Chapter 5 FOOD AND NUTRITION SECURITY IMPLICATIONS OF CROP DIVERSIFICATION IN MALAWI'S FARM HOUSEHOLDS

John Mazunda, Henry Kankwamba, and Karl Pauw

ABSTRACT: THIS CHAPTER PROVIDES SELECTED DETAILS FROM A STUDY OF THE LINKS between crop production diversity and dietary diversity among Malawian households. We use data from Malawi's Third Integrated Household Survey (2010–2011) to construct a food group–based, household-level dietary diversity score. To sharpen our "nutrition lens," we also construct indicators for household-level access to micronutrients. Results indicate significant and positive associations between food crop production diversification and both types of indicators. The strongest associations are for households' micronutrient access. Production diversification is associated with a 35 percent increase in access to iron, a 47 percent increase in access to vitamin A, a 45 percent increase in access to folate, and a 35 percent increase in access to zinc. As deficiencies in these micronutrients continue to present a public health challenge in Malawi, these findings support the hypothesis that crop production diversification is a viable option to increase nutrition sensitivity in agriculture.

Malawian diets are characterized by a heavy reliance on staples, particularly maize (Ecker and Qaim 2011). Poorly diversified diets characterized by an overreliance on starchy staples are a red flag for malnutrition. Conversely, diets that include a variety of foods are considered important for positive health. Diets that include nutrient-rich pulses, animal-source foods, and fruits and vegetables are associated with micronutrient adequacy and lower levels of chronic undernutrition (Arimond and Ruel 2004; Thompson and Amoroso 2011). In Malawi, discussions on promoting more diverse diets through agricultural policy often focus on diversifying crop production. However, this assumes that diversification in household-level production of food crops does, indeed, lead to diversification in the diets of individuals.

While crop diversification is an explicit goal of the Government of Malawi, continued support for achieving maize self-sufficiency through the provision of input subsidies also remains a strong policy objective (MOAFS 2011). Theoretically, these two objectives are not mutually exclusive. Increasing maize yields through intensification methods, such as those involving increased use of inorganic fertilizer and improved seed facilitated by the Farm Income Subsidy Program (FISP), the major national program that subsidizes fertilizer and improved seed, primarily for maize cultivation, could potentially free land resources for cultivation of other, more nutrient-dense food crops (Arndt, Pauw, and Thurlow 2016). However, despite dramatic increases in maize yields since the start of the FISP that have likely enhanced household maize security (Chibwana, Fisher, and Shively 2012), Malawian diets remain poorly diversified. Indeed, the contribution of foods other than maize to national per capita dietary energy supply appears to have decreased slightly in recent years.

Whether input subsidies enhance specialization is a somewhat contentious issue. Arndt, Pauw, and Thurlow (2016) note that higher maize yields achieved by farmers might prompt them to diversify their portfolio of crops, particularly toward export crops. Holden and

Lunduka (2010) use panel data on Malawi and find that farmers' average share of land allocated to maize declined significantly from 2006 to 2009. This result is also in line with Kankwamba et al. (2012), who find higher crop diversification indices for FISP beneficiaries. While most empirical findings suggest a positive relationship between subsidized fertilizer and production diversity, Chibwana, Fisher, and Shively (2012) find a shift in area toward maize and tobacco in their study that assessed cropland allocation effects of input subsidies in Malawi. Furthermore, empirical studies have found weak effects of subsidies on nutritional outcomes. For example, Michelson and Galford (2016) find weak to moderate child anthropometric outcomes as a result of input subsidy programs in Malawi.

Evidence on the relationship between crop diversification and dietary diversification is scant. Although a large number of empirical studies analyze the determinants of crop diversification or dietary diversity, only a handful assess causal linkages between the two (Herforth and Harris 2014; Hirvonen and Hoddinott 2014; Remans et al. 2014). For Malawi specifically, a recent study presented evidence on precisely this pathway. Using data from the nationally representative Third Integrated Household Survey (IHS3) of 2010–2011 (IHS3), Jones, Shrinivas, and Bezner-Kerr (2014) found that farm production diversity was associated with greater household-level dietary diversity.

