its determinants in two semi-arid districts in Malawi. A randomly selected sample of 200 households was interviewed. The descriptive statistics revealed that female-headed households were more vulnerable to food insecurity than male-headed households because of low access to resources for food production and purchases. A two-stage least squares regression analysis showed that amongst the main determinants of household vulnerability were income, household size, land size and access to climate information. The findings imply that policies should promote diversification of livelihoods and equal opportunities and rights to access resources. Copyright © 2013 John Wiley & Sons, Ltd.

Keywords: food insecurity; Malawi; semi-arid districts; two-stage least squares; vulnerability

1 INTRODUCTION

Food security in Sub-Saharan Africa is an important issue and has continued to take centre stage in policy discourses. Although Malawi has taken significant strides in reducing food insecurity in the recent past, the problem still remains in its relatively dry areas. Household food insecurity is a challenge in semi-arid areas. Yet, information on the determinants of household vulnerability to food insecurity is either inadequate or unavailable. Estimates by the Food and Agriculture Organization show that the number of undernourished people increased from 848 million to 923 million from 2003/2005 to 2007, largely owing to the

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food price crisis, poverty and climate factors (FAO, 2008). Poverty levels are high and over a billion people in Africa live on $1 or less per day (United Nation, 2005). The most affected with inadequate food intake and poverty are those who live in rural areas and include those whose livelihoods depend on drylands (Pinstrup-Andersen, 1994; Carter, 1997; Nyariki *et al.*, 2002).

Food security is relative. It depends on food preferences of the majority of people in an area. In the case of Malawi, food security is achieved if there is adequate production of and access to maize, the country's staple crop. Maize is grown by over 90 per cent of farm households and accounts for over 50 per cent of calorie consumption and over 80 per cent of cultivated land (GOM, 2006a). The country is not an exception as far as hunger and poverty are concerned. It is rated as one of the poorest and least developed countries in Sub-Saharan Africa (World Bank, 2008). Over 55 per cent of the population live in poverty based on the $1 per day poverty line (GOM, 2008). The country managed to achieve national food security between 2005 and 2008 because of the Farm Input Subsidy Programme that increased maize production and moved Malawi from being maize net exporter to net importer to countries such as Zimbabwe, Swaziland and Lesotho (Chinsinga and O'Brien, 2008). This notwithstanding, food scarcity and hunger are still commonplace in most rural households in the country. Estimates suggest that 50 per cent of the rural population runs out of food 4–6 months before harvest and 40 per cent is unable to satisfy its basic calorific needs (Pankomera *et al.*, 2009).

Cammack *et al.* (2003) argued that while national food sufficient mainly focuses on high potential areas, a concern for household food insecurity requires focus on marginal areas. This paper examines the degree of household vulnerability to food insecurity and the causal determinants in two semi-arid districts of Malawi as a case study.

2 CONCEPTUAL CONSIDERATIONS

The concept of food security is complex, covering a wide range of definitions that have been refined over time (UN, 1975; FAO, 1983; FAO, 1996; FAO, 2002, Coleman-Jensen *et al.*, 2012). The definition of food security is contextual because of variability in food choices, preferences and availability. However, the most adopted definition of food security is 'a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (FAO, 2002). A household is food secure if it has the ability to acquire acceptable foods in socially acceptable ways, that is, without resorting to emergency food supplies, scavenging, stealing or other coping strategies (Coleman-Jensen *et al.*, 2012). This definition is also applied at a household level with emphasis on intra-household food consumption because household food security is determined by individual consumption. The assumption is that a household is food secure if individual members of the household have access to acceptable food. According to this study, the acceptable food in Malawi is maize. During the interviews, it was noted that households claim to be food insecure if they eat less preferred food, for example, sweet potatoes. Food security at household or national level in Malawi is measured by the amount of maize harvested in a particular season. For instance, the 2007/2008 food security issue in Malawi was due to surplus maize that was produced in the season.

Household food insecurity exists when households have inadequate access to food and nutrition. Food insecurity may be chronic or transitory. Chronic food insecurity exists

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when there are consistent food shortages and inadequate nutrients that may occur because of the inability to access food by production, gifts, purchase and aid, whereas transitory food insecurity is a temporary shortfall in food availability and consumption (Nyariki and Wiggins, 1997). Thus, reduction in production because of natural disasters such as floods, droughts and dry spells may lead to temporary food insecurity. However, perpetual extreme weather events usually result in chronic food insecurity.

