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REPORT

AGRICULTURE, FOOD SECURITY, AND NUTRITION IN MALAWI

Leveraging the Links

EDITED BY NOORA-LISA ABERMAN, JANICE MEERMAN, AND TODD BENSON

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ABOUT IFPRI

The International Food Policy Research Institute (IFPRI), established in 1975, provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition. IFPRI's strategic research aims to foster a climate-resilient and sustainable food supply; promote healthy diets and nutrition for all; build inclusive and efficient markets, trade systems, and food industries; transform agricultural and rural economies; and strengthen institutions and governance. Gender is integrated in all the Institute's work. Partnerships, communications, capacity strengthening, and data and knowledge management are essential components to translate IFPRI's research from action to impact. The Institute's regional and country programs play a critical role in responding to demand for food policy research and in delivering holistic support for country-led development. IFPRI collaborates with partners around the world.

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EXECUTIVE SUMMARY

Although the Malawian food supply is shaped largely by trends in smallholder food crop production, Malawi's decades-long focus on improving smallholder productivity has only moderately improved food security and nutrition outcomes. Country statistics indicate an estimated 36.7 percent of rural Malawian households failed to access sufficient calories between 2010 and 2011. During the same period, 47 percent of children under the age of five years were estimated to be stunted in their growth. These indicators imply that some Malawian diets are lacking in terms of quantity (total calories consumed), and most are lacking in terms of quality (sufficient calories derived from nutrient-dense foods, such as meat, fish, eggs, dairy, legumes, fruits, and vegetables). Good nutrition requires both enough total calories (quantity) and enough vitamins and minerals per calorie (quality).

How can Malawi better leverage its smallholder agriculture sector to improve nutrition? This report provides a series of primary and secondary data analyses that examine different aspects of this question:

Chapter 1 presents a widely accepted conceptual framework for four complementary causal pathways through which agriculture may affect household and individual nutrition outcomes: (1) as a source of food; (2) as a source of income; (3) as a moderator of women's time use and decision-making power; and (4) as a moderator of food markets. For each pathway, increased access to and availability of nutrient-rich foods is a key step, mitigated by environmental factors that either constrain or enable access. Food safety challenges, natural resource endowments, availability of potable water, food prices, and nutrition knowledge and norms are among these factors.

Chapter 2 provides an overview of metrics and measures, and the relevant data sources that are commonly used to examine or track agriculture, nutrition, and food security issues. This chapter makes the critical point that while diets are the mediating factor between agriculture and nutrition, data on individual diet outcomes are not routinely collected in national surveys in Malawi or elsewhere. As a result, analyses of food consumption patterns in many assessments of agriculture–nutrition links rely on less informative household-level, rather than individual-level, data. As a case in point, most of this report's analyses use household-level data from the third wave of Malawi's Integrated Household Survey (IHS3).

Chapter 3 investigates diversification in agricultural production and the relative importance of own-consumption, agricultural income, and women's time and empowerment pathways for diets. Findings are based on a qualitative assessment conducted in three districts of Malawi of dietary preferences and household decision making in the context of the promotion of nutritious and marketable crops among smallholder farmers.

Chapter 4 uses IHS3 data to examine the effects of the food market environment on household access to food and micronutrients. Among the factors considered are the salience of agriculture as a source of household income, food prices, and government interventions in food production and marketing.

Chapter 5 explores the effects of farm production choices on food consumption via both the income and own-consumption pathways. The analysis, based on data from the IHS3, includes assessing the determinants of farm production diversity and its impact on household dietary diversity, with a focus on household access to micronutrients.

Chapter 6 uses IHS3 data to investigate how lifting a natural resource constraint, that of seasonal rainfall, through the use of irrigation affects, first, agricultural production and, then, food consumption.

Among the conclusions of the studies are that both production diversification and irrigation have the potential to improve diet quality in Malawi. While both are currently identified as national policy objectives, the design of efforts to increase diversity in crop production and the use of irrigation will need to be reframed and strengthened to include specific nutrition objectives if these efforts are to result

in improved diets. Policies that strongly emphasize production of staple crops—particularly maize—may undermine efforts to improve diet quality. Additional agricultural strategies to improve nutrition that are not current policy priorities but hold high potential include (1) addressing seasonality through support to value chains for nutrient-dense foods, including perishable products, and (2) increasing the use of native, wild, and foraged foods in diets.

Finally, a critical message across the board is the need to focus more strongly on diet quality—primarily in terms of availability and affordability of nutrient-dense foods—as the key goal for leveraging agriculture for improved nutrition and health.

Chapter 1 IMPROVING AGRICULTURE'S CONTRIBUTION TO NUTRITION IN MALAWI: A CONCEPTUAL INTRODUCTION

Jody Harris, Janice Meerman, and Noora-Lisa Aberman

ABSTRACT: WITH MALAWIAN DIETS HEAVILY DOMINATED BY STAPLE FOODS—MAIZE FIRST and foremost, but also rice and cassava in some areas—food security in Malawi is often equated with having access to enough maize. What is missing in this traditional measure of food security in Malawi is the importance of the quality, in addition to the quantity, of dietary intake. This household-level scenario is reflected in, and exacerbated by, national development priorities; food security is a top-line agenda item for agriculture in Malawi, whereas nutrition is still considered primarily a health issue. To guide analysis and action in this complex environment, we present a conceptual framework to illuminate the multiple and complex linkages from agriculture to food security and nutrition. This framework reveals a number of ways in which the agriculture sector can help strengthen diet quality. These include: (1) promoting production of nutrient-dense foods via subsidies and other incentives; (2) promoting food processing, marketing, and consumption in ways that conserve nutrients, create demand, and decrease prices; and (3) supporting women farmers through, for example, targeted efforts to increase their productivity and bargaining power.

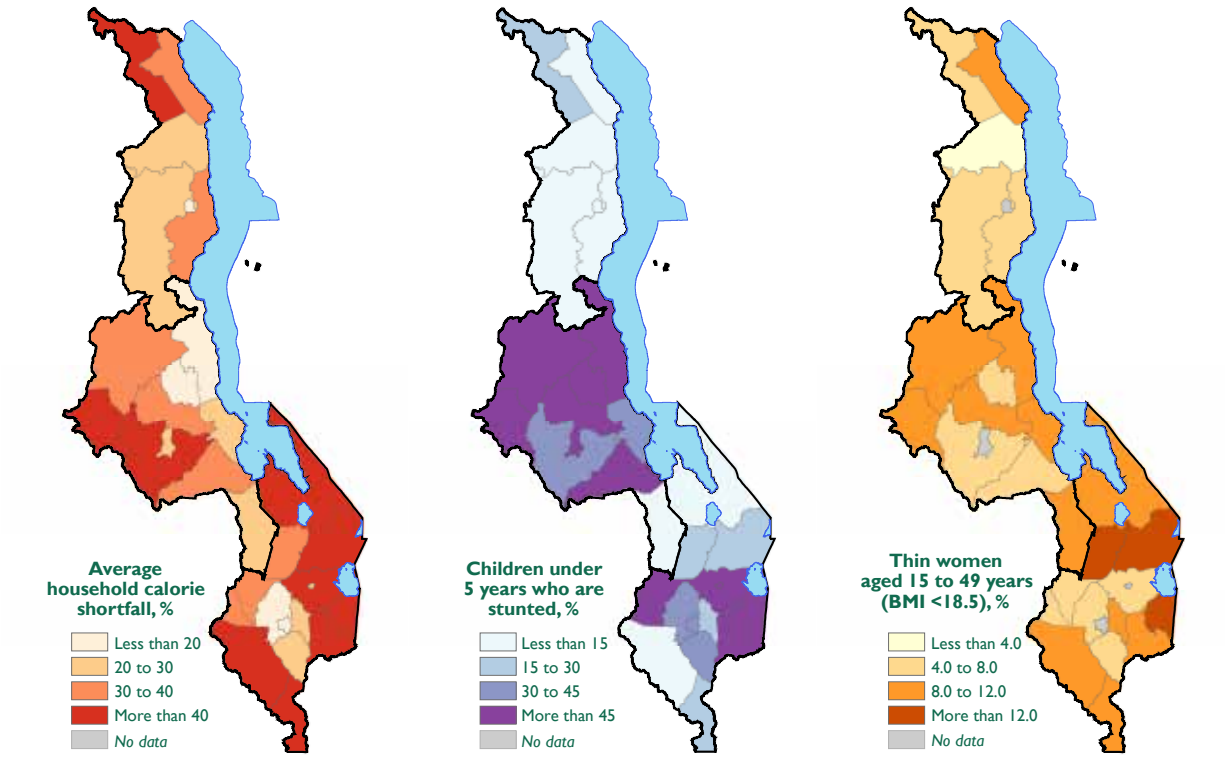
Smallholder agriculture is the mainstay of Malawi's economy. Its importance for livelihoods cannot be overstated. Ninety-four percent of rural residents and 38 percent of urban residents engage in agriculture to some extent (Jones, Shrinivas, and Bezner-Kerr 2014), the vast majority as smallholder farmers with landholdings of less than one hectare. Maize accounted for nearly half of smallholder-cultivated land between 2010/11 and 2014/15, followed by groundnut, bean, cassava, sweet potato, and other food crops (Benson and Edelman 2016). These foods are grown for household consumption and for sale at local and regional markets. The Malawian food supply, especially in rural areas where markets are thin with few buying or selling options, is shaped largely by trends in smallholder food crop production.

In the last decade, Malawi has experienced rapid smallholder-led growth in the agricultural sector, largely attributed to the Farm Input Subsidy Program (FISP), a major government program that annually provides about half of all smallholder farming households with heavily subsidized fertilizer and seed (Arndt, Pauw, and Thurlow 2016). Despite this progress, the country still faces significant challenges in terms of food security and nutrition outcomes (Figure 1). Analysis of data from the Third Integrated Household Survey (IHS3) of 2010–2011 suggests that 36.7 percent of rural Malawian households fail to access sufficient calories (NSO 2012). Estimates from the 2010 Malawi Demographic and Health Survey (DHS) indicate that 47 percent of children under the age of five in Malawi are stunted (height-for-age index scores below minus two standard deviations from the median of an international reference population) (NSO and ICF Macro 2011).[1] Thus Malawian diets are lacking in terms of the quantity of food—total calories consumed—and more so in terms of the quantities of nutrient-rich foods, such as meat, fish, eggs, dairy, legumes, fruits, and vegetables.

Good nutrition requires both—that is, enough total calories (quantity) and enough total vitamins and minerals per calorie (quality). Without a high-quality diet, even children who can fill their bellies on most days will suffer from chronic undernutrition. The most obvious sign of chronic undernutrition is stunted growth, or low height-for-age, where children are significantly shorter than well-fed and healthy children of the same age (WHO and UNICEF 2009).

In addition to suboptimal physical growth, there are invisible, insidious effects of chronic undernutrition. Children under two who consistently consume poor-quality diets are known to have impaired cognitive development that can lead to economic underperformance and other adverse outcomes in adulthood (Hoddinott et al. 2008). Poor educational attainment, low per capita income, low wage rates, and an increased likelihood of falling below a designated poverty line in adulthood are some of the indicators associated with chronic undernutrition in childhood (Martorell et al. 2010). And while it is individuals and families who bear the heaviest burden in terms of lives lost and potential wasted, the ripple effects of undernutrition reach all the way up to national and regional economies. Stunting is associated with GNP losses of up to 11 percent across Africa and Asia, where prevalence rates are highest (Haddad 2013). In Malawi, where stunting prevalence is very high according to global standards (NSO and ICF Macro 2011), child undernutrition is a huge drain on the human and physical capital of the country, constraining national economic growth.

FIGURE 1 AVERAGE HOUSEHOLD CALORIE INTAKE SHORTFALLS, PREVALENCE OF STUNTED CHILDREN UNDER 5, AND PREVALENCE OF THIN WOMEN AGED 15 TO 49, BY DISTRICT, MALAWI, 2010



Source: Maps by M. Kedir Jemal, IFPRI, of IHS3 and DHS results and IHS3 calorie intake deficiency from the analytical results of Verduzco-Gallo, Ecker, and Pauw (2014).

As such, reducing stunting rates in young children in order to improve human capital for future health and productivity is good policy. Examples of health-based programming to improve nutrition are deworming, micronutrient supplementation, improved antenatal care, and therapeutic treatment of acute malnutrition. These direct nutrition actions target women of childbearing age and young children, primarily during the key window of opportunity between pre-pregnancy and two years of age. They are typically delivered via clinics, hospitals, and community health workers.

However, it is now widely accepted that in addition to the health sector, agriculture and other sectors also have roles to play in reducing undernutrition (World Bank 2013, Ruel et al. 2013, WFP 2016). Given this approach, what expanded role might the agricultural sector—particularly the dominant smallholder farming systems of the country and the food supply chains they influence—play to significantly improve Malawi's nutrition statistics? And more broadly, what options exist for agriculture-based strategies to improve these statistics? While other factors besides agriculture policy—such as high population growth, limited land resources, and climatic shocks—are seen as playing a strong role in various dimensions of the nutrition challenge, we theorize that agriculture has a strong role to play in improving diets in particular. Some perspectives on these questions are offered below—first, via consideration of the food security concept, which along with health and care is considered a key driver of nutrition outcomes,[2] and second, by presenting a conceptual framework describing causal pathways through which agriculture affects nutrition.

FOOD SECURITY IN MALAWI: WHERE DOES NUTRITION FIT?

Food security is commonly defined as "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). This definition includes four dimensions that must be fulfilled simultaneously:

- Physical food *availability* at a national or community level determined by food production, stock levels, and net trade.
- Households' and individuals' economic and physical *access* to food.
- Food *utilization*, commonly understood as energy and nutrient intake by individuals as a result of care and feeding practices, food preparation, diversity of the diet, and intrahousehold distribution of food. Food utilization can be considered the most explicitly nutrition-oriented aspect of food security. It is important to note that utilization of food is a biological process that is affected not only by food intake but also by the presence of infection or disease, since a sick individual will absorb or utilize the nutrients in food less effectively than someone who is healthy.
- *Stability* of the other three dimensions over time.

In general, Malawian diets are heavily dominated by staple foods, maize first and foremost, but also rice and cassava in some areas. As such, food security in Malawi is often equated with having access to enough maize—whether through own production or from other sources, especially local markets—for a household to meet the caloric needs of its members. What is missing in this traditional measure of food security in Malawi is the importance of the quality, in addition to the quantity, of dietary intake. While maize and most other popular staple crops are high in carbohydrates, they are low in proteins, vitamins, and minerals. Because most Malawian meals rely heavily on maize, other nutrient-rich foods, such as fruits, vegetables, fish, beans, and meat, are often consumed in small amounts or not at all. Thus, meals are often adequate in terms of total calories or quantity, but likely to be inadequate in terms of quality.

This household-level scenario is reflected in—and exacerbated by—national development priorities; food security is a top-line agenda item for agriculture in Malawi, whereas nutrition is still considered primarily a health issue. This conceptual division

facilitates conflation of food security with staple crop production alone, as opposed to encouraging a comprehensive perspective that systematically considers the importance of non-cereal crops and pays greater attention to the utilization dimension of food security. This perspective also results in adopting approaches to addressing nutrition needs exclusively through health-based delivery platforms, where the primary focus is on women's and children's health as described above, as opposed to seeing nutrition as a multisectoral issue for which diverse food is a key component and agriculture and food systems are important drivers.

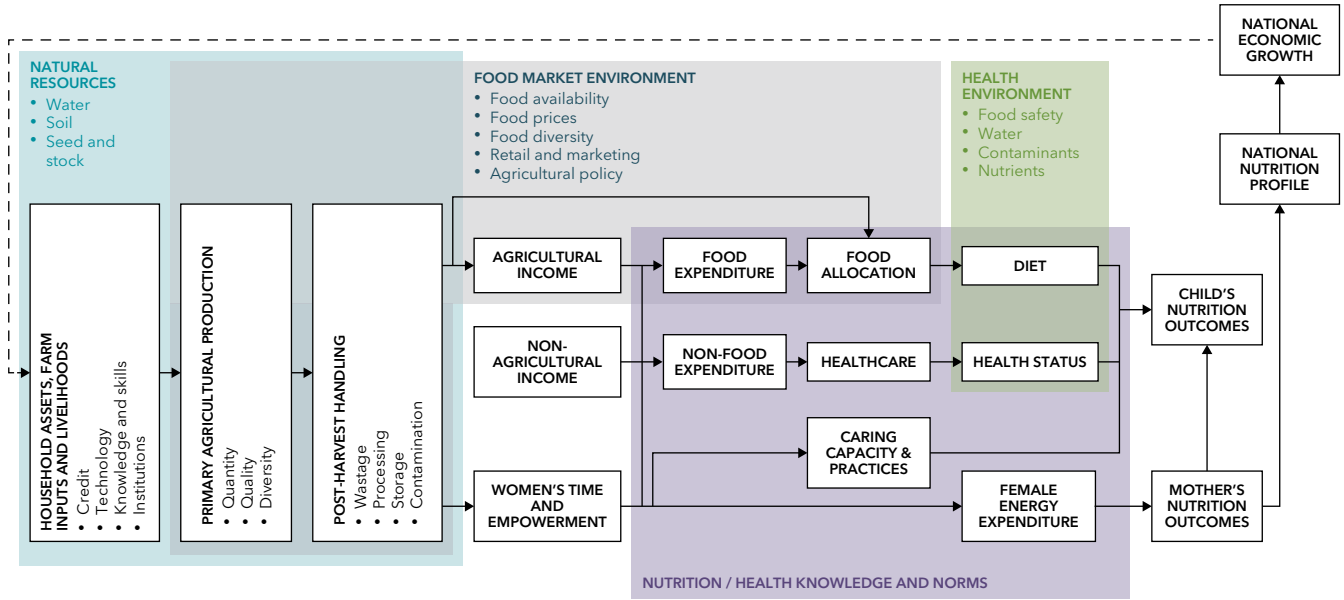
CONCEPTUAL PATHWAYS FROM AGRICULTURE TO NUTRITION

Applying a food and agriculture lens to nutrition requires a conceptual framework that clarifies the causal pathways through which agriculture affects nutritional outcomes. The framework in Figure 2—adapted to the Malawi context and referenced throughout this publication—does just this. Agricultural investments and activities are listed on the left of the diagram, while nutrition outcomes are listed on the right. While the trajectories from agriculture to nutrition are not always linear, in general, they can be divided into four main pathways, all of which apply to household- and individual-level outcomes.