Our study builds on these results by analyzing the same IHS3 data on household food consumption by farm households, but with an additional focus on the determinants of crop diversification and looking more specifically at micronutrients. In addition to constructing a Household Dietary Diversity Score (HDSS), we also construct Household Micronutrient Access indicators to estimate the effect of crop diversification on household access to zinc, iron, vitamin A, and folate. In so doing, we further refine Malawi-specific findings on returns for improved nutrition from food crop diversification.

Our results indicate significant and positive associations between diversification in food crop production and both nutrition indicators. The strongest associations were for Household Micronutrient Access. Production diversification was associated with a 35 percent increase in access to iron, a 47 percent increase in access to vitamin A, a 45 percent increase in access to folate, and a 35 percent increase in access to zinc. These findings support the hypothesis that crop production diversification is a viable option to increase the nutrient content of the diets of members of farm households in Malawi.

Malawian woman farms groundnut plot

PLAUSIBLE IMPACT PATHWAYS

Three main theoretical pathways can be used to hypothesize the effects of crop production diversification on household food security and the diets of household members. They correspond directly with the pathways described by the conceptual framework on causal pathways from agriculture to nutrition provided in Chapter 1.

- Production diversification can directly alter the food a family consumes if it eats what it produces, as do most farm families in Malawi. If a farm family produces a more diverse set of foods, then it has access to a more diverse set of foods to consume. Furthermore, if some of these foods are sold, then others who rely on markets for meeting some of their food needs will also have access to a more diverse set of foods.
- Production diversification can lead to increased income for farm families with which they can buy more diverse and more nutritious foods. This can

be achieved through production of marketable, higher-value crops if local markets can offer producers good prices for those crops. It is important to note that the extent to which agricultural income influences household nutrition and food security depends on several factors, including the characteristics of food markets, decisions on household food purchases, and household nutritional knowledge. Depending on how these factors—captured in the enabling environment component of our conceptual framework—come together, agricultural income-generating activities can have a positive, negative, or neutral effect on nutritional outcomes (World Bank 2007).

In addition, it is important to note that the extent of bargaining power and control that women have over choices about the consumption of what the family produces and the use made of income from crop sales will moderate the degree to which the above two pathways will lead to improved food security and diets.

METHODS

We used data from the IHS3 for this analysis. Carried out between March 2010 and March 2011, the nationally representative survey was designed to provide information on various aspects of household assets, consumption, and welfare in Malawi. It includes a household questionnaire that has modules that cover a range of topics, including household income, food and nonfood consumption, demographics, education, asset holdings, and employment. With respect to agriculture, households surveyed for the IHS3 provided detailed reporting on cultivation and production practices for the most recently completed rainy and dry seasons, including any input subsidies received. Our analysis used information provided by the 10,234 sample households from the IHS3 that defined themselves as agricultural, that is, "involved in agricultural or livestock activities" (NSO 2012a).

We defined crop diversity based on the definition of crop diversification used by the Ministry of Agriculture, Irrigation, and Water Management, which is the production of more than one crop. To identify whether households diversified their cropping activities, we first created a count variable that summed up the total number of crops grown by a household. We then created a dummy variable whereby households producing one crop were not considered diversified and those producing more than one crop were considered diversified.

Household dietary diversity was assessed using HDDSs and Micronutrient-sensitive Household Dietary Diversity Scores (MsHDDSs):

- The HDDS was calculated based on a simple counted score of how many food groups from a total of 12 that sample households reported consuming over the past seven days. This score was constructed from IHS3 recall data on food expenditures and household consumption.
- The MsHDDS disaggregates and reorganizes the HDDS food groups into 16 micronutrient-based groups. As with the HDDS, MsHDDS values were calculated based on simple counts taken from IHS3 food consumption recall data.
- Constructed from detailed IHS3 recall data on what all household members ate, the per capita calorie and micronutrient intake of sample households was estimated based on the quantities of foods they reported consuming. These calculations were used to estimate Household Micronutrient Access indicators for iron, vitamin A, folate, and zinc.