Vulnerability to food insecurity is defined as the presence of factors that place people at the risk of becoming food insecure or malnourished (FAO, 1999). This definition incorporates causes of food insecurity other than climate factors. The concept of vulnerability refers to hunger vulnerability of individuals or households rather than vulnerability of the nation or region.

There are a number of factors that determine households' ability to secure food including access to natural, physical, social and financial resources, which in turn influence access to on-farm and off-farm employment. This study considers food availability and food access either from own production or purchases or social networks as crucial in ensuring household food security. Notably, availability of food at household level may not necessarily determine the health status of its members because of the different factors that affect the nutrition status of individuals, for instance, women and children (Nelson *et al.*, 2002). However, sufficient food availability at household level ensures improved in-house food distribution and consumption, which in turn leads to high intake of calories (QuinnV and Gittinger, 1990; Nyariki *et al.*, 2002).

The availability and access of resources such as land, labour and agricultural technologies, complemented with good climate, play a crucial role in food production and household income in developing countries such as Malawi. When climate is not favourable, food and income from agriculture production reduces drastically and labour resources determine the income to be earned from other livelihoods to access food. A household that depends on its own production is greatly influenced by climate variability and access to the technologies available for crop production. Access to technologies and their adoption by households are influenced by the availability of cash (either from sales, credit or remittances) and ability to use the technologies, cost of the technology, beliefs, benefits, access to information on technologies and labour requirement (Nyariki and Wiggins, 1997, Nyariki *et al.*, 2002).

3 METHODOLOGY

3.1 Study Area and Data Collection

The study was conducted in two Extension Planning Areas (EPAs), Mitole and Manjawira, located in Chikhwawa and Ntcheu districts respectively. The two districts are located in the southern and central regions of Malawi, respectively. Chikhwawa covers about 4755 km^2 with a population density of 91 persons per square kilometre, whereas Ntcheu covers 3424 km^2 with a population density of 138 persons per square kilometre. The districts are semi-arid, characterized by variable and erratic rainfall patterns, dry spells, floods and droughts. The rainfall regime is unimodal, starting in November and ending March/April, giving only one growing season. Ntcheu experiences a diversity of rainfall because of varying topography in the district. The seasonal rainfall amount ranges from 279.8 to 1871 mm. However, rainfall patterns are very erratic with other places in the district

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receiving relatively low rainfall. Manjawira EPA (where the study was conducted) lies along the valley and receives lower rainfall compared with other EPAs in the district. The main food crop grown in the areas is maize; however, other crops such as millet, sorghum, rice, sweet potatoes, Irish potatoes and beans are also grown. The population in the two areas is composed of smallholder subsistence farmers who mainly depend on rain-fed agriculture for their livelihood.

A multistage sampling technique was employed to select 100 households from each EPA, making a total of 200 households. Household interviews were conducted to collect cross-sectional data from February to March 2010, using a pretested structured questionnaire. Data collected included maize harvests and purchases, land size, household size and composition, income, access to resources and the characteristics of the household head.

3.2 Household Food Security Measure

Maize was used as a proxy for measuring household vulnerability to food insecurity because over 90 per cent of the rural population depends on it. It was measured in terms of total maize available (own harvest plus purchases) per adult equivalent. This study considered adults as persons older than the age of 16 years. Children, 16 years and younger, were weighted at half an adult (refer to similar conversion by Bouis *et al.*, 1992; Nyariki *et al.*, 2002). The estimates show that adults require 270 kg of maize per annum and children about 135 kg per annum (GOM, 2006b). Maize contributes roughly 55 per cent of total caloric intake and has 3578 kcal per kg. Using the Food and Agriculture Organization recommended daily intake of 2250 kcal per adult per day, each adult in Malawi consumes 1237.5 kcal (55 per cent of 2250 kcal) per day from maize. Therefore, per capita consumption requirement is estimated at 126 kg of maize per adult per year, which is given by (1237.5 kcal/day × 365 days/year)/3578. The per capita requirement for children is half of an adult, that is, 63 kg per year, calculated based on the adult requirement. However, all children younger than 16 years in the household were converted into adult equivalents, and this factor was used in calculating household vulnerability to food insecurity,

The household vulnerability to food insecurity measure was calculated by dividing total maize available (maize harvested plus maize purchased) by the number of adult equivalents multiplied by 126 kg. This is illustrated as follows:

$$FS = \frac{m*50}{AE*126}$$

where FS is the household vulnerability to food insecurity, m is the number of 50 kg maize bags available in a household and AE is the adult equivalent.