(1) Agriculture as a source of food: Agriculture affects nutrition most directly when food grown by the household is consumed within that household. Farm households can improve nutrition of household members if

- their production practices and post–harvest practices improve the diversity, consistency over the year, and quantity of foods available to the household;
- the foods available to the household are allocated to individual household members, based on age and gender-specific nutrient requirements; and
- the health status of household members does not hinder absorption of nutrients from the healthy foods that they eat.

FIGURE 2 CONCEPTUAL PATHWAYS BETWEEN AGRICULTURE AND NUTRITION



Source: Herforth and Harris (2014), p. 3.

BOX 1 ENABLING ENVIRONMENT FOR NUTRITION: NATURAL RESOURCES, HEALTH, KNOWLEDGE, AND NORMS

Natural resources environment: Appropriate management of natural resources—water, land, and biodiversity—has direct consequences for the livelihoods and nutrition of farm families. Irrigation, for example, facilitates production diversity and increased yields with positive implications for food consumption and nutrition; however, it can also increase the risk of ill health due to waterborne disease and fertilizer runoff.

Climate change should be a routine consideration in management strategies. Early or late onset of rains, floods, droughts, shortened crop seasons, and premature harvests cause yield declines, which lead to decreased food availability and income for farming households. These challenges require farmers to continually adapt their agricultural livelihood strategies to maintain the viability of their natural resources base.

Health environment: Agricultural production interacts with health environments and related water and sanitation environments to influence nutrition for better or for worse. For example, livestock production schemes may increase exposure to zoonotic disease and impair good sanitation practices. Similarly, employment schemes in rural areas that target women may increase income, but may also reduce the amount of time that women can spend on childcare, cooking, fetching water and firewood, and home-based agricultural work, all of which are directly related to nutrition and health. Agriculture projects will have a higher likelihood of successfully impacting nutrition when these inherent tradeoffs are acknowledged as important considerations to be routinely addressed in project implementation via nutritional-risk reduction measures.

Knowledge and norms: Farming and nutrition knowledge held by family and community members has a major bearing on decisions related to agriculture and nutrition that are made within households. For example, activities that promote knowledge of nutrition and health may affect decisions around food production, purchase, and consumption. These decisions may enhance positive outcomes for both the agriculture and nutrition sectors while avoiding negative impacts. Conversely, knowledge and use of key agricultural practices and skills can include information that builds awareness and protects against harm to health and nutrition. For example, nutrition-sensitive livestock-raising practices may change how animals are kept in relation or proximity to the home, or nutrition-sensitive irrigation practices may help avoid household consumption of contaminated water. Social and behavioral change activities promoting nutritious diets and healthy practices—provided by an agricultural extension system or in collaboration with other sectors—can further enhance the impact of agricultural activities on nutrition.

(2) Agriculture as a source of income: Income from wages earned through agricultural labor or the sale of agricultural products can be used to purchase food and other nutrition-relevant items, such as healthcare. As discussed in Chapter 5, income from crop specialization could be as beneficial to nutrition as crop diversification. Agricultural income can improve nutrition of household members if

- household income produced from agricultural activity is partly spent on diverse and nutritious foods;
- diverse and nutritious foods are available and affordable in local markets throughout the year for purchase by households;
- the foods available to the household are allocated to individual household members based on age and gender-specific nutrient requirements; and
- the health status of household members does not hinder absorption of nutrients from the foods eaten.

(3) Agriculture as moderator of women's time use and decision-making power: Women regularly work in agriculture and they make most nutrition-related decisions for the family, for young children in particular. When women have greater control over the use of household income, it is more frequently used on food and healthcare for family members (Smith et al. 2003). However, women often do not have control over household resources or power in household decision making. We examine issues of household decision making related to cropping and spending decisions in Chapter 3.

Thus, agricultural activities that increase women's income and decision-making power can have positive impacts on nutrition due to resultant increased household expenditures on nutrition-relevant goods and services. However, this assumes that these agricultural activities have a positive net effect on

- the amount of time a woman is occupied in them, as this will have consequences for the time she can focus on the food, health, and care of her family; and
- the amount of energy a woman expends on them, as this too has consequences for her own nutrition and health outcomes, as well as those of her children (and for fetal health if she is pregnant).

(4) Agriculture as a moderator of food markets: Agriculture and food-system policies affect a range of supply and demand factors that influence how well food markets perform in terms of the availability, price, and diversity of food. Food markets are a part of the environment in which farm households fulfill their food security and nutrition needs. Chapter 4 examines aspects of the food market environment, such as prices and availability and the implications for demand for nutritious foods. Food market performance can affect nutrition through

- the income of net seller households and the purchasing power of net buyers, and
- the availability and affordability of diverse and nutritious foods in local markets throughout the year.

Agriculture as a moderator of food markets is of particular importance in the Malawian context given the contribution of smallholder agriculture to domestic food supply. Only 5 percent of Malawi's farmers are exclusively commercial producers, while the remainder are largely subsistence-oriented, both buying and selling food to supplement food stocks and to address cash needs (Jayne, Zulu, and Nijhoff 2006). This pathway is captured in the gray-shaded box in Figure 2 on the food market environment. This environment affects the kinds of foods that are available locally and likely to be purchased, as well as those that are likely to be produced by farm households as a response to price signals and market incentives. Farm households determine what crops they will sell to markets and what crops will be consumed at home largely as a response to conditions in the food market environment.

Food market environments also are influenced by government policy and the actions of the private sector. In Malawi, input subsidies for maize, plans for investment in irrigation (the implications of which are covered in Chapter 6), and private-sector investment

in groundnut-based value chains are prime examples. In regard to value chains, it is important to note that labeling and social marketing are tools used by both the public and the private sectors to influence food purchase decisions and consumption habits. These tools send messages about the convenience of purchase and preparation of particular foods, their nutritional content, and related perceptions of quality and safety. Depending on the context, these messages can affect purchase decisions by households as much as the relative price of foods. This raises the issues of promoting the nutritional value of food chains, as is discussed in Chapter 3.

In addition to food markets, natural resources (in the blue box in Figure 2), the health environment (the green area), and nutrition and health knowledge and norms (the purple area) are often referred to collectively as the "enabling environment for nutrition" (see Box 1). Together, these contextual factors affect the trajectories of the causal pathways from agriculture to nutrition described.

UNPACKING THE FACTORS AND PATHWAYS: FROM AGRICULTURE TO FOOD SECURITY AND NUTRITION

Agriculture has the potential to affect nutrition through all these pathways, often through multiple pathways at once. For each pathway, increased access to and availability of nutrient-rich foods is a key step. However, achieving such increases in Malawi requires addressing major challenges in several areas, not least of which are strong cultural preferences for meals based heavily on maize and other starches, and the high cost of nutrient-rich foods relative to staples. National agricultural policy can contribute to overcoming these challenges by (1) promoting production of nutrient-dense foods via subsidies and other incentives; (2) promoting food processing, marketing, and consumption in ways that conserve nutrients, create demand, and decrease prices; and (3) supporting women farmers through, for example, targeted efforts to increase their productivity and bargaining power.

This publication provides a series of primary and secondary data analyses that are illustrative of these challenges and their potential mitigation. Subsequent chapters delve deeper into the issues raised in the conceptual framework above. The authors of these chapters examine a number of pathways through which agriculture can potentially impact diets and nutrition, including agricultural practices and technologies, food prices, crop sales, household income, poverty status, and women's decision-making power. However, it should be noted that this report is not explicitly concerned with poverty or with increased income as outcomes. Rather, increased income is seen as an important potential pathway for individuals and households to access a more diverse and nutritious food basket.

In Chapter 2, we discuss the common metrics and measures used to analyze or track agriculture, nutrition, and food security, as well as the data required. Working across sectors with complex pathways, it is important for policy makers, researchers, and practitioners to understand which indicators are appropriate for tracking progress along the pathways. While diets are the mediating factor between agriculture and nutrition, data limitations constrain our ability to directly measure diets in this report; thus most analysis of food consumption patterns takes place at the household rather than individual level. This is a critical data challenge faced both in Malawi and globally in determining how best agricultural activities and systems can contribute to better nutrition.

Chapter 3 explores agricultural production diversification and the relative importance of own-consumption, agricultural income, and women's time and empowerment pathways for diets. It undertakes a qualitative assessment of dietary preferences and patterns in the context of the promotion of nutritious and marketable crops among smallholder farmers.

Chapter 4 involves analysis of data from Malawi's Second and Third Integrated Household Surveys (IHS2 and IHS3) to examine the effects of the food market environment and the income pathway, including food prices and government interventions, on household access to food and micronutrients. Chapter 5 explores the effects of farm production choices on food consumption via income or own-consump-

tion pathways. Analysis includes assessing the determinants of farm production diversity and its impact on household dietary diversity, again with a focus on household access to micronutrients, using IHS3 data.

Chapter 6 examines lifting the constraint on natural resources (water) through agricultural technologies and how this affects first agricultural production and then food consumption. Specifically, the associations between irrigation and food security and nutrition outcomes are explored also using IHS3 data. Finally, Chapter 7 synthesizes a set of conclusions from the previous chapters on how agricultural systems and activities in those systems in Malawi might contribute significantly to achieving better diets in the country.

The authors of the chapters in this report largely rely on data from the IHS series of nationally representative surveys for their analyses. However, a significant concern in doing so arises from the potential challenges associated with the quality of the anthropometric data in the IHS3 dataset. There is a significant difference in the reported stunting prevalence for children under 5 years of age—30 percent versus 47 percent, respectively—in the estimates from the 2010–2011 IHS relative to those from the 2010 DHS. The Malawi DHS series is commonly considered the standard source of information on nutrition and health conditions for the country. However, the need for integrated data along the pathways from agriculture to diets to nutrition outcomes makes the IHS the most useful data source for cross-sectoral analysis, as discussed in Chapter 2.

As was noted earlier, the report on the 2015–2016 Malawi DHS (NSO and ICF Macro 2017), which was published as this document was being finalized, estimates a 10 percent decrease in stunting prevalence among children under five years of age nationwide since 2010. Likewise, improvements in underweight and wasting were also found. These improvements in nutrition outcomes could be the lagged positive nutritional outcomes resulting from a number of years of agriculture-led economic growth in Malawi due to favorable weather and input subsidies. However, this is not empirically tested in this publication.

While the official agricultural production estimates for Malawi are frequently discounted by users and other observers as being often subject to unwarranted adjustment for political reasons (Chirwa and Dorward 2013), the number of people requiring humanitarian food aid in Malawi was historically low between 2006 and 2012 (MVAC 2012), reflecting relatively improved food security due in part to the FISP. However, considering subsequent food shortages, culminating in the El Niño–driven food crisis Malawi faced in 2014/2015 and 2015/2016 planting seasons, there is a serious concern that these recently observed improvements in the prevalence of chronic malnutrition among young children will slow if not reverse. As such, understanding and leveraging the linkages between agriculture and nutrition in order to maintain progress—considering climatic variability, pervasive poverty, and vulnerability to shocks—is all the more salient in the face of these recent improvements.

Chapter 2 INDICATORS FOR EXAMINING LINKS BETWEEN AGRICULTURE, FOOD SECURITY, AND NUTRITION

Janice Meerman, Noora-Lisa Aberman, Jody Harris, and Karl Pauw

ABSTRACT: HOW CAN THE NUTRITION IMPACT OF AGRICULTURE PROGRAMS BE ASSESSED?
Depending on context, data may need to be collected on production practices for food, livestock, and cash crops; post–farm gate value chain and other market-based activities; commodity prices; household food security; women's empowerment; dietary quality and quantity, and nutritional status. This chapter provides a primer[3] on commonly used indicators for these processes and outcomes: diet and nutritional status; household food security; gender, household decision making, and empowerment; agricultural production, productivity, and diversification; and food markets and prices. The importance of dietary quality as a key intermediary between agriculture and nutrition is emphasized throughout this chapter. Individual dietary quality is best measured by dietary diversity as dietary diversity indicators have been repeatedly validated as predictive of nutritional adequacy. Individual dietary quality is a key outcome to measure the success of most agricultural programs and policies, if an impact on population well-being is desired. However, in many countries the surveys which collect data on individual dietary patterns (and other nutrition indicators) are not the same as those which collect information on agricultural production. While justifiable from a sectoral perspective, this "data disconnect" poses a challenge to analyzing agriculture–nutrition links.

ASSESSING DIETARY AND NUTRITIONAL STATUS

Agriculture produces food, food comprises diets, and diets determine nutritional status. Diet (quality and quantity of food consumed) and nutrition (weight and height) outcomes are measured at the individual level, as they relate to what an individual consumes and the physical process of absorbing and utilizing nutrients within the body. These types of metrics are appropriate for assessing the utilization dimension of food security (see Chapter 1) in which individual nutrition practices can be detected.

DIETARY RECALL AND INDIVIDUAL DIETARY DIVERSITY SCORES

Twenty-four-hour food recall surveys collect detailed information on the precise foods[4] and amounts eaten by an individual over the past day. Food composition tables are then used to assess the nutrients in these foods, providing an estimate of an individual's dietary quality and the quantity of nutrients consumed (Jones et al. 2013).

Eating a variety of foods helps ensure adequate intake of essential nutrients and promotes good health. Accordingly, individual dietary diversity measures are used as indicators of dietary quality. Dietary diversity scores for an individual are computed from information on the number of specific food groups from which the individual consumed food over a recent short period of time. These metrics have been repeatedly validated as having a robust and consistent positive statistical association with adequacy in individual micronutrient consumption. In other words, the higher the dietary diversity score for an individual, the more

likely that individual has a diet that meets his or her vitamin and mineral requirements (Ruel, Harris, and Cunningham 2013).

The populations from which indicators of individual dietary diversity are most commonly collected are women of reproductive age, via the Women's Dietary Diversity Score (WDDS), and children under two years of age, via the Infant and Young Child Dietary Diversity Score (IYCDDS) (Leroy et al. 2015).

ANTHROPOMETRY

Anthropometry assesses the physical growth status of an individual relative to an international reference population. In other words, it measures the impact of an individual's diet on his or her weight and height. Thus, anthropometric statistics are typically reported as indexes based on standard deviations from the mean of this reference population, or Z-scores. In children, two of the most commonly used anthropometric indexes are height-for-age (HAZ) and weight-for-height (WHZ) (WHO 2008).

Children whose height-for-age is less than two standard deviations below the median height of individuals of the same age in the reference population (HAZ<-2.0) are considered stunted in their growth and suffering from chronic (long-term) undernutrition. In contrast, children with low weight-for-height (WHZ<-2.0) are assumed to be wasted and suffering from acute (recent and severe) undernutrition. Stunting prevalence can be high even in situations of relative food security, depending on the quality of diets consumed and the prevalence of infectious disease. Wasting in children is often seasonal due to food shortages and disease and carries a higher risk of death.

In addition to these indicators, mid-upper arm circumference or MUAC, is also used to assess the nutritional status of children and, in some cases, adults. Body mass index (BMI), which is computed as the weight of an individual in kilograms divided by the height of the individual in meters squared (kg/m^2), is a more commonly used anthropometric indicator for adults and is used to detect both under- and overnutrition.

Demographic and Health Surveys (DHSs) are considered among the best sources of anthropometric data in many countries, including for Malawi. Five nationally representative DHSs have been carried out in Malawi—in 1992, 2000, 2004, 2010, and 2015.

ASSESSING HOUSEHOLD FOOD SECURITY

Household food security measures provide estimates of families' access to food. Access, in this context, is both physical and economic, including foods that a household grows for its own consumption and foods that a household purchases outside the home. Household access to food is typically used as an indicator of income and household calorie availability or lack thereof (Hoddinott and Yohannes 2002; Swindale and Bilinsky 2006).