Using the "etregress" command in the Stata statistical software package, version 13.1, we estimated a standard treatment effect model that uses maximum likelihood to estimate the effect of an endogenously chosen binary treatment on continuous endogenous food security and nutritional variables. In our case, the model consists of a selection equation for the household decision to diversify cropping activities and an outcome equation on the extent of household dietary diversity. While an instrumental variable approach would have been most appropriate to measure the impact of crop diversification on food security and nutritional outcomes, a Heckit treatment effect model

TABLE 5 VARIABLES AND DESCRIPTIVE STATISTICS USED IN ANALYSIS OF THE NUTRITIONAL IMPLICATIONS FOR FARM HOUSEHOLDS OF FOOD CROP DIVERSIFICATION

Variable	Mean	Standard Deviation
Dietary and nutritional diversity		
Household Dietary Diversity Score (HDDS)	7.9	2.20
Micronutrient-sensitive Household Dietary Diversity Score (MsHDDS)	9.4	2.58
Iron (mg/d)	22.9	70.99
Zinc (mg/d)	12.7	47.56
Vitamin A (RE mcg/d)	594.4	1,680.24
Folate (DFE mcg/d)	453.7	1,273.17
Crop diversity		
Crops are diversified (0/1, yes = 1)	0.76	0.42
Demographic and socioeconomic characteristics		
Age of the household head (years)	43.1	16.51
Male household head (0/1)	0.80	0.40
Head has formal education (0/1)	0.76	0.44
Household size	2.60	0.63
Institutional factors		
Has access to credit (0/1)	0.08	0.28
Has access to agricultural extension (0/1)	0.46	0.50
Distance to market (km)	7.70	10.77
Engaged in crop sales (0/1)	0.53	0.50
Sanitation index	0.95	1.27
Agricultural characteristics		
Tropical Livestock Units owned	0.88	5.18
Agricultural income (MK/year)	4,800.31	29,038.74
Landholding size (ha)	0.75	0.46
Received subsidized fertilizer (0/1)	0.54	0.50
Agro-ecological zones, based on Agricultural Development Divisions (ADD), control is Karonga ADD		
Mzuzu ADD	0.07	0.27
Kasungu ADD	0.12	0.33
Lilongwe ADD	0.26	0.44
Machinga ADD	0.19	0.39
Blantyre ADD	0.07	0.26
Shire Valley ADD	0.16	0.36
Salima ADD	0.05	0.22

Source: Authors' own calculation based on IHS3 data.

Note: DFE = dietary folate equivalent; MK - Malawian kwachas; RE = retinol equivalent

was used, considering the challenges of finding an instrumental variable that is both highly correlated with the treatment condition and uncorrelated with the error term of the outcome regression (Guo and Fraser 2010). Dependent variables used in the outcome equation include HDDS, MsHDDS, and Household Micronutrient Access indicators for iron, vitamin A, folate, and zinc, whereas the decision to diversify crop production was used as the dependent variable in the selection equation.

Explanatory variables used in both equations were selected a priori based on existing theory regarding the determinants of household dietary diversity and potential confounding factors of crop diversification and household dietary diversity. Table 5 lists the variables used in the analysis.

FINDINGS

A majority (76 percent) of the sample was categorized as practicing some crop diversification, and about half (53 percent) reported being engaged in crop sales. Only 8 percent of the sample reported having access to credit, 46 percent reported access to extension services, and 54 percent reported receiving fertilizer subsidies. The average distance to the nearest local market was 7 km. (See Figure 12 for maps of travel time to larger market centers.) The average landholding was less than 1.00 hectare (0.75 ha).