3.3 Simultaneous Equation Model

A simultaneous equation model was used to assess the determinants of households vulnerability to food insecurity. Most of the explanatory variables are agriculture related and are expected to possess a feedback relationship. Therefore, the simultaneity problem

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was expected in the model, and it was confirmed by Hausman specification test. The assumption was that there were exogenous and endogenous variables in the model that could not be estimated by ordinary least squares but rather by a two-stage least squares (2SLS) approach.

Household vulnerability to food insecurity was conceptualized as the relationship between the amount of maize available (from own farm production and purchases) and household and farm characteristics, income and on-farm and off-farm employment. Land size cultivated and education were presumed endogenous because they are influenced by other factors such as income and household size, which are also explanatory variables in the model. Therefore, these factors are likely to correlate with the error term. However, Hausman test for exogeneity, as suggested by Gujarati and Sangeetha (2007), was conducted to confirm the endogeneity of the variables. The assumption in the model was that maize availability is influenced by two main endogenous variables: land size and education of the household head and other exogenous variables. However, education and land size also influence each other and are in turn influenced by the availability of maize and some of the exogenous variables that are not included in the main equation. The model therefore contains the dependent variable, predictors, predictors and instrumental variables and purely instrumental variables (Figure 1).

The model can generally be expressed as follows:

$$Y_{1i} = \beta_{10} + \beta_{11} Y_{2i} + \beta_{12} Y_{3i} + \lambda_{1k} X_{1k} + \mu_{1i} \tag{1}$$

$$Y_{2i} = \beta_{20} + \beta_{21} Y_{1i} + \beta_{22} Y_{3i} + \lambda_{2k} X_{2k} + \delta_{2k} Z_{2k} + \mu_{2i} \tag{2}$$

$$Y_{3i} = \beta_{30} + \beta_{31} Y_{2i} + \lambda_{3k} X_{3k} + \delta_{3k} Z_{3k} + \mu_{3i} \tag{3}$$

where Y_1 is a dependent variable; Y_2 and Y_3 are endogenous variables or jointly dependent variables; X_{1k}, X_{2k} and X_{3k} are observed exogenous variables or predetermined variables associated with given equations; Z_{2k} and Z_{3k} are observed exogenous variables influencing only endogenous variables; β_{10}, β_{20} and β_{30} are constants; βs are coefficients for endogenous variables (Y); λs are coefficients for exogenous variables *(X)*; δs are coefficients for exogenous variables (Z); μ_{1i}, μ_{2i} and μ_{3i} are stochastic disturbances and i is the total number of observations.

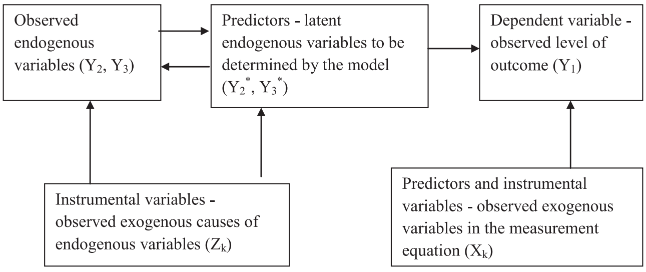

Figure 1. Theoretical Framework for the simultaneous equation model

DOI: 10.1002/jid

3.4 Tests for Identification, Simultaneity and Exogeneity

3.4.1 Test for identification

The order and rank conditions of identification, as described by Gujarati and Sangeetha (2007), were used to find out if the equations were exactly identified or overidentified. The results from our model showed that all the equations were overidentified. It was appropriate, therefore, to use the 2SLS to estimate the parameters in the model. According to rank condition, the results showed that there existed at least one nonzero determinant of order 2×2 from the coefficients of the variables excluded from a given equation but included in other equations. The equations used in the model are the following:

$$\begin{aligned} FS_{\text{mj}} = {} & \alpha_0 + \alpha_{11} LS_{\text{mj}} + \alpha_{12} ED_{\text{mj}} + \lambda_{11} IN_{\text{mj}} + \lambda_{12} DW_{\text{mj}} + \lambda_{13} DM_{\text{mj}} \\ & + \lambda_{14} CI_{\text{mj}} + \lambda_{15} SH_{\text{mj}} + \lambda_{16} TF_{\text{mj}} + \lambda_{17} OE_{\text{mj}} + \mu_0 \end{aligned} \tag{4}$$

$$\begin{aligned} ED_{\text{mj}} = {} & \alpha_1 + \alpha_{21} FS_{\text{mj}} + \alpha_{22} LS_{\text{mj}} + \lambda_{21} IN_{\text{mj}} + \lambda_{22} SH_{\text{mj}} + \lambda_{23} OE_{\text{mj}} \\ & + \delta_{21} AG_{\text{mj}} + \delta_{22} GH_{\text{mj}} + \delta_{23} MS_{\text{mj}} + \mu_1 \end{aligned} \tag{5}$$

$$\begin{aligned} LS_{\text{mj}} = {} & \alpha_2 + \alpha_{31} ED_{\text{mj}} + \lambda_{31} IN_{\text{mj}} + \lambda_{32} SH_{\text{mj}} + \delta_{31} AG_{\text{mj}} + \delta_{32} GH_{\text{mj}} \\ & + \delta_{33} SN_{\text{mj}} + \delta_{34} ES_{\text{mj}} + \delta_{35} AT_{\text{mj}} + \delta_{36} MS_{\text{mj}} + \mu_2 \end{aligned} \tag{6}$$

$$\begin{aligned} FS_{\text{mi}} = {} & \beta_0 + \beta_{11} LS_{\text{mi}} + \beta_{12} ED_{\text{mi}} + \gamma_{11} IN_{\text{mi}} + \gamma_{12} DW_{\text{mi}} + \gamma_{13} DM_{\text{mi}} \\ & + \gamma_{14} CI_{\text{mi}} + \gamma_{15} SH_{\text{mi}} + \gamma_{16} TF_{\text{mi}} + \gamma_{17} AT_{\text{mi}} + \gamma_{18} ES_{\text{mi}} + \varepsilon_0 \end{aligned} \tag{7}$$

$$\begin{aligned} ED_{\text{mi}} = {} & \beta_1 + \beta_{21} FS_{\text{mi}} + \beta_{22} LS_{\text{mi}} + \gamma_{21} IN_{\text{mi}} + \gamma_{22} SH_{\text{mi}} + \varphi_{21} AG_{\text{mi}} \\ & + \varphi_{22} GH_{\text{mi}} + \varphi_{23} OE_{\text{mi}} + \varphi_{24} MS_{\text{mi}} + \varepsilon_1 \end{aligned} \tag{8}$$

$$\begin{aligned} LS_{\text{mi}} = {} & \beta_2 + \beta_{31} ED_{\text{mi}} + \gamma_{31} IN_{\text{mi}} + \gamma_{32} SH_{\text{mi}} + \gamma_{33} AT_{\text{mi}} + \gamma_{34} ES_{\text{mi}} \\ & + \varphi_{31} AG_{\text{mi}} + \varphi_{32} GH_{\text{mi}} + \varphi_{33} SN_{\text{mi}} + \varphi_{34} MS_{\text{mj}} + \varepsilon_2 \end{aligned} \tag{9}$$

where mj stands for Manjawira; mi for Mitole; *FS* stands for vulnerability to food insecurity; *LS* is the land size; *ED* is the education of the head of household; *IN* is the income; *DW* is the distance to water sources; *DM* is the distance to market; *CI* is the access to climate information; *SH* is the size of household; *TF* is the type of fertilizer; *ES* is the access to extension services; *AG* is the age of the head of household; *GH* is the gender of the head of household; *OE* is the access to on-farm employment; *MS* is the marital status of the head of household; *SN* is the access to social networks; α_0, α_1, α_2, β_0, β_1 and β_2 are constants; αs and βs are coefficients of endogenous variables; λs and γs are coefficients of predictors and instrumental variables; δs and ϕs are coefficients of instrumental variables and μs and εs are error terms.