While some of the most commonly used household food security indicators look only at household access to different food groups, others go further, estimating per capita calorie and micronutrient availability based on international recommendations for individual requirements. However, if these estimates are based on household-level data that do not capture how food is divided between household members, they should not be considered representative of individual-level diets.

HOUSEHOLD DIETARY DIVERSITY SCORE

As it is strongly associated with household calorie access and socioeconomic status, household-level dietary diversity is considered a proxy indicator for food access. It is used to measure the quantity and type of foods eaten by a household as a whole, thus providing information on what dietary options are available to individual household members, albeit without unpacking how those options may be exercised, since the allocation of food to individual members is not addressed during data collection (Hoddinott and Yohannes 2002; Kennedy et al. 2010). Household-level dietary diversity cannot be used to assess individual-level dietary intake or quality.

The most commonly used indicator of household dietary diversity is the Household Dietary Diversity Score (HDDS). HDDSs are calculated by summing

equally weighted response data on the consumption of 12 food groups by the family over a given recall period. These food groups are cereal grain staples, roots and tubers, vegetables, fruits, meat, eggs, fish, pulses and nuts, dairy products, oils and fats, sugar, and condiments. Higher numbers of food groups consumed and, hence, higher HDDS scores are associated with higher household access to calories (Hoddinott and Yohannes 2002; Kennedy et al. 2010). For Malawi, HDDSs can be calculated using food consumption data collected for Malawi's Second and Third Integrated Household Surveys (IHSs).

MICRONUTRIENT-SENSITIVE HDDS AND HOUSEHOLD MICRONUTRIENT ACCESS

The Micronutrient-sensitive Household Dietary Diversity Score (MsHDDS) was created by IFPRI to increase understanding of which micronutrients are available to households through the foods that families reported eating (Verduzco-Gallo, Ecker, and Pauw 2014). To date, the MsHDDS has only been applied in Malawi, using food consumption recall data from IHS2 and IHS3.

Based on the same idea as a conventional HDDS, the Malawi MsHDDS further subdivides the food groups used to calculate the final score: the vegetable group is divided into dark green leafy vegetables, vitamin A–rich (red/orange/yellow) vegetables, and other vegetables; the group of fruits is divided into vitamin A–rich fruits and other fruits; and the group of meat is divided into red meat and white meat (mainly poultry). A total of 16 different food groups are used for the MsHDDS, rather than the 12 groups used for the HDDS.

An additional indicator, household micronutrient access, can then be estimated. This indicator—based on per capita estimates of micronutrient intake—provides more detail on which micronutrients are available to household members than is provided by the MsHDDS alone, which only provides a simple count of food groups eaten. The per capita intake estimates are compared to age- and sex-specific nutritional requirements (using World Health Organization standards) to estimate the prevalence of shortfalls in micronutrients accessed by the household (Ecker and Qaim 2011).

As with the HDDS, lack of information about intrahousehold food allocation is the primary reason why the MsHDDS and related estimates of per capita micronutrient consumption should be viewed as a measure of household access to diverse foods and adequate micronutrients rather than of individual nutrient intake. Furthermore, while there are clear theoretical associations between these indicators and individual dietary quality,[5] these associations have not been empirically validated.

Nonetheless, the MsHDDS adds a useful nutrition lens to a common food security indicator, and the Household Micronutrient Access indicator provides a rare example of nationally representative food-based micronutrient access estimates. The fact that these indicators can be constructed using household consumption and expenditure data increases their value (see section below on Addressing the "Data Disconnect").

FOOD CONSUMPTION SCORE

Developed by the World Food Programme (WFP), the Food Consumption Score (FCS) is a composite score comprising data on food groups and the frequency of consumption of those food groups. The typical recall period is usually 7 days (as opposed to the HDDS, which may be either 7 days or 24 hours) and data are collected on fewer food groups—8 food groups, rather than 12. Each food group is weighted according to its nutritional value (for example, sugar and oil receive a weight of 0.05, while meat, milk, and fish receive a weight of 4.00), and the questionnaire collects information on how often each of the food groups was consumed by one or more family members over the past week. The FCS is intended to monitor changes in food security status across large geographic areas, such as regions or countries, and is positively associated with per capita calorie consumption (Jones et al. 2013; Lovon and Mathiassen 2014). Using household survey data, WFP periodically computes FCS for Malawi as part of its food security monitoring efforts, presenting aggregate results at national and district levels.

HOUSEHOLD FOOD INSECURITY ACCESS SCALE AND COPING STRATEGIES INDEX

The Household Food Insecurity Access Scale (HFIAS) is based on the assumption that there is a set of predictable reactions to the experience of food insecurity that can be summarized and quantified (Carletto, Zezza, and Banerjee 2013). Based on the administration of nine questions to a household respondent, this measure has been incorporated into household surveys around the world and has been validated in Latin America and Africa south of the Sahara for reliability and validity in local contexts (Knueppel, Demment, and Kaiser 2010; Melgar-Quiñónez et al. 2006). However, other validation studies suggest that this indicator's cross-cultural comparability may be weak, due largely to cultural and language issues that complicate interpretation of results across contexts (Swindale and Bilinsky 2006). In response to this criticism, the Household Hunger Scale (HHS) was created and has been cross-culturally validated, although its design only captures severe cases of food insecurity (Ballard et al. 2011). The harmonized Latin American and Caribbean Food Security Scale (ELCSA) and the recently launched Food Insecurity Experience Scale (FIES) are examples of similar, experience-based food security scales (Cafiero et al. 2014). In Malawi, the FIES is currently included in IHS and in a nationally representative annual survey administered by the Gallup World Poll.

The Coping Strategies Index (CSI), developed by WFP, also takes an experiential approach to food security analysis, assuming that there are several behavioral coping strategies used by households to manage food shortages. The CSI is composed of a weighted average of the frequency and severity of a menu of these coping strategy behaviors, developed and assessed based on location-specific assessments and appraisal methods (Carletto, Zezza, and Banerjee 2013). The CSI is periodically reported for Malawi by WFP.

Unlike household dietary diversity indicators, the food insecurity scales and the CSI have been validated to predict food vulnerability (Carletto, Zezza, and Banerjee 2013). That is, these indicators can predict impending food insecurity, as opposed to providing only an immediate snapshot of what foods households were accessing at the time of the survey.

ASSESSING GENDER, HOUSEHOLD DECISION MAKING, AND EMPOWERMENT

As women are more likely than men to influence the nutrition outcomes of family members due to their roles as primary caretakers and mothers, agricultural interventions that include an emphasis on women's empowerment generally have proven to be more effective at improving nutrition than approaches that do not (Hawkes and Ruel 2007). Moreover, women's nutritional status and control over assets are important for improving agricultural productivity and investment (FAO 2011, Meinzen-Dick et al. 2011). As such, measuring women's empowerment and decision-making power is considered an essential requirement for understanding the linkages between agriculture, food security, and nutrition (Quisumbing et al. 2014; van den Bold, Quisumbing, and Gillespie 2013).

Women's empowerment is best viewed as a process and thus is often assessed in terms of improvements in decision-making power over time. Proxies for decision-making power include women's income, education, and assets (Malapit and Quisumbing 2014). Assets can include physical assets, such as jewelry and livestock, or social assets, such as group membership. Direct indicators of empowerment and decision-making power include how the earnings of the woman and her husband are spent; how much the woman earns relative to her husband; whether she owns or co-owns land or a house; and who makes decisions concerning the woman's healthcare, major purchases, and visits to family (Heckert and Fabic 2013). In the context of nationally representative surveys, these questions are primarily asked to one woman in each household.

The Women's Empowerment in Agriculture Index (WEAI) collates multiple dimensions of women's empowerment as they relate to agricultural production and human development outcomes, including nutrition (IFPRI 2012). The WEAI is a composite empowerment score, comprising standardized questions posed to the primary male and female decision makers in the household across the following domains: input into agricultural production decisions; autonomy in production; ownership of assets; purchases, sales, or transfers of assets; access to and decisions on credit;

control over the use of income; group membership, public speaking, and other leadership activities; existence of leisure time; and workload. To date, WEAI interviews provide one of the most comprehensive data sources for assessing women's empowerment and how it relates to agriculture, food security, and nutrition outcomes. The WEAI was developed by IFPRI and is currently used in projects of the Feed the Future initiative of the US government in Malawi and elsewhere.

ASSESSING AGRICULTURAL PRODUCTION, PRODUCTIVITY, AND DIVERSIFICATION

Unlike nutrition and food security indicators—many of which have been rigorously validated—metrics for assessing agricultural production, productivity, and diversification are often best considered as theoretical proxies. As such, the discussion below differs somewhat from the sections above. More detail is provided on data sources and the theoretical underpinnings of these indicators, while less is provided on validation and construction.

AGRICULTURAL PRODUCTION: CROPS

The most commonly used agricultural indicators are those pertaining to production of crops or livestock. Because of the cereal-centric nature of agriculture and food preferences in Malawi and many other countries, crop production estimates typically receive more attention than livestock production estimates. Crop yields are usually defined as output per unit of land—typically metric tons per hectare. Estimates can be aggregated to district or national levels, or assessed at the household or farm level.

The most common approach is to rely on local government agricultural extension workers—typically from the Ministry of Agriculture or similar agency—to provide estimates of local crop yields. These local production statistics are then aggregated up to the district or national level. In Malawi, the Agricultural Production Estimates Survey (APES) of the Ministry of Agriculture, Irrigation, and Water Development (MoAIWD) produces three rounds of crop estimates annually. While estimates from extension officers are perhaps the easiest way to collect yield data, they are also considered highly subject to measurement error, given that they usually rely on informal interviews with farmers and local communities (Jayne and Rashid 2010, 2). Ministerial crop estimates also tend to be vulnerable to upward or downward revision for political reasons.

Alternatively, detailed, nationally representative data on cropland allocation, crop production, and crop sales can be captured through household surveys, such as Malawi's IHS, or the less frequent National Census of Agriculture and Livestock (NACAL), last conducted in 2006/2007. In Malawi, these surveys are implemented by the National Statistical Office (NSO) and may be more accurate than the annual crop estimates, both because of the more accurate methods used and because the likelihood of political interference is lower.

AGRICULTURAL PRODUCTION: LIVESTOCK

Both crop forecast surveys and household surveys often collect data on livestock ownership. In some cases, data collected by household surveys may be quite detailed, capturing information on current livestock ownership and stock changes due to new births, purchases, sales, theft, or consumption over a 12-month period. Specific indicators include whether a family owns any livestock, which and how many species they own, and the type or amount of animal products, e.g., milk, eggs, meat, honey, and the like, produced by the household.

One convenient way of quantifying ownership of a wide range of different livestock types in a standardized manner is to convert numbers to equivalent tropical livestock units (TLUs). For example, relative to a cow of 250 kg (with TLU = 1.0), a sheep or goat weighing 30 kg will have a TLU = 0.2. The ratio is based on the concept of metabolic weight (that is, energy expenditure per unit of body weight per unit of time) and the fact that smaller animals produce more heat and consume more food per unit of body size.[6] This conversion can be done in Malawi with both the NACAL and the IHS datasets.

CROP DIVERSIFICATION

The term agricultural diversification broadly relates to the concept of allocating resources (inputs) across an increasing number of agriculture-related activities. The concept can be applied at the farm, district, or country level. Crop diversification, more narrowly, refers to the idea of not only increasing the number of crops (or varieties) that are grown, but also to how equitably land is allocated across those crops. Crop diversification is seen as an approach toward broad-based agricultural development and an important risk-management strategy for farm households, especially in a country like Malawi that relies heavily on a limited range of rainfed food crops, yet faces significant weather challenges in the short run (Devereux 2007). From a nutrition perspective, studies in Kenya, Malawi, Uganda, and Rwanda have found that agricultural systems with greater agrobiodiversity are associated with greater dietary diversity at village, farm, and household levels (Herforth 2010; Remans et al. 2011; Jones et al. 2013; Romeo et al. 2016).

The most commonly used indicator of crude crop diversity is a simple crop count, that is, how many crops or varieties are being grown. However, several indexes, including the Herfindahl–Hirschman Index (HHI) and the Simpson Index of Diversification (SID), are often used with or instead of these simple counts to assess not only the number of crops grown, but also the share of land allocated to each (Minot et al. 2006; Joshi et al. 2003). The SID, for example, equals zero under complete specialization, indicating that all land is allocated to one crop. Theoretically, it approaches one under increased diversification, indicating that a very large number of crops are being grown under equitable land allocation. In Malawi, crop counts and diversification indexes can be calculated using APES, NACAL, and IHS datasets at differing levels of aggregation.

AGRICULTURAL PRODUCTIVITY

The rate of production for given inputs is described as productivity. In a context like Malawi's, where land is scarce and productive inputs such as fertilizer are expensive, productivity per unit of land, labor, fertilizer, or other inputs into agricultural production is often discussed. Raising productivity through adoption of improved farming techniques or technological innovation—such as small-scale irrigation or sustainable-intensification approaches—is seen as an important strategy for improving food availability. Increased productivity may also be associated with increased farm profits and household income, which, in the presence of reliable food markets, can improve access to food. Indicators of productivity generally are derived using the same agricultural production data sources as above—in Malawi these are IHS, APES, and NACAL.

ASSESSING MARKET ACCESS, MARKET PARTICIPATION, FOOD PRICES, AND SEASONALITY

MARKET ACCESS AND PARTICIPATION

The degree to which households participate in or have access to markets is relevant to food security and nutrition outcomes. Households may engage either as sellers of their own produce, buyers of food available in local markets or trading centers, or both. Market access is often assessed in terms of a household's physical proximity to markets. Specific indicators include distance, traveling time, or cost of transportation to improved roads or to trading centers. Participation simply refers to whether a household engages in market transactions, including barter.

Household surveys often collect detailed information about market access and participation. In Malawi, the IHS agricultural questionnaire captures information about the quantity and value of crop sales (i.e., by producers), including the place of sale (farm gate or local market) as well as the distance and cost of transport to that place of sale. The latter often reflects a combination of distance and quality of road networks. Utilizing such information, Jayne et al. (2010), for example, find that among smallholder maize producers in Malawi, around 55 percent only buy maize at markets; 9 percent only sell maize; 8 percent engage as both buyers and sellers of maize;

and 28 percent of maize producers are autarkic, meaning they do not participate in markets at all. This suggests that almost three-quarters of maize farmers have physical access to and actively participate in markets. However, for the remaining autarkic households, the choice not to participate does not necessarily imply a lack of physical access, and for this reason information about distance and transport costs to markets is useful for better understanding their choice.

Also on the consumption side, which may include farm and nonfarm households, the IHS contains useful information about market access and participation. When reporting on food consumption, households report the quantities of food obtained from own production, gifts, or market purchases; for the latter category, actual expenses are also reported. This permits the calculation of unit food prices and their distribution across different regions, which alongside consumption data can be used in the analysis of costs of living, poverty, and food access and availability (see, for example, Chapter 4). The extent to which households procure food from the market is an indication of their access to markets; however, as is the case with farm households choosing not to participate in markets, households reporting zero food purchases do not necessarily lack physical access to markets, but may simply choose not to participate, perhaps because they obtain sufficient quantities of food from other sources. For example, IHS data show that around 36 percent of maize consumed in rural areas is purchased, while in urban areas this share is 68 percent. For the relatively large share of households—especially in rural areas—that are not dependent on markets for their maize needs, it is necessary to also consider information about distance or transport costs to markets before drawing conclusions about market access. In this regard, the IHS community questionnaire, administered to village or neighborhood representatives, asks several questions about the distance and frequency of visits to local markets, as well as the availability of staple foods in markets compared with five years before.

FOOD PRICES AND SEASONALITY

Food price volatility is most commonly measured by the coefficient of variation (CV) in prices, a standardized indicator of the degree to which a commodity's price in a particular market diverges from the mean regional or global price of that commodity. In this sense, the CV can be said to measure the price transmission of a particular commodity from international to domestic markets.

In addition to whether local food prices transmit or reflect regional and global prices, national and subnational market characteristics are also relevant to households' access to food. These include the cost of transporting food to markets, usually measured by road infrastructure and fuel costs; the ratio of buyers and sellers to producers; whether markets are connected or isolated from each other in terms of geographical access and in terms of price alignment; and the presence or absence of government policies that intervene in the market, such as setting price ceilings or floors for specific foods or implementing export bans on particular commodities.

In contexts like that of Malawi, where high transport costs and few buyers and sellers relative to the number of producers cause markets to be thin, prices are volatile. This volatility often results in unpredictable and highly seasonal food prices, which have significant implications for food security. Indicators of seasonality in food prices are typically constructed using household-level food consumption and food price data. In Malawi, price data are collected throughout the country on a weekly basis by the government, under the Agricultural Market Information System (AMIS).