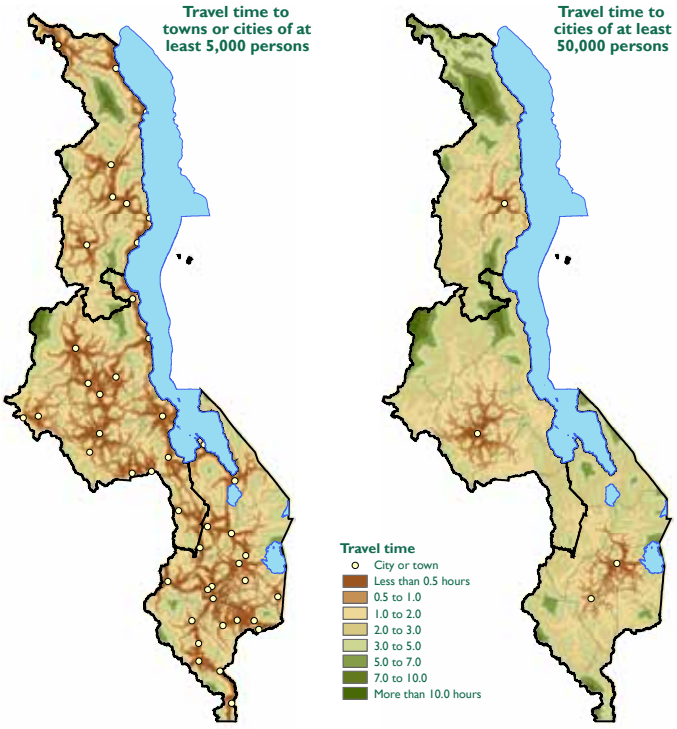
Regression results are shown in Table 6. The household head having received some formal education, the size of landholdings, access to subsidized fertilizer, and market participation are all positively and significantly associated with crop diversification. In addition to subsidized fertilizer, it is worth noting that the FISP package included maize as well as legumes, albeit at minimal quantities compared with maize (Arndt, Pauw, and Thurlow 2016). Our analysis on crop diversification regarding the FISP focused only on the receipt of fertilizer and not the whole FISP package. Receipt of the entire package, particularly where households received different types of seeds, may also have enhanced production diversity. The association with access to extension services was also positive and significant, though with a smaller effect. Interestingly, access to credit was negatively and significantly associated with diversification. A positive and significant, albeit small, association was also found between distance to markets (Figure 12) and crop diversification—that is, the greater the distance from markets, the more likely a household was to diversify its production.

The mean HDDS for surveyed households was 7.9 for the 12 groups. Crop diversification was associated with a substantial 19 percent increase in HDDS and MsHDDS. However, when the data were disaggregated into urban and rural households, families living in rural areas appeared to be at a distinct disadvantage, with regression results showing rural households to be associated with a 25 percent decrease in HDDS and a 24 percent decrease in MsHDDS. While the effect is quite small at 0.5 percent, owning some livestock was also positively and significantly associated with HDDS and MsHDDS.

With respect to micronutrients, results indicated a significant and positive association between crop diversification and all four indicators of Household Micronutrient Access. Diversification was associated with a 35 percent increase in adequate access to iron, a 47 percent increase in adequate access to vitamin A, a 45 percent increase in adequate access to folate, and a 35 percent increase in adequate access to zinc. Interestingly, while owning livestock was associated with improvements in access to vitamin A, folate, and zinc, there was no significant association with iron, which is one of the key nutrients most easily absorbed from animal-source foods and one of the nutrients for which Malawians have high levels of deficiencies (Government of Malawi 2009). The household head having received some formal education was positively and significantly associated with all the dependent variables: HDDS, MsHDDS, and the four Household Micronutrient Access indicators.

In terms of gender, the results controlled for the sex of the head of the household. Male-headed households were less likely to diversify production. However, male-headed households were associated with a 5 percent increase in HDDS and MsHDDS. The Household Micronutrient Access scores also indicated that households headed by men accessed higher

FIGURE 12 MAPS OF TRAVEL TIME TO MARKET CENTERS IN MALAWI WITH POPULATIONS OF 5,000 AND 50,000



Source: Analysis by M. Kedir Jemal, IFPRI, of spatial data for Malawi on population centers, the road network, and land use and land cover.

amounts of micronutrients, except vitamin A, for which insignificant results were obtained. While this is at odds with Jones, Shrinivas, and Bezner-Kerr (2014), who found male-headed households to be associated with a slightly lower HDDS, they also included a variable for control over agricultural income that indicated a much larger significant effect. This suggests that shared control over income between spouses may be more important for dietary diversity than the gender of the household head alone.

DISCUSSION

Taken together, these results indicate a tendency for farm households to practice market-oriented production diversification when land, inputs, and market access allow. Furthermore, the positive association between subsidized fertilizer and production diversification may be due to a propensity for smallholders to diversify their production only after they have satisfied household requirements for maize. Sometimes referred to as filling the maize basket, this theory is based on the assumption that farmers who produce more maize due to the receipt of FISP-subsidized inputs are in a better position in terms of their level of household food security to risk expanding into other crops (Snapp and Fisher 2014).