3.4.2 Test for simultaneity

The methods of 2SLS and instrumental variables (IV) give consistent and efficient estimates if there is simultaneity in the model. Hausman specification error test was used

DOI: 10.1002/jid

to test for simultaneity. The reduced form equations were obtained from the endogenous variables in the model and are given by Equations (10) and (11).

$$\begin{aligned} ED = \prod\nolimits_0 + \prod\nolimits_1 IN + \prod\nolimits_2 DW + \prod\nolimits_3 DM + \prod\nolimits_4 CI + \prod\nolimits_5 SH + \prod\nolimits_6 TF + \prod\nolimits_7 OE \\ + \prod\nolimits_8 AT + \prod\nolimits_9 ES + \prod\nolimits_{10} AG + \prod\nolimits_{11} GH + \prod\nolimits_{12} SN + \prod\nolimits_{13} MS + v \end{aligned} \tag{10}$$

$$\begin{aligned} LS = \prod\nolimits_{14} + \prod\nolimits_{15} IN + \prod\nolimits_{16} DW + \prod\nolimits_{17} DM + \prod\nolimits_{18} CI + \prod\nolimits_{19} SH + \prod\nolimits_{20} TF + \prod\nolimits_{21} OE \\ + \prod\nolimits_{22} AT + \prod\nolimits_{23} ES + \prod\nolimits_{24} AG + \prod\nolimits_{25} GH + \prod\nolimits_{26} SN + \prod\nolimits_{27} MS + \omega \end{aligned} \tag{11}$$

The results showed that at less than 5 per cent level of significance, the coefficient of $\hat{\omega}$ (0.206) for Manjawira was statistically significant, indicating the presence of simultaneity problem. However, the coefficients of $\hat{v}$ for Manjawira and Mitole and coefficient of $\hat{\omega}$ for Mitole were closely equal to zero (−0.033, 0.064, 0.104) but were not statistically significant. This implies that the hypothesis that they are equal to zero is rejected. Therefore, the coefficients for these residuals were not statistically equal to zero; hence, there was simultaneity problem in the model.

3.4.3 Test for exogeneity

It was not obvious to identify the variables that were endogenous in the model. Hausman test was used to test if the endogenous variables were truly endogenous. The results showed that the coefficient of $\hat{\boldsymbol{LS}}$ for Manjawira was statistically not equal to zero and was significant at 10 per cent. This showed that land size was truly endogenous in the model. The coefficients of $\hat{\boldsymbol{ED}}$ for Manjawira and Mitole and the coefficient of $\hat{\boldsymbol{LS}}$ for Mitole, although they were closely equal to zero, were not significant in the model. Therefore, the hypothesis that they were equal to zero was rejected, meaning that land size and education were endogenous variables in both models. One striking finding was that when the estimated residuals were substituted by the endogenous variables, the *R*-square, adjusted *R*-square and *F* statistics remained the same, although the coefficients of the estimated endogenous variables were different. This implies that the endogenous variables were highly correlated with the error terms in the model. Hence, the choice of the simultaneous equation model and the 2SLS approach for estimating the parameters was appropriate.

4 RESULTS

4.1 Results of Descriptive Analysis

Table 1 presents the results of the descriptive analysis associated with the dependent and explanatory variables used in the model. The analysis is disaggregated by gender in the study areas. Using a computed vulnerability to food insecurity measure, the results showed that Mitole households were more vulnerable to food insecurity than Manjawira households. Female-headed households in both areas were more vulnerable than the male-headed households. On the other hand, vulnerability to food insecurity measured from their perceptions during the household interviews indicated that more than 80 per cent of the

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Table 1. Summary of variables