In cases where seasonality has an adverse effect, the relationship between food consumption and price levels will be inverse. This reflects a typical cycle of selling at a time when prices in the market are low but household cash needs are high, such as just after the harvest, then buying at times of high prices when household food stocks dwindle and the next harvest has not yet arrived.[7] This vicious circle has been well documented in Malawi (Kaminski, Christiaensen, and Gilbert 2014; Jayne et al. 2010).

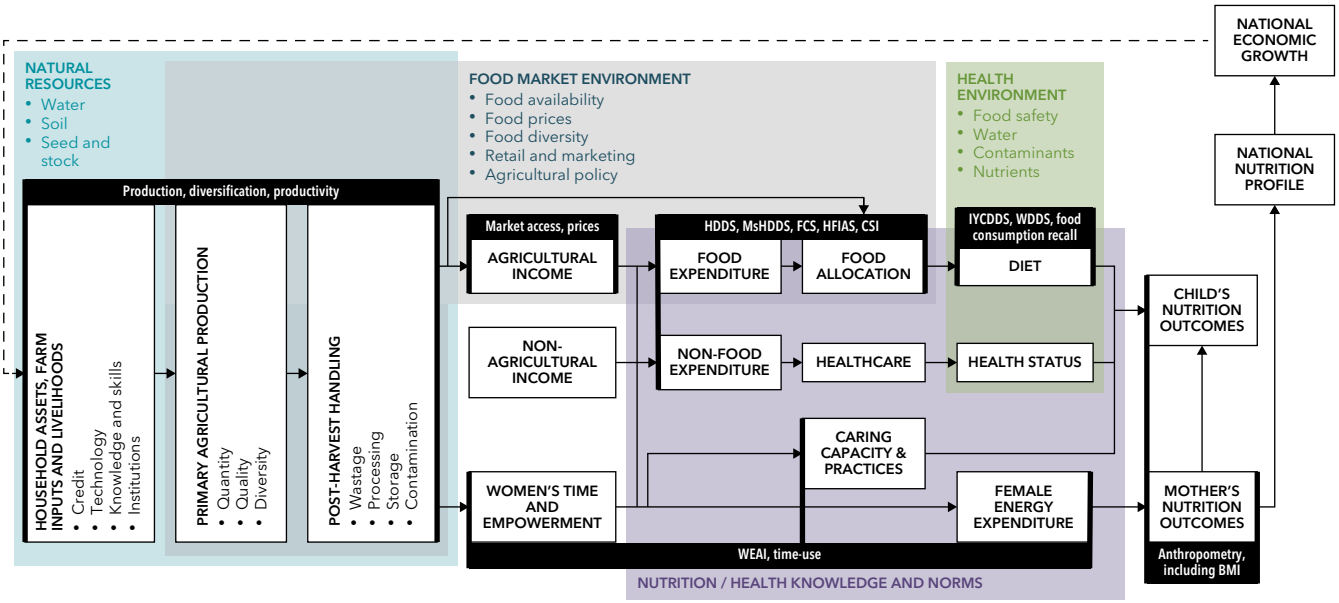
ADDRESSING THE "DATA DISCONNECT"–OPPORTUNITIES FOR MALAWI

Figure 3 overlays indicators reviewed in this chapter onto the conceptual framework described in Chapter 1, providing a visual representation of the range of metrics needed to investigate the association between agriculture and nutrition.

Among the datasets reviewed in this chapter, those which provide information on individual diets are the most informative for assessing how food-related factors affect individual nutritional status–in Figure 3, these are the Infant and Young Child Dietary Diversity Score (IYCDDS), Women's Dietary Diversity Score (WDDS), and food consumption recall datasets associated with the Diet component of the conceptual pathways between agriculture and nutrition. As discussed earlier, household-level indicators stop short of estimating individual dietary or nutrition outcomes, thus preventing assessment of the final frontier of utilization. In contrast, anthropometric indicators provide excellent estimates of how individuals are utilizing nutrients. However, these metrics do not distinguish between what proportion of undernutrition is caused by health considerations, such as infection, and what is caused by problems related to food accessibility and related constraints to dietary intake. As it is food that is most directly affected by agriculture,[8] individual diets are a key outcome to measure the success of most agricultural programs and policies, if an impact on population well-being is desired (Herforth and Harris 2014). Especially important is the issue of dietary quality–meaning diets that include safe and hygienic foods from as many food groups as possible, providing a variety of nutrients in addition to calories. A focus on dietary quality is often missing in food security work, but is the key concept linking agriculture and food systems with nutrition outcomes.

The IYCDDS and WDDS are currently considered the best options for accurately measuring individual dietary quality in a non-invasive, inexpensive, and efficient way (Leroy et al. 2015). Both indicators include cutoffs and use a standardized questionnaire (although adaptation to local contexts is required for the

FIGURE 3 INDICATORS FOR EXPLORING CONCEPTUAL PATHWAYS BETWEEN AGRICULTURE AND NUTRITION



Source: Herforth and Harris (2014), revised by authors.

Note: BMI = Body Mass Index; CSI = Coping Strategies Index; FCS = Food Consumption Score; HDDS = Household Dietary Diversity Score; HFIAS = Household Food Insecurity Access Scale; IYCDDS = Infant and Young Child Dietary Diversity Score; MsHDDS = Micronutrient-sensitive Household Dietary Diversity Score; WDDS = Women's Dietary Diversity Score; WEAI = Women's Empowerment in Agriculture Index.

latter), facilitating intercountry implementation and comparability of results. Dietary recall is also a good option for assessing dietary quality, but such surveys are more time consuming and costly. Anthropometric outcomes are best considered when examining health and sanitation dimensions, in addition to agriculture.

In many countries, the analytical imperative to collect individual dietary quality information is constrained by what is referred to as the agriculture and nutrition data disconnect (Gillespie, Harris, and Kadiyala 2012). This fracture occurs because of long-standing divides between agriculture and health in commonly collected nationally representative data sources. In Malawi, as in many other countries, agricultural data are usually not available in the same datasets as individual diet, women's empowerment, and nutrition outcome data. As such, agriculture–nutrition analyses are often hamstrung by lack of appropriate, integrated data resources. While justifiable from a sectoral perspective, the disconnect results in there generally being limited reliable data that provide information on diet and nutrition outcomes as well as on agricultural production practices, market access, food prices, women's empowerment, and all the other indicator areas required to trace the full trajectory of a causal pathway from agriculture to nutrition outcomes for individuals.

That said, there are instruments that hold considerable potential for the systematic collection of data on standardized livelihood or agricultural production practices, food security, and, in some cases, nutrition (Carletto et al. 2013). In Malawi, many of these instruments already exist. Table 1 provides an overview of the country's key large-scale data sources that provide such complementary data in a systematic manner. An

TABLE 1 DATA SOURCES ACROSS NUTRITION PATHWAYS: OPTIONS IN MALAWI

	Domain					
Data source	Food systems and markets	Agriculture	Food security (availability & access)	Women's empowerment	Individual diets	Individual nutrition outcomes
Demographic and Health Survey (DHS)	–	–	–	Empowerment Decision making	WDDS, IYCDDS Dietary recall	Anthropometry
Integrated Household Survey (IHS)	Seasonality Market access Food prices	Crop & livestock production Crop diversification	HDDS MsHDDS HH Micro-nutrient Access	–	–	Anthropometry
Women's Empowerment in Agriculture Index (WEAI)	–	–	Household Hunger Scale	Empowerment Decision making	WDDS	Anthropometry (women)
Agricultural Production Estimates Survey (APES)	–	Crop production	–	–	–	–
Agricultural Market Information System (AMIS)	Market integration Seasonality Food prices	–	–	–	–	–
National Census of Agriculture and Livestock (NACAL)	Market access	Crop & livestock production Tropical livestock units	–	–	–	–

Source: Authors' compilation.

Note: HDDS = household dietary diversity score; HH = household; IYCDDS - infant and young child dietary diversity score; MsHDDS = micronutrient-sensitive household dietary diversity score. WDDS = women's dietary diversity score

example of how data from multiple survey sources in Malawi can be incorporated into a single analysis for nutrition program planning purposes is shown in the Appendix to this chapter.

Of all the data sources listed in Table 1, the data-collection instrument with the highest potential for assessing agriculture–nutrition linkages in Malawi is the Integrated Household Survey series. This survey series covers multiple sectors. The IHS3 of 2010–2011, for example, collected information on household food consumption, crops grown using rainfed and *dimba* wetland cultivation, crop sales, livestock ownership and sales, child anthropometry, and food prices. The advantage of data from the IHS surveys over the Agricultural Production Estimates Survey (APES) and DHS data is that, for example, agricultural production data obtained through the IHS are easily merged with detailed household consumption data (including from own produce or purchased foods) and child nutrition indicators. The fact that the unit of analysis is household-level is important. While the Appendix to this chapter presents an approach to incorporating into a single analysis information obtained from different survey samples by undertaking rank correlation analyses at the survey strata level (typically, district-level), this is clearly a second-best solution. If an integrated, multi-topic, representative household survey dataset is available, this generally will be the preferred dataset to use for planning programs that seek to improve nutritional outcomes. The Malawi IHS series is an important resource for these purposes.

Although the IHS covers an impressively high number of relevant indicators, it still fails to collect data on individual diets, the key intermediary between agriculture and nutrition. Furthermore, the quality of IHS anthropometrics has been called into question, as figures obtained from analysis of the IHS3 differ significantly from those in the 2010 DHS—the DHS being the traditional source of estimates of nutrition indicators for the population of Malawi (Verduzco-Gallo, Ecker, and Pauw 2014).

While substantial retrofitting of the IHS is not practical, the addition of a simple measure of individual diet—such as the WDDS, which is especially valuable given its focus on women—and improvements to the quality of the anthropometric measurements would make the IHS a powerful tool for unpacking how agriculture in Malawi links to food security and nutrition outcomes. Such dietary diversity indicators can be constructed based on an easy-to-administer questionnaire that can be completed quickly by enumerators and at relatively low cost (Leroy et al. 2015). The inclusion of this type of module in the questionnaire for Malawi's IHS surveys could facilitate more thoughtful and robust research on the agriculture–nutrition nexus in the country.

APPENDIX–AGRICULTURAL CORRELATES OF AGGREGATE NUTRITIONAL OUTCOMES IN MALAWI: A DISTRICT-LEVEL RANK ANALYSIS

Todd Benson

Obtaining empirical evidence on the relative importance of agriculture for the nutritional status of individuals is difficult. Most datasets that shed light on nutrition outcomes provide limited information on agricultural livelihoods. Here we take advantage of the fact that the 2010 Demographic and Health Survey (DHS) for Malawi (NSO and ICF Macro 2011) used comparable survey strata to that of the Third Integrated Household Survey (IHS3) (NSO 2012a), a survey conducted in 2010–2011 that collected extensive information on agricultural production. While the surveys sampled different households and individuals, the results of both are representative at the district level. Using a non-parametric rank correlation approach, we use district-level results from the surveys to examine whether any associations exist between the prevalence of stunted children (low height-for-age Z-scores [HAZ]) and of thin women (Body Mass Index below 18.5 kg/m2) in the districts of Malawi (Figure 1) and selected district aggregate characteristics of agricultural production. We then extend our analysis to examine other possible nonagricultural determinants of nutritional status.

Our dataset consists of 27 cases, corresponding to the 27 districts of Malawi covered by the two surveys. This small set of cases limits the sorts of statistical analyses we can use. Moreover, our analysis is based

on aggregate statistics. As nutritional status is a characteristic of individuals, information on how nutritional status varies within the population is lost when one uses aggregate statistics. Similar information is also lost on the distribution of the factors examined as potential determinants of those nutritional outcomes. As no assumptions can be made about the distribution of these variables within the population, we must use a nonparametric approach to gain insights from these district-level statistics.

Here we use a rank correlation analysis. This quantifies the degree of similarity between the rankings of two variables across cases to assess whether any significant relationship exists between the variables. We examine whether the ranking of nutritional outcomes by district is similar to the ranking of any agricultural factors by district, either positively or negatively. Where association in the ranking is seen, this indicates the potential existence of a causal relationship between the agriculture and nutrition variables and may merit further study. Where the absolute value of the Kendall's statistic for rank correlations is between 0.10 and 0.30, we consider this association worthy of note, while associations with a coefficient above 0.30 are judged to merit even closer examination.

Potentially important agricultural and nonagricultural determinants of nutrition outcomes were identified for the analysis. Primarily using data from the two surveys, we compute district-level statistics for 10 potential agricultural determinants and about 20 potential nonagricultural determinants. The nonagricultural determinants are categorized into four groups—diet, gender, health, and welfare.

The rank correlation analysis results for the agricultural factors are shown in Appendix Table 1. Relatively limited associations are seen, suggesting that direct relationships between agricultural activities and nutritional outcomes in Malawi are relatively weak. Moreover, the strongest associations run counter to expectations—for example, more district residents engaging in cropping activities is associated with a greater prevalence of thin women. Of the other agriculture–nutrition associations considered, a few are encouraging, such as for livestock and tobacco. Greater average agricultural sales in a district are also associated with improved nutritional outcomes. However, unfavorable or no associations are observed for several other district-level agricultural factors, including for irrigation intensity, district maize yield levels, horticultural production, and the number of crops grown or sold by district households.

APPENDIX TABLE 1 STRENGTH OF RANK CORRELATIONS BETWEEN POTENTIAL AGRICULTURAL DETERMINANTS OF NUTRITION OUTCOMES AND THOSE OUTCOMES, RANK CORRELATION COEFFICIENT, DISTRICT-LEVEL AGGREGATE DATA, MALAWI, 2010

Variable	Stunted children	Thin women
Households engaged in crop production, %	0.13	**0.36**
Landholding size, ha/household	ns	ns
Livestock ownership, Tropical Livestock Units per household	−0.14	ns
Irrigation prevalence, % of households	0.14	ns
Maize yield, kg/ha	ns	ns
Tobacco production prevalence, % of households	−0.15	−0.11
Horticulture production prevalence, % of households	ns	ns
Number of crops grown per household	ns	ns
Number of agricultural products sold per household	ns	ns
Per capita gross agricultural sales, MK thousands	−0.12	−0.13

Source: Authors' analysis of Malawi Demographic and Health Survey (NSO and ICF Macro 2011) and Third Integrated Household Survey (NSO 2012a) datasets.

Note: Kendall's rank correlation coefficients with an absolute value less than 0.10 are judged to indicate an insignificant association between the variables and are not reported. Coefficients with an absolute value greater than 0.30 are associations that are judged to merit closer examination, and are shown in boldface. MK = Malawi kwachas; ns = not significant.

These contrary or insignificant associations signal that the relationship between all dimensions of strengthened agricultural livelihoods and nutritional outcomes in Malawi will not always be positive or benign.

Appendix Table 2 extends the analysis to examine associations between district-level nutritional outcomes and potential nonagricultural determinants of those outcomes. For factors related to food access, districts with higher calorie consumption per capita and greater dietary diversity show lower levels of child stunting and thin women, while those in which a higher proportion of surveyed households reported inadequate food consumption tend to have higher levels of malnutrition.

The strongest positive associations with nutritional outcomes are for the gender variables. Higher average educational attainment levels for women are strongly associated with lower district averages for the nutritional indicators considered—a strongly beneficial relationship (Appendix Figure 1). Moreover, larger average differences between men and women in their educational attainment are associated with worse average nutritional outcomes at the district level. Similarly, women's participation in decision making within the household demonstrates that greater women's empowerment in these decisions is associated with the reduced prevalence of stunted children and of thin women. In districts in which women are more often excluded from such decisions, average malnutrition levels are higher.

Health factors do not provide as strong associations with those outcomes as do the diet and gender variables considered, and the nature of some associations is counter to expectations. For example, better access to safe water is associated with lower child stunting levels, as expected, but also with a higher prevalence of thin women. In contrast, the associations related to welfare are consistent with

APPENDIX TABLE 2 STRENGTH OF RANK CORRELATIONS BETWEEN NUTRITION OUTCOMES AND POTENTIAL AGRICULTURAL DETERMINANTS OF NUTRITION OUTCOMES (RANK-CORRELATION COEFFICIENT, DISTRICT-LEVEL AGGREGATE DATA, MALAWI, 2010)

Variable type	Variable	Stunted children	Thin women
Food access	Calorie consumption per capita/day	−0.12	**−0.30**
	Dietary diversity index (HDDS—12 food groups)	−0.16	**−0.36**
	Households reporting inadequate food past month, %	0.18	ns
Gender; empowerment of women	Female head of household, % HHs	0.17	**0.32**
	Married head of household, % HHs	−0.19	**−0.30**
	Highest level of schooling—women aged 15-49, median years	−0.17	−0.27
	Difference between men and women in years of schooling completed	0.13	0.19
	Married women who decide on purchases for daily needs, %	**−0.32**	−0.21
	Married women who do not participate in household decisions, %	0.17	0.13
Health and public health	Drinking water—improved source, % population	−0.23	0.17
	Improved household sanitation facilities, % population	ns	−0.11
	Member had an illness in previous 2 weeks, % HHs	0.10	ns
Welfare	Per capita annual household nonfarm income, MK thousands	−0.21	−0.18
	Per capita annual total real expenditure, MK thousands	−0.13	**−0.31**
	Individual poverty head count, % below the poverty line	0.15	0.29

Source: Authors' analysis of Third Integrated Household Survey (NSO 2012a) and Malawi Demographic and Health Survey (NSO and ICF Macro 2011) datasets and spatial data from Malawi.