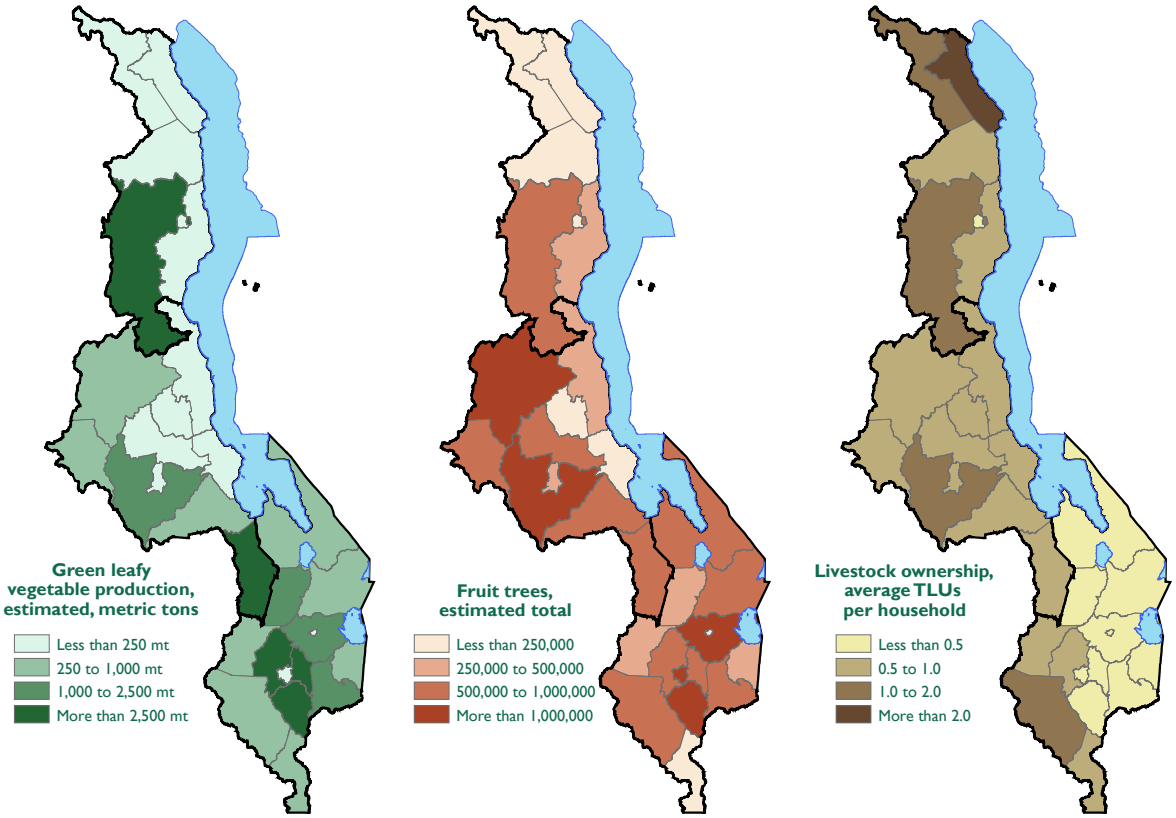
Both the HDDS and the MsHDDS showed a positive and significant association with production diversity, implying that when crops other than maize are grown (Figure 13), whether for market sale or for own consumption, this increases household food security and allows households to access a more diverse set of foods. The fact that these relationships held true across all four Household Micronutrient Access indicators is noteworthy, particularly because micronutrient deficiencies remain a major challenge in Malawi (Government of Malawi 2009). Theoretically, it follows that the ability to diversify should improve individual nutrition outcomes. However, this hypothesis could not be tested here since the IHS3 did not collect information on individual-level dietary intake.