Variables	Unit, definition	Manjawira		Mitole	
Dependent variable		Male	Female	Male	Female
Household vulnerability to food insecurity	Continuous variable; less than 1 is vulnerable to food insecurity	1.22	1.17	0.76	0.65
Household food security (perceptions)	Binary: 1 for food insecure and 2 for food secure	84% for 1	88% for 1	83.3% for 1	93.5% for 1
Explanatory variables					
Household characteristics					
Household size	Residents present	5.54	4.66	5.43	4.96
Gender of household head	Binary: 1 for male and 2 for female	50	50	54	46
Education of household head	Scaled 0–3, 0 for no education, 1 for primary, 2 for secondary and 3 for tertiary	1.12	0.88	1.04	0.63
Age of household head	Age in years	47.5	43.25	45.4	45.7
Farm characteristics					
Land size	(ha)	2.47	1.82	1.84	1.28
Maize harvests	50 kg bag	11.24	7.67	6.26	4.45
Extension services	Binary: 1 for yes and 2 for no	32 for 1	33 for 1	43 for 1	35 for 1
Agricultural technologies	Binary: 1 for yes and 2 for no	37 for 1	28 for 1	33for 1	30 for 1
Climate information	Binary: 1 for yes and 2 for no	35 for 1	31 for 1	34 for 1	24 for 1
Type of fertilizer	Scaled 1–3: 1 for chemical, 2 for manure and 3 for no fertilizer	46hh (mode = 1)	48hh (mode = 1)	27hh (mode = 1)	21hh (mode = 1)
Earnings					
Household income	Malawian Kwacha per year	38 330.00	17 867.35	35 191.11	25 686.96
Income per adult equivalent	Malawian Kwacha per year	9469.07	5775.83	9312.81	6889.41
On-farm employment	Binary: 1 for yes and 2 for no	39 for 1	42 for 1	46 for 1	31 for 1
Other factors					
Distance to markets	Scaled 0–4, the larger the longer distance	3–4 km (mode = 2)	3–4 km (mode = 2)	1–2 km (mode = 1)	1–2 km (mode = 1)
Distance to water sources	Scaled 0–4, the larger the longer distance	<1 km (mode = 0)	<1 km (mode = 0)	<1 km (mode = 0)	<1 km (mode = 0)

Source of data: household questionnaire survey.

households in both areas were vulnerable to food insecurity, with more female-headed than male-headed households (Table 1).

The results also showed that male-headed households have bigger land size than female-headed households. The average land size for female-headed households was 1.56 ha, whereas that for male-headed households was 2.15 ha. The median total income was found to be different, with female-headed households from Manjawira having the least income. The income results translate to $0.65 per day ($1 = MK152) for male-headed households and $0.39 per day for female-headed households, well below the poverty line of less than $1 per day. Access to credit facilities, climatic information, modern agricultural technologies, extension services and education was also low among female-headed households. Credit facilities included cash capital and inputs in the form of fertilizer, seeds, cuttings and livestock. The respondents mentioned a number of reasons why they could not access credit, namely, inadequate credit facilities, high interest rate, few beneficiaries of credit facilities, poor management of credit facilities and inability to pay back the loan. Women highlighted household responsibilities as a challenge to engage in income generating activities to pay back credit.

4.2 Simultaneous Equation Model Results

Table 2 presents the 2SLS results for Manjawira and Mitole for Equations (4) and (7), respectively. The results showed that income, land size, access to climatic information, fertilizer and modern agricultural technologies exert a positive and significant influence on food security. The distance to the nearest market, access to on-farm employment and household size showed a significant and negative effect. Households with more residents are likely to be vulnerable to food insecurity. The results from the two districts exhibit few similarities and differences. Similarities are observed on the influence of income and household size on vulnerability to food insecurity. The differences are seen in the effects

Table 2. Factors influencing household vulnerability to food insecurity in Manjawira and Mitole

	Manjawira			Mitole		
Variable	*β*	*t*	*p*	*B*	*t*	*p*
Household size	−0.125	−3.081**	0.003	−0.097	−3.171**	0.002
Income/adult equivalent	1.4	1.973**	0.052	1.79	3.307**	0.002
Land size	0.212	1.819*	0.073	0.109	0.609	0.545
Education of household head	0.356	1.601	0.114	0.164	0.884	0.381
Distance to water sources	−0.105	−0.862	0.391	−0.296	−1.398	0.168
Distance to nearest market	−0.037	−0.312	0.756	0.271	2.483**	0.016
Type of fertilizer	−0.089	−1.016	0.313	−0.086	−2.140**	0.037
Climate information	−0.335	−2.182**	0.032	0.001	0.006	0.996
On-farm employment	1.007	4.759**	0.000	—	—	
Agricultural technologies	—	—		−0.284	−1.761*	0.084
Extension services	—	—		0.129	0.658	0.513
Constant	0.337	0.715	0.477	0.95	2.555**	0.013

*Significant at 10%. **Significant at 5%.
Manjawira: $R^2 = 0.599$; adjusted $R^2 = 0.55$; $F = 12.137$; $**N = 100$.
Mitole: $R^2 = 0.449$; adjusted $R^2 = 0.35$; $F = 4.557$; $**N = 100$.