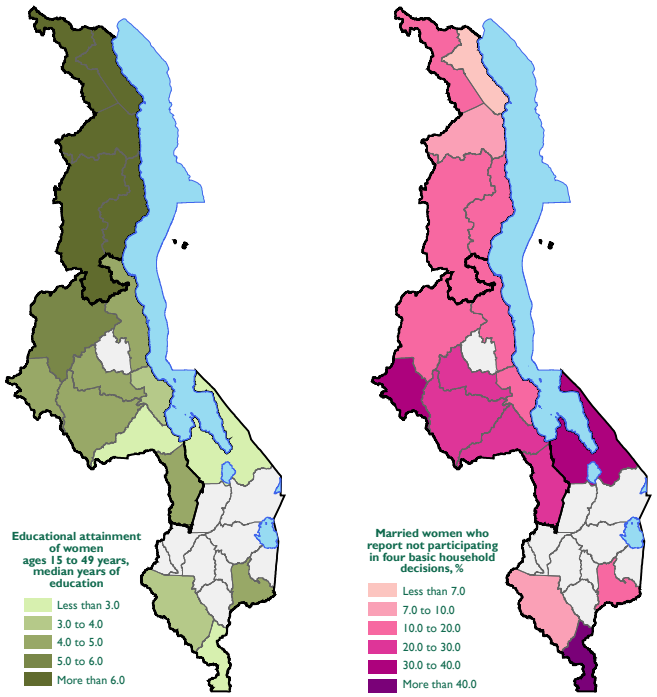
Note: Kendall's rank correlation coefficients with absolute value less than 0.10 are judged to indicate an insignificant association between the variables and are not reported. Coefficients with an absolute value greater than 0.30 are associations judged to merit closer examination and are shown in boldface. Negative associations (green bars) indicate improvements in nutritional status associated with the determinant under consideration, while positive values (red bars) indicate deterioration. ns = not significant. MK = Malawi kwacha.

expectations—higher levels of nonfarm income and expenditures are associated with lower levels of malnutrition, while higher poverty levels are associated with increases in those levels.

This analysis was done to gain additional understanding of how agricultural factors may contribute to nutritional outcomes. However, relatively limited associations are seen, suggesting that direct relationships between agricultural activities and nutritional outcomes in Malawi are relatively weak. Moreover, the nature of several of the associations examined runs contrary to expectations, suggesting more complex relationships between strengthened agricultural livelihoods and nutritional outcomes in Malawi than we might expect. When we extend the analysis, nonagricultural potential determinants of nutritional status show somewhat stronger associations—particularly for gender factors.

The broader insight obtained from this study is that the pathways through which agriculture can lead to nutritional improvement in Malawi are indirect. A broader range of equally necessary determinants of improved nutrition must be in place if significant reductions in malnutrition are to be achieved. In considering these results, however, this analysis must be treated as exploratory. More detailed examinations of any associations of interest using individual- and household-level data are required. Nonetheless, the district-level analysis presented here demonstrates that there are methods that can be used with somewhat coarse and seemingly incompatible data on nutrition status and its potential determinants to skirt around the agriculture and nutrition data disconnect discussed in Chapter 2 and build a better understanding of how agricultural activities can serve to improve nutrition in Malawi.

APPENDIX FIGURE 1 WOMEN AGED 15 TO 49 YEARS, MEDIAN HIGHEST LEVEL OF SCHOOLING ATTAINED AND PROPORTION REPORTING NOT PARTICIPATING IN HOUSEHOLD DECISIONS, BY DISTRICT, MALAWI, 2010



Source: Maps by M. Kedir Jemal, IFPRI, of DHS results.

Chapter 3 UNDERSTANDING HOUSEHOLD PREFERENCES ON THE PRODUCTION, CONSUMPTION, AND SALE OF NUTRITIOUS CROPS

Noora-Lisa Aberman and Terry Roopnaraine

ABSTRACT: VALUE CHAINS AND AGRICULTURAL COMMERCIALIZATION ARE INCREASINGLY promoted as mechanisms for agricultural transformation, inclusive growth, and, more recently, improved food security and diets. In particular, donors and implementers of nutrition and food security programs are promoting the production of nutritious crops as a mechanism for improving the quality of and diversity in the diets of the rural poor. However, while a theoretical basis exists for suggesting that production of these crops may improve diets, there is limited empirical understanding of how agricultural production impacts diets (impact pathways) and under what circumstances production of nutritious foods can lead to improved diets. This chapter examines pathways from production to diets by analyzing qualitative data collected from three districts in three regions of Malawi. The analysis specifically explores contemporary food preferences, patterns, and decisions related to crop sales, and gendered household decision-making dynamics. The results indicate that households desire diverse diets, but access to (affordability) and availability of diverse foods are limiting factors, as is a dominant maize-first approach to assuring household food security. In addition, many nutritious crops that households produce are both consumed and sold. Decisions about what or how much to sell are based on consideration of a range of factors. Nutrition training—promoting consumer demand for key commodities—combined with value chain approaches to decrease price and increase availability might successfully improve diets in this context.

Value chain development and agricultural commercialization are promoted as mechanisms to support agricultural transformation and inclusive growth. More recently, the potential for leveraging value chains to improve food security and diets is being explored. Views of commercialization in agricultural development discourse fluctuated over the years. Initially framed in terms of moving subsistence farmers into cash cropping and specialization, and subsequently criticized for exposing the poor to the high risk of engaging in commodity markets, the discourse shifted over a decade ago to include commercialization in terms of its effects on nutrition (Alderman 1987; Kennedy and Cogill 1987; DeWalt 1993; Peters and Herrera 1994; von Braun 1995). Theoretically, market-oriented production should allow farmers to increase their incomes and purchase more nutritious foods. However, there is very little empirical understanding of the pathways through which such production impacts diets and under what circumstances. What is clear is that a variety of constraints posed by commercial farming can impede positive dietary changes. These include the tendency of men to control income from cash crops, the inherent price instability of cash crops, and the tendency to spend lumpy income (payments that happen infrequently and irregularly) on nonfood items (DeWalt 1993).

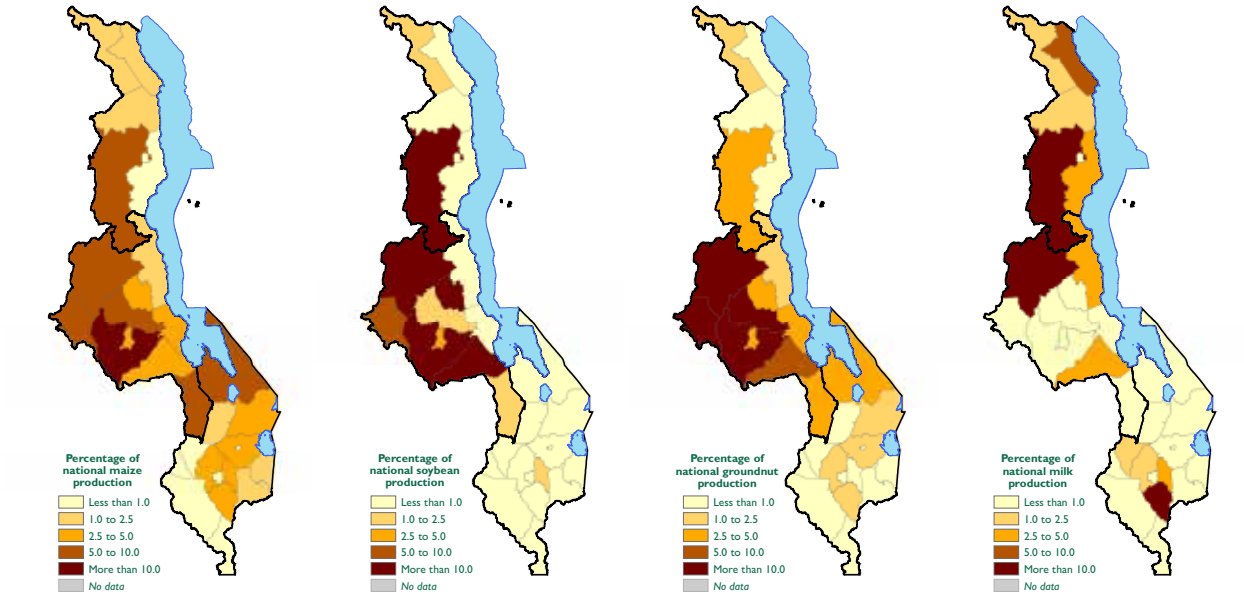
Because Malawi's current development agenda increasingly focuses on measures to transform and commercialize a largely subsistence-based agricul-

ture sector, the implications of commercialization for diets and nutrition are highly relevant for Malawi, especially when the country's high rates of child stunting are considered. Maintenance of subsistence farming practices alongside cash crops can be viewed as a mechanism to minimize the inherent risks associated with volatile market prices (Gillespie, Harris, and Kadiyala 2012). Furthermore, crops that are both nutritious and commercially viable can overcome the inherent risks associated with engaging in markets because they can be consumed if market prices are not profitable. This type of approach can be described as harnessing value chains for nutrition (VCN) (Gelli et al. 2015). Distinct from typical value chain assessments that emphasize economic factors, the VCN approach applies a nutrition lens through increasing demand for and/or supply of nutritious foods, and through nutrition-focused value addition to agricultural commodities (Gelli et al. 2015; Hawkes and Ruel 2011).

For instance, groundnut and soybean are both nutritious foods that, in Malawi, are (1) eaten raw or as a minimally processed food by households, (2) sold for medium- or large-scale domestic processing into higher-value products for human or animal consumption, (3) processed on a small scale at the village level for human consumption, or (4) exported raw regionally or internationally. As such, groundnut and soybean in Malawi are high-potential commodities for VCN, as they have the potential to enhance livelihoods, reduce risk, support private-sector and market development, and improve dietary quality. (See Figure 4 for maps on district-level production of several commodities discussed in this chapter.)

However, the effectiveness of the VCN approach for improving diets is mediated by social norms about preferred foods and intrahousehold allocation of food, control over decision making for farm activities and use of income, and knowledge about nutrition and willingness to pay for nutritious foods

FIGURE 4 DISTRICT-LEVEL PRODUCTION OF MAIZE, SOYBEAN, GROUNDNUT, AND MILK IN MALAWI, BY PERCENTAGE OF NATIONAL PRODUCTION SHARE, 2010



Source: Analysis by M. Kedir Jemal, IFPRI, of IHS3 data.

Note: Annual national production-level estimates based on weighted analysis of household production data reported by IHS3 respondents are maize: 1,684,000 metric tons (mt); groundnut: 235,000 mt; soybean: 30,000 mt; and milk: 31,000 mt.

(Gelli et al. 2015). All of these are closely linked to gender relations in the household. As such, this chapter examines contemporary food preferences, patterns, and decisions related to crop sales and gendered household decision-making dynamics, all of which have implications for strengthening value chains for nutrition.

Specifically, we assess the social drivers (or limiters) that mediate farm households' ability to produce these foods to improve diets in rural Malawi. We emphasize gendered household preferences and decision-making dynamics related to the production, consumption, and sale of nutritious commodities. The findings are based on information obtained through a series of individual interviews with women and men from a sample of households in Balaka, Karonga, and Ntchisi districts.

PLAUSIBLE IMPACT PATHWAYS

Adding a nutrition lens to discussions on expanding the commercialization of agricultural production provides several potential benefits. The most direct impact pathway to improved diets is through production of these foods, leading to increased own consumption of nutritious commodities. That is, increased production ostensibly for commercial purposes could increase the quantity and diversity of food consumed by individuals within producing households. The second pathway is through the sale of crops. Increased income from commercial sales can be used to purchase higher-quality, nutrient-dense foods for household consumption, if the foods are available in the market and acceptable to or preferred by family members. Third, the increased production of nutritious foods can increase their availability in markets, making it easier and more affordable for people to access them.

The final pathway is through impacts of commercialization of agricultural production on women's time and decision-making power. Commercialization may increase household income, but women's influence over decisions about how to spend that income or how much of the nutritious commodities produced by the household they will keep mediate the extent to which any improvements to diets will be achieved. In addition, the impact of commercial activities on the time commitments women face can either free up or further constrain time for the feeding and care of nutritionally vulnerable household members. Central to the impact this pathway has on nutritional outcomes are the prevailing social and cultural norms at play that determine the role of women—traditionally the primary caretakers in the household—in commercialization.

The empirical evidence is not conclusive in terms of the relative effectiveness of these pathways, globally or in Malawi. Impacts on nutrition of interventions to increase production of cash crops will not occur through the own-consumption pathway, but could potentially impact diets through increased income or through women's empowerment if women are targeted or otherwise impacted. However, increasing production of nutritious crops can impact diets through own-consumption or income pathways if the crops are also marketable. Nutritious crop production can also impact women's time and empowerment, depending on the gendered characteristics of the crops, such as the extent to which women or men are responsible for production, who can sell and keep proceeds related to the product, and how other activities and responsibilities are positively or negatively affected. Furthermore, the impact pathways here assume that the production of most food in Malawi continues to be dominated by small-scale producers. If the principal source of food shifts to large-scale industrialized producers, then the rural poor would be more dependent on wage labor to gain access to sufficient food for their needs and their degree of access would be more affected by changes in global food prices than is currently the case (Carolan 2016).

Investigating the income pathway, an evaluation conducted in Kenya in 1987 found that households participating in a sugarcane outgrowers scheme had greater calorie consumption but no improvement in child nutrition outcomes compared with nonparticipating households (Kennedy and Cogill 1987). A study in Malawi showed that while cash-cropping families had

higher incomes, the lumpiness and seasonality of their incomes reduced the positive effects this income otherwise might have had on household food intake (Masangala 2005). Moreover, while a 1994 study of tobacco producers found that income source had no effect on stunting in children (Peters and Herrera 1994), a more recent study found that when faced with an income shock, children in tobacco-producing families fared worse in terms of stunting (Wood and Nelson 2013).

Recent studies examining crop diversification in Malawi show that as the incomes of farming families rise and they engage in markets, they tend to increase household calorie consumption and household dietary diversity (Jones, Shrinivas, and Bezner-Kerr 2014; Snapp and Fisher 2014). Similarly, a study on the commercialization of cassava in southeastern Africa documents the food security benefits of cassava production, whereby cassava was seen as both insurance against a failed maize crop and a marketable commodity (Haggblade et al. 2012). This may point to the effectiveness of crop diversification in improving food security through overcoming the barriers associated with the lumpiness of income from a single crop noted above, although these studies did not examine effects on individual diets or nutrition outcomes. Furthermore, these studies did not specify whether the increase in household calories was due to own-consumption or income pathways, or if there was any impact on the quality of foods consumed.

When farm households produce nutritious commodities, they may be sold in the market or consumed. This may impact dietary quality—in addition to having a potential effect on calories consumed—through own-consumption or income pathways. An early study of dairy cooperatives in India found that the nutrient consumption of commercialized farmers increases not through own consumption (as they do not consume more milk), but rather through purchasing other nutritious foods in the market (Alderman 1987). Value chain studies on groundnut, soybean, and pigeonpea in Malawi show a complex household decision-making process over consumption and sale of some of the harvest. Pigeonpea is largely consumed by the producing household, though some is sold domestically and internationally (Makoka 2009). However, soybean and groundnut fluctuate between being cash crops and own-consumption crops, depending on the local context, such as the gender dynamics, profitability, and need for inputs (Cook et al. 2014).

Several studies examine the effects of women's time and decision-making power on nutrition outcomes. Women's education and status relative to men's was found to be strongly associated with child malnutrition globally (Smith and Haddad 2000). Cunningham et al. (2015) find that women's empowerment (measured with the Women's Empowerment in Agriculture Index) is significantly associated with improved child nutrition status. Finally, a recent review of studies on women's time use and nutrition indicates that women are indeed time constrained due to their significant role in agricultural production, and that agriculture interventions tend to further constrain time (Johnston et al. 2015). Impacts of agricultural practices on nutrition are not clear-cut, but are mediated by several household characteristics, such as socioeconomic status, ability to purchase food, and the presence of household members who can take up additional work when needed.

METHODS

This inductive analytical study seeks to contribute to a clearer understanding of how the production of nutrient-dense, commercially marketable foods affects diets in rural Malawi. In particular, we are interested in better recognizing the social drivers (or limiters) of the possible impact pathways already defined in the conceptual literature. Because women's time use and decision-making power mediate all the possible impact pathways from production of nutritious commodities to improved diets, we primarily examine the gendered household preferences and decision-making dynamics related to production, consumption, and sale of these commodities. We examine

- social norms and perceptions about preferred foods and eating patterns;
- rationales and trade-offs related to the decision to sell or consume certain different crops;

- social norms about gender relations, because they affect control over farm decision making and the use of income from sold commodities; and
- knowledge of nutrition, because it can influence demand for nutritious foods and feeding practices.