TABLE 6 RESULTS OF THE ANALYSIS OF CROP DIVERSIFICATION ON FARM HOUSEHOLD DIETARY DIVERSITY AND MICRONUTRIENT INTAKE, CONDITIONAL ON SOCIOECONOMIC VARIABLES

Variable	Crop diversification	HDDS	MsHDDS	Iron	Vitamin A	Folate	Zinc
Crops produced are diversified (0/1)	-	0.1878***	0.1892***	0.3459***	0.4755***	0.4492***	0.3475***
Age (years)	−0.0014	−0.0020***	−0.0019***	0.0016***	0.0010	0.0011**	0.0013***
Male head of household (0/1)	−0.0711*	0.0511***	0.0454***	0.0507***	−0.0278	0.0618***	0.0672***
Head has formal education (0/1)	0.1881***	0.1199***	0.1236***	0.0752***	0.1710***	0.1152***	0.0925***
Household size (number)	0.0146*	0.0009	0.0023	0.1231***	0.0987***	0.1066***	0.1205***
Has access to extension (0/1)	0.0845**	-	-	-	-	-	-
In poorest quintile (0/1)	−0.0343	-	-	-	-	-	-
Land area owned (hectares)	1.9830***	-	-	-	-	-	-
Land area owned squared (hectares)	−0.5668***	-	-	-	-	-	-
Distance to market (km)	0.0074***	-	-	-	-	-	-
Has access to credit (0/1)	−0.1201**	-	-	-	-	-	-
Received subsidized fertilizer (0/1)	0.3840***	-	-	-	-	-	-
Sold crops (0/1)	0.8592***	-	-	-	-	-	-
Mzuzu ADD	0.1580**	-	-	-	-	-	-
Kasungu ADD	0.1259*	-	-	-	-	-	-
Lilongwe ADD	−0.0055	-	-	-	-	-	-
Machinga ADD	0.4070***	-	-	-	-	-	-
Blantyre ADD	1.0666***	-	-	-	-	-	-
Shire Valley ADD	0.9261***	-	-	-	-	-	-
Salima ADD	0.1478**	-	-	-	-	-	-
Log of agricultural income	-	−0.0004	−0.0001	0.0076***	0.0066**	0.0096***	0.0088***
Rural household	-	−0.2549***	−0.2434***	−0.0922***	−0.1582***	−0.1591***	−0.1594***
Northern region	-	0.0635***	0.0481***	−0.1038***	0.0448	0.0058	−0.1058***
Central region	-	0.0155**	0.0315***	0.1029***	0.2591***	0.0743***	0.0909***
Tropical livestock units owned	-	0.0051***	0.0050***	0.0048	0.0063**	0.0072**	0.0067**
Sanitation index	-	-	-	0.0645***	0.0652	0.0871***	0.1353***
Constant	−1.3173***	2.0635***	2.1955***	3.4061***	6.4118***	6.3593***	2.8556***
Chi-squared value	2,002	2,002	1,859	2,449	702.4	1,642	2,447
p value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, based on robust standard errors. 10,233 observations. ADD = Agricultural Development Division. HDDS = household dietary diversity score; MsHDDS = micronutrient-sensitive household dietary diversity score

FIGURE 13 MAPS OF DISTRICT-LEVEL PRODUCTION IN MALAWI OF NUTRIENT-DENSE PRODUCTS—GREEN LEAFY VEGETABLES, FRUIT, AND LIVESTOCK



Source: Maps by M. Kedir Jemal, IFPRI. The vegetable and livestock maps are based on IHS3 data, while the fruit tree map is based on data from the 2006/2007 National Census of Agriculture and Livestock (NACAL).

Note: mt = metric tons; TLU = Tropical Livestock Units.

At the household level, male-headed households had greater access to micronutrients even if they were less likely to diversify crop production activities. This may point to men's better access to resources that improve access to food through the mechanisms of agricultural specialization and market engagement. Greater productivity may allow male-headed households sufficient surplus to sell maize and purchase diverse foods for home consumption.

With respect to gender, our results show that male-headed households are more likely to be food secure and have access to more diverse foods. There is strong evidence highlighting the food insecurity challenges faced by women, who are often more constrained than men in terms of access to credit, land, extension services, and other productive resources (Alkire et al. 2012). As such, female-headed households often operate at a disadvantage in terms of their agricultural production activities relative to male-headed ones, resulting in adverse food security and nutrition implications for all household members.

In addition to addressing constraints of female-headed households, the extent to which women have control over agricultural income, regardless of the sex of the household head, is a critical part of improving food security outcomes. These findings support the call to better incorporate gender considerations into agriculture-based programming, captured in the pathway of "agriculture as moderator of women's time use and decision-making power" discussed in Chapter 1.