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of land size and access to on-farm employment and climatic information, which are significant in Manjawira but not in Mitole. Although access to modern agricultural technologies, type of fertilizer and distance to the nearest markets are significant in Mitole and not in Manjawira. Education did not show any significant influence in both Manjawira and Mitole probably because of lack of variation in the responses.

5 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

This study has shown that factors related to food production and food purchase are essential for achieving household food security in semi-arid areas. The main determinants of household vulnerability to food insecurity are income, household size, land size, access to on-farm employment, climate information and modern agricultural technologies. The results are consistent with previous findings (Nyariki *et al*., 2002; Amaza *et al*., 2009; Pankomera *et al*., 2009; Oni *et al*., 2010; Bartfeld and Hong-Min, 2011; Mkwambisi *et al*., 2011). The direct relationship between land size and food security is consistent with previous studies (Pankomera *et al*., 2009; Oni *et al*., 2010; Mkwambisi *et al*., 2011). However, the inverse relationship has also been reported between farm size and production in Malawi (Matchaya, 2007) probably because the total output from the farm was used to represent production in such studies, whereas in the current study only maize output was used.

The issue of household size is very sensitive in most cultures in Malawi. Although this study found an indirect relationship between household size and food security, most people in rural areas believe that larger households provide more labour for food production. This belief is consistent with findings from previous studies (Reardon and Vosti, 1995; Wasonga, 2009). Therefore, both positive and negative benefits are expected when household size is large. Moreover, because household size is taken as the number of residents in a household, some residents may not necessarily be the children of the head of household. The culture of extended families and social cohesion in Africa inflates the number of residents in a household, although the children may be few. Obviously, this unity needs to be encouraged especially with the increased trends in the number of orphans. Hence, this study has no policy implication regarding household size.

Furthermore, female-headed households are more likely to be vulnerable to food insecurity than male-headed households because of poor access or control over resources such as land, climate information, technologies and income, which are the main determinants of household vulnerability in the study areas. The current finding may result from cultural beliefs, whereby access to resources for food production such as land and inputs is low among women in developing countries (Nelson *et al*., 2002; Mbote, 2005; Kakota *et al*. 2011). Therefore, policy interventions that enable women to gain control and access over land, and those that promote access to climate information and technologies on improving production are likely to have more community benefits than those that focus on men. This does not mean that interventions should only concentrate on women, but rather, both men and women should have equal opportunities to resources for food production and purchases.

The results from this study have uncovered that food production is not all that matters to achieve household food security, especially in areas that are vulnerable to climate variability. Household income also plays a major role in food availability at the household level. Households that do not produce food because of climate factors can still achieve

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food security through purchases. The results imply that agricultural policy should consider factors related to food production and household income to achieve household food security. In case of crop failure because of climate and other factors, households can still achieve food security through purchases if they have sustainable sources of income. Hence, policy intervention should promote diversification of livelihoods. Alternative sources of livelihood such as small and medium scale businesses may assist households to become food secure. Furthermore, agricultural policies that support low income households to adapt through the provision of farm inputs and credit facilities are crucial in achieving household food security. Moreover, policy interventions are required to promote the adoption of modern agricultural technologies and to improve the dissemination of climate information among the rural households especially those that are affected by climate variability. Interventions should also focus on localizing the collection and recording of climate factors in rural areas. This can be carried out through capacity building in collecting and recording climate factors using locally available materials to ensure that data on climate are available at local level to improve future prediction of climate and weather forecasts. In line with this, strong social networks among communities may likely provide a platform for introducing interventions and new policies. Although the results of this study are relevant for Manjawira and Mitole in Malawi, these findings can be used as a case study for other semi-arid areas.

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