While we highlight three commodities of interest for their nutritious and marketable qualities, during interviews we allowed respondents to define what they considered to be nutritious commercial crops. Generally, when asked what commercial crops they produce, respondents included all crops that can be sold in the market. The commodities we focused on were soybean, groundnut, and cow milk.

Soybean, while not widely considered a locally preferred food, is highly nutritious in terms of protein, fiber, and micronutrients; is in high demand by domestic processors and the regional export market; and can have positive impacts on soil quality through biological nitrogen fixation. Industrial uses of soybean in Malawi include large-scale oil pressing and processing the resultant cake into chicken feed or for export. Typical food uses include processing into flour for porridge or into soy pieces, a meat substitute. Ntchisi in the Central Region was targeted for our study as a high soybean production district.

Second, groundnut is in high demand as a locally marketed and consumed food. It is typically consumed after processing into a powder and mixed with vegetables. In addition, there is local processing of peanut butter, other snack products, and ready-to-use therapeutic foods (RUTF) for moderately and severely wasted children. There is also high demand regionally and from high-value markets, such as Europe and South Africa. Access of Malawian producers to these markets is currently impeded by the high aflatoxin levels of domestic groundnut. In fact, the nutritional benefits of consuming groundnut must be weighed against the negative effects of high aflatoxin levels. Balaka in Southern Region was targeted as a high groundnut production district.

Finally, production and consumption of milk is extremely low in Malawi, as is cattle ownership. While per capita production increased moderately over the last decade, it is still among the lowest in the world, at 4.3 kg annually in 2011 (FAO 2015). However, milk could provide critical nutrients that are missing from a staple-heavy Malawian diet. While lack of adequate cold chains currently makes extensive commercialization and export of milk products challenging, initiatives to promote local storage and marketing of milk could have significant impacts on dietary quality. Because Malawi's Northern Region has a relatively higher level of cattle ownership, Karonga was targeted as a milk-producing district.

We took a purposive sampling approach, starting with targeting districts that are producing the products of interest for the study and that have high levels of stunting. Then we relied on government agricultural extension staff in the target districts to guide us on the choice of an appropriate study village based on two criteria: (1) that many village members produce one or more of the crops of interest and (2) that they are located within 5 km of a major daily market. The second criterion allows us to take the focus off market-access constraints—which are usually greater for women than for men, but are not the focus of this study—and allow us to discuss in-depth other factors related to the decision to market products. Three communities were targeted using these criteria, and between 12 and 15 households within each community were sampled for in-depth individual interviews, with a total of 80 individuals interviewed (39 men and 41 women).

Interviews were digitally recorded, transcribed, and translated from the Chichewa and Chitumbuka languages to English. Transcriptions were thematically coded using NVivo software. An initial coding pass was used to determine the main concepts arising from the interviews, which were used to augment and enrich an a priori, deductive coding schema. Interviews were then systematically coded against this list. A range of code- and text-based search protocols, including both Boolean and proximity searches, was then applied to extract findings on each topic of interest.

FINDINGS

PREFERRED FOODS AND EATING PATTERNS

Although the study districts were purposively selected to capture production of soybean (Ntchisi), groundnut (Balaka), and milk (Karonga), accounts of foods consumed at home were quite similar. Except for dairy products, which were most intensively consumed in Karonga, aggregate dietary patterns in the study households exhibited little variation by either district or household.

Nsima (maize meal polenta) is the starch par excellence in these areas. Breakfasts are often porridges made from maize or other starches, cakes or sweet fritters, and occasionally tea, with or without milk and sugar. Meals taken at midday and in the evening are *nsima* accompanied by "relish." Relish is any food item that accompanies *nsima* and almost always includes pumpkin leaves, green vegetables such as okra, brassicas such as rape, mustard greens, and cabbage, and tomatoes and onions if available. In Karonga only, *chambiko*, or soured milk, is highly appreciated as a relish to accompany *nsima* or other starchy foods. If cooking oil can be afforded, the relish is cooked with oil. Relish may also include protein foods such as legumes (pigeonpea, cowpea, and other beans), soybean, groundnut (pounded and added to leafy vegetable stews), small dried fish (*matemba* or *bonya*), chicken, eggs, and more rarely, meat (typically goat or occasionally beef; pork and rodents are generally taboo, and bushmeat was not mentioned). Chicken and eggs are popular and widely appreciated; both are kept for food consumption, but may be sold when money is needed. Duck meat is more complicated: several respondents asserted that it produced an allergic skin reaction, while others stated that duck was prohibited under halal dietary laws (in fact, duck is halal if it is slaughtered in accordance with halal rules).

This meal format is ubiquitous to the point of universality. Other starches such as cassava, bread, and rice were mentioned in interviews, but the archetypal meal is based around *nsima* made from maize. This is not unusual; staple starches often occupy a very dominant position in food repertoires internationally; in such cases, the inclusion of a staple may be a defining criterion of what constitutes a meal. Certainly in these districts our household respondents' largely shared concept of a proper meal took the form of *nsima* with relish. As one informant from Balaka explained, "Relish only or *nsima* only does not make a meal. In that case, you do not have food." The preference for *nsima* was explained on the grounds that it is "satisfying," but also by allusion to tradition or upbringing—*nsima* is the main food that everyone has grown up with. Following Bourdieu (1977), it may be considered to be part of the quotidian habitus of the people composing the study population. As one Balaka respondent noted, "The reason why it is ideal is that we grew up used to these foods. We did not grow up used to other foods. I feel good, satisfied, and it tastes good. The meals that we eat in most cases are *nsima* with vegetables like cabbage, pumpkin leaves, and mustard greens." Fruits such as mango, papaya, banana, citrus, apple, and pineapple were also mentioned in interviews, chiefly as purchased items, since people do not tend to cultivate them in their gardens. Market availability of these items is seasonal. In a very small number of Ntchisi households, respondents stated that they made soy milk for home consumption, but this does not appear to be at all common, even in this district chosen based on its relatively high level of

Malawian family substitutes mangos for *nsima* during the hunger season

soybean production. Even in these soy milk–producing households, respondents complained about the lengthy processing required to make soy milk. In one Balaka household, the respondent noted that she would like to consume soy milk, but did not have any.

Maize is a critically important cultivar, and there is a clear prioritization of keeping it for food security rather than selling it—some respondents made the point that it did not make sense to sell one's maize crop, only to have to purchase maize later in the year. That said, maize is sold, and at times purchased, but concern is certainly widespread that enough should be kept to avoid running out later in the season. Many other foodstuffs, however, are bought at local markets when money and produce are simultaneously available. These include protein items such as fish, meat, beans, soybean, and groundnut; vegetables, including greens, brassicas, tomatoes, and onions; and occasionally other starches such as rice, potatoes, and cassava.

Market purchasing is periodically subject to various constraints, the most frequently mentioned of which is financial. When respondents articulated desires to eat "aspirational" foods, such as more meat, rice, chicken, cooking oil, milk (fresh or fermented), sugar, eggs, soy products, or simply more frequent *nsima*- and relish-based meals, the most common constraint was money. Respondents explained their choices of aspirational foods with reference to satisfaction, better nutritional quality, and tastiness. In addition to financial constraints on obtaining desired foodstuffs, respondents flagged distances to markets—although communities were purposively chosen to be within 5 km of a major daily market—and the limited availability of a wider range of foods in the markets.

It is instructive to examine responses to a line of questions about substitution—what do people do when they do not have access to key foodstuffs? It is clear that the choices available are often limited. It is also evident that the absence or shortage that most concerns people is not relish, but *nsima*—when asked about substitutions, informants focused principally on explaining what they did if they did not have *nsima*.

One strategy mentioned by several informants is to substitute porridge for *nsima*. In effect, this means increasing the proportion of water to maize flour, so that a given amount of starch—maize meal or other—feeds more people. Another approach is to increase the amount of gathered fruit in the diet (especially mangoes, which may be boiled). This is considered to be a particularly poor substitute if no starch is available. Interestingly, rice is mentioned as a potential substitute for *nsima*, which seems contradictory given the frequency with which rice is mentioned as an aspirational food—in the latter category, rice is an object of desire, while in the former it is a second choice if *nsima* is unavailable. Cassava is also regarded as a potential substitute for maize-meal *nsima*.

CONSUMPTION AND SALE

Many food cultivars sold in these districts are also used for household consumption, although the converse is not true. These include maize, pigeonpea, and other beans; groundnut; and soybean. Sesame, cultivated in Karonga, is technically a consumable crop, but in practice it is not consumed; instead, it is treated as a nonfood cash crop like cotton. In better-off households, livestock are kept: cattle, pigs, goats, ducks, and chickens. Cows produce milk and work as draft animals at home or rented out for extra income, while also serving as insurance policies in the event of serious income shocks. *Chambiko*, or soured milk, a popular food in Karonga, is generally either bought in the market or made from milk produced by family cows. It is only made from cow milk; goat milk is reserved for drinking. Only 3 of the 15 Karonga households interviewed mentioned selling their *chambiko*; overall in Karonga, *chambiko* is more often consumed than sold. Chickens and eggs are kept for both household consumption and cash sale, although it is less common to slaughter and consume chickens than to sell them. Small livestock are often used as a way of saving cash, though perhaps not large amounts. When a household needs money, a smaller animal may be slaughtered and sold. It might also be used for home consumption.

Households in our study communities give careful thought to balancing consumption and sale; this is important given that the foods grown do dual duty as food and as commodities. This is evident in the explanations around food crop sales provided by the respondent from Ntchisi below. Study participants explained in interviews that they took a range of factors into account when making decisions about what or how much to sell. This is an especially relevant point when considering a VCN approach, because it demonstrates that a population mainly composed of subsistence crop producers is accustomed to evaluating a broad range of factors before selling nutritious food commodities. In terms of programming implications, this means that much of the educational groundwork is already in place—people have a good understanding of how to make decisions based on assessments of competing priorities. In other words, while some priorities might need to be reassessed in light of limited nutrition knowledge, for example, the heavy focus on *nsima*, the analytical apparatus for doing so, in fact, is present. This point is illustrated in the quote below.

> *I had one and a half pails of soybean, but sold one pail because of a problem of school fees for the child . . . I kept half a pail for consumption, and there was no influence from any organization. I just keep some soybean for porridge at home. On the part of maize, I did not sell any of the 22 bags I produced, because it is the main food for the home, but I also expected some money from the soybean that were submitted for sale, so there was no pressure to sell maize. As for beans, I produced 60 kg, and it was all sold in August, but the money is not yet received. I just kept a little bean, about 2.5 kg, for consumption. Otherwise, we are not allowed to keep any of it if it is a contract. I also produced 2 bags of cowpea. It was all sold at MK300 per kg in August. I did not keep any, following the contract terms. Groundnut produced six unshelled bags, and I sold three bags in August. I kept some for consumption by adding to relish, but also for roasting, as it provided nutrition to the body.*
>
> (Male head of household in Ntchisi)

Key issues taken into consideration in decision making about food sale and consumption include:

- **Food security:** This is the first and foremost factor to consider. People are very unwilling to jeopardize their household food security, particularly as it relates to maize. As one Balaka informant explained, "It is always expensive to buy maize, especially knowing that you had it and you sold it. It is only . . . a lack of income that makes us sell our maize." The food security argument is not relevant only to maize—indeed, people are careful to keep some or all of their food crops for consumption. But maize is certainly the commodity that people feel most strongly about. Informants also noted that a household that found itself without maize would need to engage in piecework to earn money to buy maize.
- **Financial needs:** Families require cash for a range of household needs, such as school items, building materials, soap, relish ingredients, medical items, and productive assets, such as tools and fertilizer. Once food security has been taken into account, families consider these needs and make decisions about sales. Note that in cases where families hire labor, another requirement is paying the piece-workers, either in cash obtained from commodity sales or in-kind using maize grain or meal.
- **Quantity:** Related to the discussion of food security above, if harvest quantities are too low, selling is not considered a viable option.
- **Seed banking:** As subsistence horticulturalists, residents of these districts understand the need for making their seed supplies sustainable. In particular, quantities of peas and beans are held

back from both sale and consumption to sow fields again the following season.

- **Pricing:** Particularly in relation to maize, respondents noted that they were strategic about when to sell their production. If prices are too low, maize, which stores well, can be stored until prices rise again. This principle also applies to other commodities. We do not have direct responses on this, but it may be the case that in situations where maize prices are unattractive for sale, people respond to more immediate financial needs by slaughtering and selling livestock.
- **Social Needs:** Feeding needier relatives is culturally important. Households take this into consideration, particularly after ensuring that their own food security is adequate.
- **Insurance:** As noted above, livestock ownership may serve both as a device for saving money and as an insurance policy against severe income shocks.

GENDER AND DECISION MAKING

> *"But the ones I control are like useless crops because they are kitchen crops."*
>
> (woman in Karonga)

Our data show great, though largely unpatterned, variation in responses to questions exploring the relationship between gender and decision making in production and sale of crops as well as on expenditures made with the proceeds of such sales. This variation principally revolves around the question of who makes decisions in the household and is evident both between and within households, as in many cases both husbands and wives within households were interviewed.

Wife, Balaka:

Q: *Are there any decisions that you are supposed to make because you are a woman?*

A: ***Yes, especially on maize and other edible crops. Mostly men are never home, so if you put all the control on a man, he can disappoint you when he has gone out. Sometimes they go away for weeks; it is better that I should have my own input as a woman. A woman is the one who prepares food for the family compared to men.***

Husband, same household, Balaka:

Q: *Who made the decision on selling the crops that you sold?*

A: ***On sales, I was the one who decided to sell maize. I made that decision and told my wife, and she obeyed. I did the same with pigeonpea.***

Despite this variation, it is possible to discern a basic overall pattern of decision making. This pattern evokes the highly critiqued concept of domestic (female) and public (male) spheres and references the quotation at the beginning of this section. Overall, men have more decision-making weight around crops where exchange value dominates use value—that is, with crops that engage more closely with the public sphere of exchange. Women, on the other hand, have more decision-making power around crops whose use-value dimension is stronger, that is, with crops that tend to be conceptualized as occupying the domestic sphere of consumption. While informants tended to reject ideas about "women's crops" and "men's crops," this is, in effect, the operative division. Beans, pigeonpea, vegetables, and cowpea fall into the former category, while nonfood crops, such as sesame and cotton, occupy the "men's crops" end of the spectrum. Soybean, groundnut, and maize occupy a middle ground because of their important dual roles as key items for household consumption and as a market commodity. This is illustrated in Figure 5.

FIGURE 5 GENDER ROLES WITH REGARD TO DECISIONS ON THE CONSUMPTION OR SALE OF KEY CROPS AMONG MALAWIAN FARM HOUSEHOLDS

Source: Authors.

While this model is quite dominant among the study households, it is also important to note that in a significant number of households reference was made to collective decision making and discussion. The key message for any contemplated VCN program would be that, except for nonfood cash crops, most of the crops produced by the study households exhibit some degree of duality in terms of men's and women's decision making. That said, there are certainly cultivars for which decisions on their use tend to be gendered.

NUTRITION KNOWLEDGE

Respondents were asked a series of questions about nutritious diets. Nutrition knowledge was generally quite good in the study sample, although we note that different respondents tended to emphasize different aspects. We also note that informants were not asked about specific infant and young child feeding practices, even though suboptimal young child feeding practices and lack of understanding of their specific, rapidly changing nutrition requirements are a major contributor to child undernutrition. Rather, the focus was simply on their knowledge about nutritious foods and concepts of nutrition in general. Key points raised were the following:

- The importance of dietary diversity—respondents mentioned a wide range of foods, including starches, legumes, meat, fish, chicken, vegetables, dairy, fruits, and fats, and stressed the importance of varying these in the diet and producing mixed and balanced meals.
- The role of good nutrition in resisting disease, building and repairing the body, and providing energy—several respondents associated these qualities with vitamins, proteins, and carbohydrates and fats, respectively.
- The importance of proper food preparation to maximize nutrient access.
- The importance of good handwashing and sanitation practices to avoid illness.

DISCUSSION

Respondents had a relatively good understanding of nutrition; however, it was not seen as a priority issue compared with other criteria underlying their food decisions. Food security, which can be interpreted as having enough maize for the year, was topmost and was largely reflected in concerns about maintaining sufficient supplies of maize for *nsima*. However, food preferences included eating more diverse and often more nutritious foods. This somewhat contradictory set of results can be interpreted as a preference for food security over maize security, but not necessarily as a lack of knowledge or desire for a diverse diet.

Needs for cash are numerous and important, but people avoid selling food crops if they do not feel they can meet their immediate food needs with their stocks. Holding onto food stocks may also serve as a means of hedging, waiting for a better price, or keeping a store of assets in case of an income shock or unexpected major expense.

While financial obstacles were the most commonly mentioned barriers to purchasing preferred or nutritious foods in the market, lack of availability was also a major barrier. As such, it is possible that specific VCN approaches could effectively combine nutrition training—promoting consumer demand for key commodities—with value chain approaches to decrease price and increase availability. Many nutritious crops that households produce are both consumed and sold. Decisions about what or how much to sell are based on consideration of a range of factors.

Regarding specific commodities, soybean, groundnut, and maize are both sold and consumed. Thus they have potential for responding to VCN approaches to improve their impact on nutrition through increased productivity, nutrition training to increase consumption, or linking producing households to nutrition-enhancing supply chains. Because fruit tends not to be produced at home but purchased in the market, there may be an opportunity to promote more household fruit production as well as improved linkages to nutrition-enhancing supply chains for farm households producing fruit.

A common deficiency in Malawian diets is the lack of animal-source foods, including meat, poultry, and dairy (Government of Malawi 2009). Unfortunately, livestock and poultry are more often viewed as banks of wealth rather than as a food source. Fresh milk and, more important, homemade *chambiko,* which has a longer shelf life and is used as relish, may be exceptions, particularly in Karonga. Milk and *chambiko* consumption are very low in the other two study districts and, as discussed above, do not make up a central part of typical diets there. However, it is possible that a combination of nutrition training and promotion of supply-chain linkages for milk and dairy products to decrease prices may increase demand marginally. In fact, there is evidence that *chambiko* consumption increases when its price goes down, whereas fresh milk consumption increases only in response to an income increase (Akaichi and Revoredo-Giha 2012).

Past research documented shifts in gendered control over crops like groundnut and soybean when commodity commercialization programs moved such crops from largely being under the control of women to being under the control of men (Cook et al. 2014; Quisumbing et al. 2014). Our research shows that household decision-making dynamics between women and men are more diverse and complex than that. Respondents tended to reject the idea of men's and women's crops; however, overall they tend to conform to stereotypical gendered roles in terms of men having more power in decisions over crops with high exchange value rather than those produced primarily for consumption. Soybean, groundnut, and maize fit into a unique category, as they play an important dual role for household consumption and as commodities and thus a dual role in terms of gendered control. These crops are also more likely to be the focus of intrahousehold, cross-gender discussion and debate over whether they should be sold or consumed.

Chapter 4 POVERTY, FOOD PRICES, AND DIETARY CHOICES IN MALAWI

Karl Pauw, Iñigo Verduzco-Gallo, and Olivier Ecker

ABSTRACT: THIS CHAPTER REPORTS ON THE LINKS BETWEEN HOUSEHOLD FOOD consumption choices, food prices, and household income, using data from Malawi's Second (2004–2005) and Third (2010–2011) Integrated Household Surveys. Results indicate that while income poverty appears to have decreased on average, substantial disparities remain and are indeed increasing, with the richest quintile becoming disproportionately better off, and the poorest of the poor becoming even worse off, a trend that may well shape nutritional outcomes in the future. Further, all but the richest households appear to be spending more money on food than in the past, although much of this trend is likely explained by a relative decline in the cost of nonfood goods. Trends in food consumption appear mixed. They include some predictable responses. For example, with respect to maize nationwide, prices decreased and consumption increased, while for leafy greens, prices increased and consumption decreased nationwide. More unpredictable responses were also observed. These include an increase in consumption of red meat, fruit, rice, and fish nationwide, despite rising prices for all four commodities. Based on these results, indicators for household-level access to micronutrients were constructed to estimate household access to vitamin A and iron, as well as total calories. Results indicate substantial shortfalls across income quintiles for iron in rural areas, and vitamin A shortfalls nationwide. And while access to calories improved overall, significant differences exist in the levels and rate of decline in rural and urban areas, with the improvement in urban households being far greater.

The links between household income growth, household food security, and individual dietary outcomes are complex. While we expect higher incomes to lead to an increase in the quantity and quality of foods accessed by the household—particularly in a resource-constrained context like Malawi's—other considerations, such as the allocation of household budgets for the purchase of nonfood items and the relative prices of nutrient-dense food items, also influence what people eat.

In this chapter, we analyze Malawi's recent food consumption trends, including per capita calorie and micronutrient consumption estimates, and reflect on how these pertain to (1) changes in poverty and household income, and (2) relative changes in food prices. In so doing, we extract from a detailed analysis of household food consumption (Verduzco-Gallo, Ecker, and Pauw 2014) and from an assessment of recent poverty trends (Pauw, Beck, and Mussa 2016). Both of these studies draw on the second and third rounds of Malawi's nationally representative Integrated Household Surveys (IHS2 and IHS3) collected in 2004–2005 and 2010–2011, respectively (NSO 2005, 2012a).

Although in economics, the term "consumption" usually refers to the monetary value of expenditure on goods or services or both, the food consumption modules of the IHS questionnaire specifically ask respondents to report quantities and values of food actually consumed by household members

during a seven-day recall period. The interpretation of consumption in this study is therefore closer to the way nutritionists understand consumption—what people ingest. However, as the data are drawn from household surveys, we cannot comment on the allocation of food among household members or make statements about the bioavailability of the food consumed.

Our results indicate that while income poverty appears to have decreased between 2004–2005 and 2010–2011 on average, substantial disparities in welfare remain and are indeed increasing, with the richest quintile of the population of Malawi becoming disproportionately better off, and the poorest of the poor becoming even worse off. In addition, results show that households are generally allocating a larger share of their budgets to food than they did in the past, despite rising incomes. And while the country is consuming more of some nutrient-rich foods, such as white meat, vegetable consumption has decreased, which is likely to exacerbate micronutrient malnutrition.

REASSESSING MALAWI'S POVERTY ESTIMATES

Malawi ranked as the third poorest country in the world in 2010. Gross domestic product (GDP) per capita was US$780, compared with figures of between US$1,105 and US$3,925 in neighboring Mozambique, Tanzania, Kenya, and Zambia (World Bank 2015). However, Malawi also witnessed record levels of economic growth between 2005 and 2011. During this period, national GDP growth averaged 7.1 percent annually (NSO 2012b). This translates to increases in per capita GDP of around 3.1 percent. While expectations were high that growth would be accompanied by rapid poverty reduction, the official narrative is that this was not the case. Malawi's National Statistics Office (NSO) reports that the national headcount poverty rate—defined as the share of the population with consumption below a poverty line that reflects the cost of a basket of food that yields sufficient calories, plus essential nonfood items—declined only marginally, from 52.4 percent to 50.7 percent, over the period. Moreover, rural poverty reportedly rose, albeit by a statistically insignificant 0.7 percentage points (NSO 2005, 2012a).

However, recent findings from Pauw, Beck, and Mussa (2016), using the same datasets, provide a somewhat different story about the evolution of poverty in Malawi. In contrast to the NSO approach, Pauw, Beck, and Mussa (2016) utilize consumption baskets that are flexible rather than static over time, thus accounting for significant shifts in consumption choices observed for poor households over time, not only in terms of their food versus nonfood budget allocations, but also in terms of the relative amounts of different foods consumed. They also adopt regional poverty lines adjusted by region-specific inflation rates rather than a single national poverty line, given observed differences not only in food and nonfood inflation, but also in overall inflation rates across regions. This approach, they argue, produces poverty results that are more consistent with the economic growth trajectory as well as evidence of significant improvements in nonmonetary dimensions of welfare.[9]

Overall, compared with official NSO numbers, Pauw, Beck, and Mussa (2016) estimate a much larger decline in national poverty than the NSO found, from 47.0 percent to 38.6 percent (that is, –8.4 percentage points). As seen in Table 2, this includes a large decline in urban poverty consistent with the NSO estimates, but also a substantial 7.5 percentage point reduction in rural poverty, which stands in sharp contrast to the 0.7 percentage point increase estimated by the NSO. Figure 6 maps the district-level poverty rates for Malawi in 2004–2005 and 2010–2011, based on estimates by Pauw, Beck, and Mussa (2016). It is apparent that the incidence of poverty is highest in the Northern and Southern Regions, particularly in the more remote districts or those along the lakeshore, but these regions also witnessed the greatest declines in poverty over the period.

With respect to extreme poverty—that is, the share of the population with consumption below the food-only component of the poverty line, the figures of Pauw, Beck, and Mussa (2016) are consistent with those of

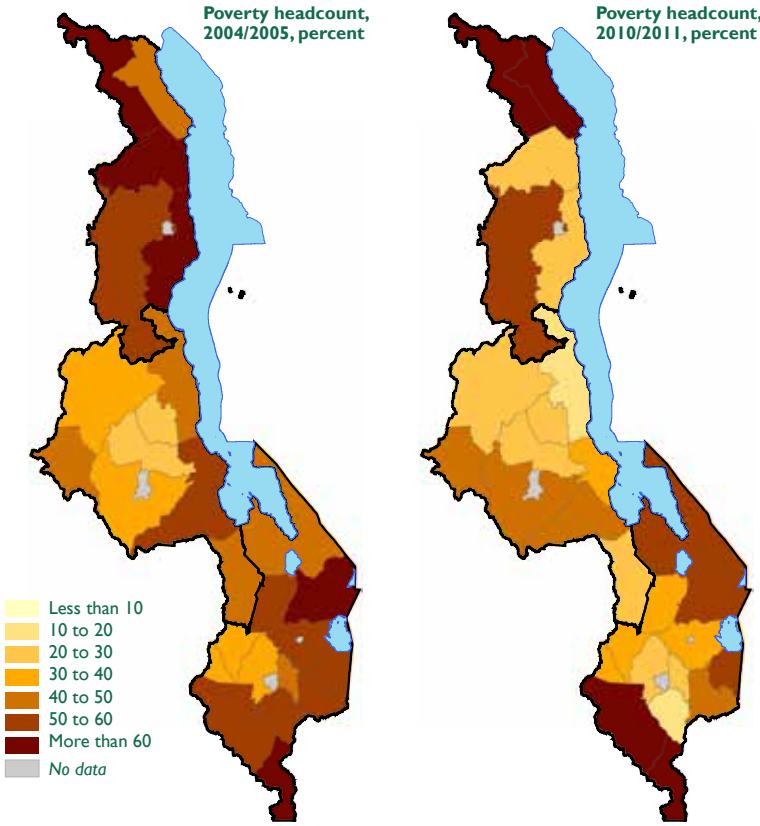
TABLE 2 ALTERNATIVE POVERTY ESTIMATES FOR MALAWI, 2004–2005 TO 2010–2011

	Poverty headcount rate (%)				Percentage point change & 95% confidence intervals	
	2004–2005 (IHS2)		2010–2011 (IHS3)			
	Pauw et al.	NSO	Pauw et al.	NSO	Pauw et al.	NSO
Normal (food plus nonfood) poverty line						
National	47.0	52.4	38.6	50.7	−8.4 ± 2.8	−1.7 ± 2.4
Urban	37.6	25.4	27.3	17.3	−10.3 ± 9.4	−8.1 ± 6.8
Rural	48.2	55.9	40.6	56.6	−7.5 ± 2.9	0.7 ± 1.4
Extreme (food only) poverty line						
National	17.1	22.3	17.9	24.5	0.8 ± 2.0	2.1 ± 2.2
Urban	9.0	7.5	4.7	4.3	−4.2 ± 3.6	−3.2 ± 3.4
Rural	18.1	24.2	20.2	28.1	2.1 ± 2.2	3.9 ± 2.4

Source: Pauw, Beck, and Mussa (2016) and NSO (2005, 2012a).

Note: IHS = Integrated Household Survey; NSO = National Statistical Office.

FIGURE 6 ALTERNATIVE POVERTY HEAD COUNT ESTIMATES FOR MALAWI, BY DISTRICT, 2004–2005 AND 2010–2011



Source: Maps by M. Kedir Jemal, IFPRI, of results of alternative poverty analysis of IHS2 and IHS3 data (Pauw, Beck, and Mussa 2016).

the NSO in terms of the direction of change, in that both estimates indicate an increase. Although the magnitude of change is smaller in Pauw, Beck, and Mussa's findings, the fact that both analyses document a rise supports the claim that the most vulnerable Malawians were excluded from the benefits of economic growth between 2005 and 2011. For example, Malawi's Farm Input Subsidy Program (FISP) has been documented as being less effective in targeting the poorest of the poor (Chibwana et al. 2014); the consumption level of most recipients of the subsidy is more likely closer to the poverty line than to the extreme poverty line. Figure 7 shows district-level extreme poverty rates, also based on Pauw, Beck, and Mussa (2016).

This rise in extreme rural poverty is a contributing factor to rising inequality in Malawi. Not only are the richest becoming disproportionately better off, but the poorest of the poor are becoming even worse off, a trend that may well shape nutritional outcomes in the future.

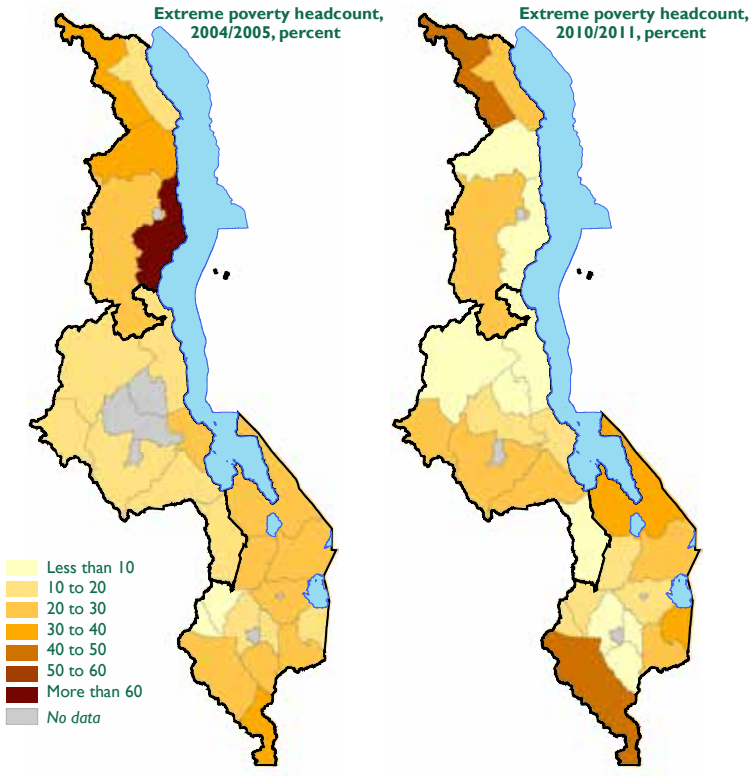
DOES INCREASED INCOME TRANSLATE TO IMPROVED FOOD SECURITY?

SHIFTS IN FOOD AND NONFOOD SPENDING

Given that the national accounts data of the NSO suggest that GDP per capita in Malawi rose by 3.5 percent annually from 2005 to 2011, the expectation is that household expenditures would also rise. Analysis of the IHS data from the same period confirms these expectations, showing average expenditure growth to have been around 2.2 percent per capita annually after adjusting for inflation (Pauw, Beck, and Mussa 2016).

We would expect a rise in income to result in households spending a smaller share of their budget on food. However, Pauw, Beck, and Mussa (2016) find that most households actually spent a greater share of their incomes on food in 2011 than in 2004. On average, household food expenditures increased

FIGURE 7 ALTERNATIVE EXTREME POVERTY HEADCOUNT ESTIMATES FOR MALAWI, BY DISTRICT, 2004–2005 AND 2010–2011



Source: Maps by M. Kedir Jemal, IFPRI, of results of alternative poverty analysis of IHS2 and IHS3 data (Pauw, Beck, and Mussa 2016).

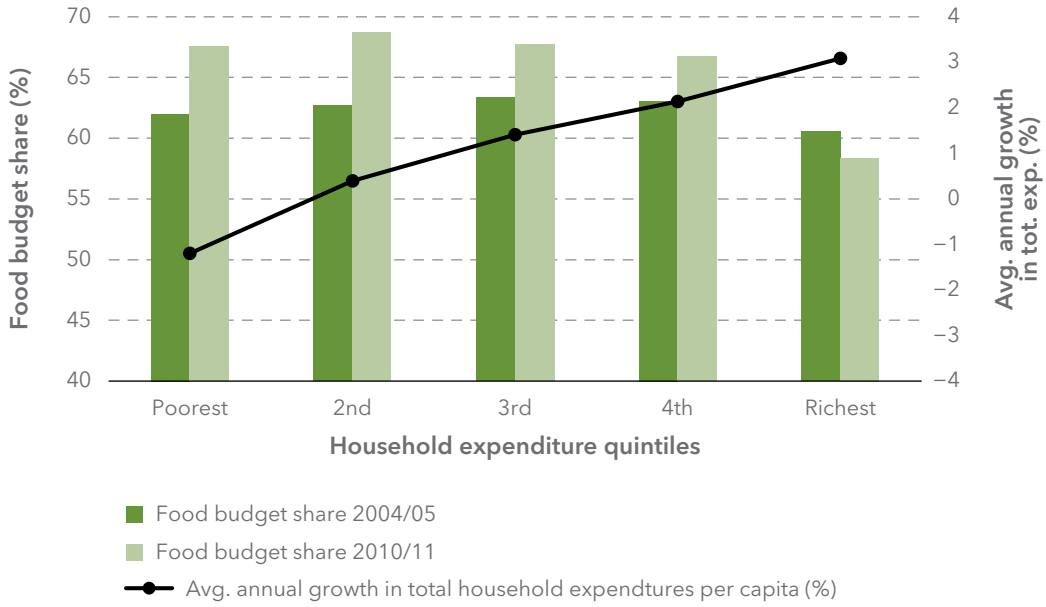
slightly from 61.7 percent to 62.6 percent between 2004 and 2011. While we might expect this scenario for the poorest quintile, who likely were not able to afford to meet their basic food needs despite substantial growth, we see in Figure 8 that the second, third, and fourth quintiles also increased their food budget expenditures. Only the richest income quintile spent a smaller share of income on food in 2010–2011 relative to 2004–2005.

A closer look at relative food and nonfood inflation rates may help explain this outcome. Using prices underlying their estimated poverty lines, Pauw, Beck, and Mussa (2016) estimate a food inflation rate of 129.0 percent, a significantly lower nonfood inflation rate of 93.1 percent, and a national average inflation rate of 114.7 percent. The NSO's own estimates also reveal higher food inflation in the period between the two IHS rounds, while the overall inflation rate for this period is also slightly higher, at 128.9 percent.

Household survey data reveal significant declines in the share of households reporting inadequate access to housing (–12.5 percent), healthcare (–27.5 percent), and clothing (–15.5 percent) between 2004 and 2011, suggesting that these nonfood expenditure items were important cost-saving components for households during this period. The subsidy value of the FISP fertilizer package (approximately US$80), available to half of smallholders or two-fifths of all Malawian households from 2006 onward, equates to around 6.8 percent of the poverty line, translating into another significant saving on nonfood items over the period. The FISP also transferred significant benefits to beneficiary households—and disproportionately to those in the lower- to middle-income brackets close to the poverty line as opposed to the extreme poor—in the form of increased value of output. By official accounts, maize yields doubled from 2005 to 2011, with the FISP officially credited as a major contributor to productivity growth (Government of Malawi 2012).

The direct benefits of the FISP combined with the significant decline in prices of some important nonfood items to a large extent explain Malawi's poverty trajectory as measured at the "normal" poverty line (in addition to justifying the adoption of flexible

FIGURE 8 HOUSEHOLD FOOD BUDGET SHARES, BY QUINTILE, 2004–2005 AND 2010–2011



Source: Authors' estimates based on IHS2 and IHS3 (NSO 2005, 2012a).

consumption baskets in estimating poverty changes). Simulations by Arndt, Pauw, and Thurlow (2016) suggest that the FISP alone accounted for a 1.7–2.8 percentage point reduction in poverty under different assumptions (that is, approximately one-quarter of the observed decline), although this is likely an underestimate given an unavoidable assumption that FISP beneficiaries were randomly selected from the subset of maize growers, when in reality the extremely poor and wealthy were more likely to be excluded.

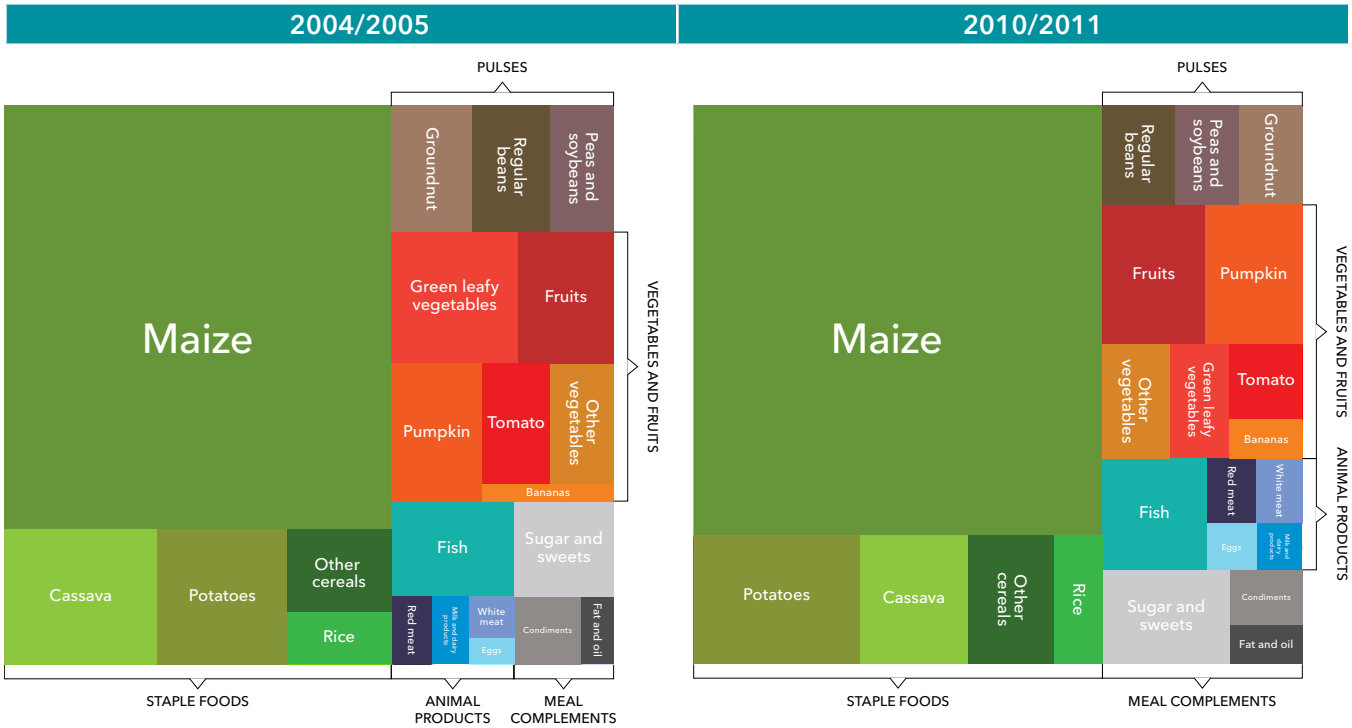
In summary, a consequence of recent income growth and spending trends was that households were able to allocate more money to food, in relative and absolute terms, without sacrificing nonfood consumption. Therefore, the question of interest, discussed in the remaining sections of this chapter, is whether this shift in household budget allocation to food translated into changes in the types of foods that were purchased, and if so, what the nutritional implications of such changes may have been.

SHIFTS IN HOUSEHOLD FOOD CONSUMPTION PATTERNS

Before considering detailed household food consumption patterns, we first look at household dietary diversity, using IHS data to construct Household Dietary Diversity Scores (HDDSs). As described in Chapter 2, the HDDS is based on a simple counted score of 12 food groups constructed from recall data on household food consumption.

As expected, results indicate that HDDSs in Malawi tend to increase as incomes increase. Nationally, alongside the increase in average incomes, the average HDDS increased from 7.9 to 8.2 between 2004–2005 and 2010–2011. However, this national average masks substantial variation across income quintiles. In line with findings on extreme poverty, the poorest Malawians did not increase their HDDSs at all, but saw a very marginal decline from 6.4 to 6.3. HDDSs increased across all other quintiles, but most markedly in the fourth (8.7 to 9.4). This is not surpris-

FIGURE 9 GRAPHICAL REPRESENTATION OF CHANGES BETWEEN 2004–2005 AND 2010–2011 IN THE SHARE OF QUANTITY OF FOOD CONSUMED IN THE AVERAGE MALAWIAN DIET, BY FOOD SOURCE



Source: Authors' estimates based on data from the Second and Third Integrated Household Surveys (NSO 2005, 2012a).

ing, as HDDSs for the wealthiest households will tend to increase at a slower rate than those of relatively poorer household groups for a given rate of income growth, as the wealthiest are already closer to their optimum HDDS (Swindale and Bilinsky 2006).

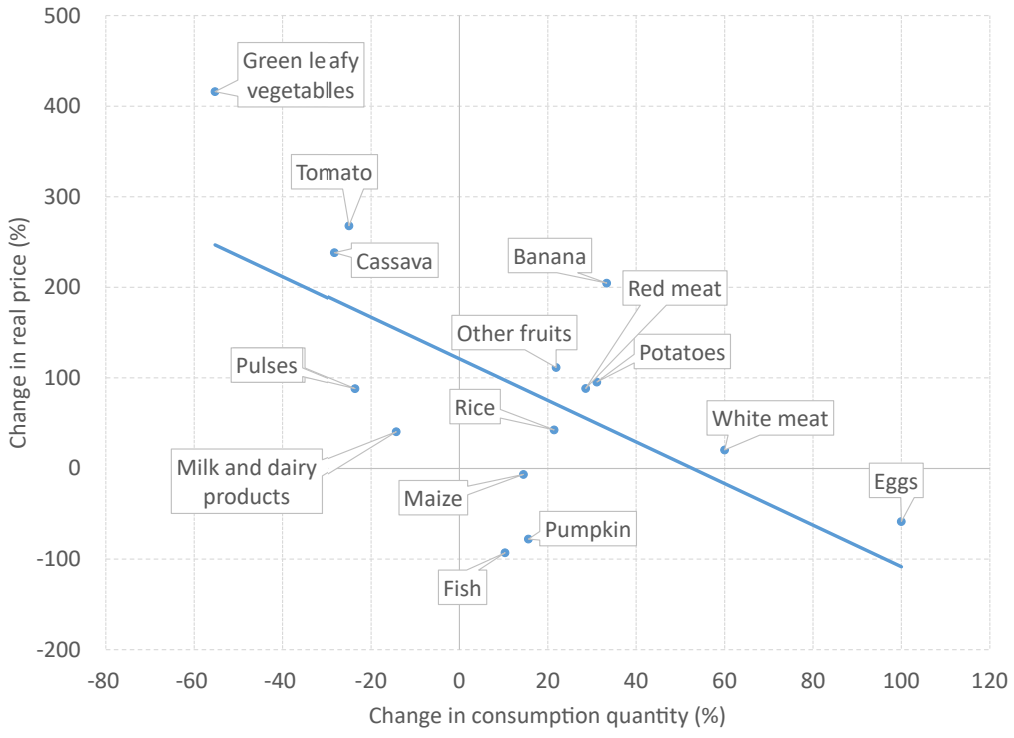
Regarding estimated consumption of specific food items, several important household food-consumption shifts appear to have occurred between 2004–2005 and 2010–2011. These shifts are shown graphically in Figure 9 for the country as a whole. In both rural and urban areas, there was a substantial increase in consumption shares of staple foods, such as rice and maize, the latter already being the most widely consumed food crop. Consumption shares of fruit and animal products also increased in both rural and urban areas, while consumption shares of vegetables and cassava declined. The consumption share of pulses, in turn, declined sharply in rural areas, but increased in urban areas, with the net effect being a decline nationally. The potato consumption share also increased in urban areas.

RELATING FOOD CONSUMPTION SHIFTS TO CHANGING FOOD PRICES

To better understand the shifts in household food consumption, we also estimate the daily per capita consumption of various foods and the change in consumption per day between 2004–2005 and 2010–2011. These estimates of average per capita availability of specific foods and food groups are based on household consumption data, not individual dietary data.

Figure 10 plots changes in the consumption levels of these foods (horizontal axis) against changes in their national median prices. While the figure disregards potentially significant regional price variations, it nevertheless conveys a powerful message of how, on average, price increases may explain decreases in consumption, as evidenced by the downward-sloping fitted trend line: the higher the price increase of a particular food group or item, the larger the expected decline in consumption, and vice versa. However, for a significant number of food items we see increases in consumption

FIGURE 10 FOOD CONSUMPTION CHANGES AND RELATIVE PRICE SHIFTS, 2004–2005 TO 2010–2011



Source: Authors' estimates based on IHS2 and IHS3 (NSO 2005, 2012a)..

despite rising prices, including luxury items such as rice and meat. These results may reflect shifting consumption choices associated with the rising income levels we have seen among wealthier households.

Staple foods. As incomes increase, households often substitute away from coarse grains (maize or sorghum) and starchy staples (potatoes or cassava) toward finer grains such as rice or wheat (Fuglie 2004). However, in Malawi, our analysis indicates that maize consumption increased by 14 percent. This increase is significant in absolute terms given that maize already accounts for around two-thirds of all calories consumed in Malawi. The most likely explanation for this is the increase in maize supply under the FISP, which coincided with a real decline in maize prices (Arndt, Pauw, and Thurlow 2016; Ricker-Gilbert et al. 2013). A relatively sharp rise also occurred in potato consumption. More detailed analysis reveals that this increase was driven mostly by rising potato consumption in urban areas.

Unlike maize and potatoes, the typical substitution response did not seem to hold for cassava, for which consumption declined substantially. Cassava is traditionally a food crop for which demand rises when maize supply is low, and so ample maize harvests and stores during the period in question are perhaps one reason for the decline in cassava consumption. However, cassava prices also more than tripled during this period, which suggests the decrease in consumption may be as much due to a price effect as an income effect. Much of the price increase was likely due to increased demand for cassava as a commercial input for manufactured food and nonfood products (Kambewa 2010).

Finally, despite an increase in the price of rice, consumption rose by an estimated 21 percent. This pattern may be due to strong consumer preference for rice evident all over Africa south of the Sahara, facilitated by increased purchasing power.

Pulses. The per capita decline in the consumption of pulses (24 percent) is also likely linked to increased prices (88 percent). However, it is important to note that this national decline in the consumption of pulses masks substantial differences in regional price changes—overall, the price of pulses in rural markets increased by 99 percent, while in urban areas the price only increased by 47 percent. Moreover, when the data were disaggregated by type of pulse, groundnut prices were found to have declined in urban areas, while pea and soybean prices increased by only around 10 percent, compared with sharp increases in the prices of these particular varieties in rural areas. These regional price trends to some extent explain regional consumption behavior—namely, that per capita consumption of pulses decreased substantially among rural households, but rose among urban households (see Verduzco-Gallo, Ecker, and Pauw [2014] for details).

Vegetables and fruits. Per capita consumption of fruit and pumpkin increased nationwide, while consumption of tomatoes and green leafy vegetables declined considerably. These consumption trends are similar across rural and urban areas, with relative price shifts again providing a likely explanation for the changes: pumpkin prices declined by 82 percent, while tomato and leafy green prices rose sharply, by 264 percent and 412 percent, respectively. The one exception within this group was bananas and other fruit. Despite two- to threefold increases in their price—admittedly from a relatively low level compared with, say, animal-source foods—consumption increased substantially. As with rice and meat products, this pattern may be due to strong consumer preferences for fruit, facilitated by increased purchasing power.

Animal-source foods. Per capita consumption of white meat (mostly chicken) increased substantially—by 60 percent—nationwide. Nationwide consumption of red meat also increased by 29 percent, albeit less drastically than for chicken. Importantly, prices for both of these animal-source foods also increased. White meat prices rose by 20 percent nationally, but declined in rural areas, possibly because of the availability of cheaper feed. In both rural and urban areas, red meat prices rose steeply, by 88 percent. As with rice and fruit, it is likely that household increases in income, combined with preferences for meat, outweighed national average price increases, with the net effect being increased per capita consumption.

In contrast, the 41 percent price increases for milk and dairy products may have led to a concomitant decline in consumption of 14 percent. Egg consumption doubled, likely due to a substantial price decrease of around 58 percent.

Fish is an important part of the traditional Malawian diet, especially for communities near the lakeshore. Per capita fish consumption increased by 10 percent alongside a sharp 93 percent decline in fish prices. This outcome is somewhat surprising in the context of dwindling fish stocks in Lake Malawi (FAO 2013), and indeed, the numbers change substantially when the data are separated into dried and fresh fish. Disaggregation reveals an almost threefold increase in the real price of fresh fish, and alongside that a decline in per capita fresh fish consumption. In contrast, per capita consumption of dried fish, some of which is imported from neighboring Tanzania and Mozambique, doubled alongside a significant decline in dried fish prices.

NUTRITIONAL IMPLICATIONS OF CHANGES IN PER CAPITA CONSUMPTION OF SPECIFIC FOODS

To better understand how shifts in household food consumption impact dietary quality, in the absence of individual dietary data we approximate daily per capita calorie and micronutrient intake given the foods and quantities accessed by the household. These per capita estimates are then compared with the daily recommended intake requirements for household members to yield Household Micronutrient Access indicator estimates. Estimates for average per capita consumption of calories, iron, and vitamin A via these food groups are based on food composition tables from Kenya and Senegal and are shown in Table 3. (More details on this estimation process can be found in Chapter 2.)

CALORIES

On average, Malawian households increased per capita consumption of calories by 4.6 percent between 2004–2005 and 2010–2011. Calorie consumption also increased across all income quintiles in both rural and urban areas. However, despite these increases, average estimated consumption among the poorest rural households remained below minimum calorie requirements.

In both rural and urban areas, the richest quintile recorded the largest increase in calories, despite already consuming calories well above required amounts. This

TABLE 3 CALORIE AND MICRONUTRIENT CONSUMPTION, BY RESIDENCE AND CONSUMPTION QUINTILE, 2004/2005 TO 2010/2011

	Calories (kcal/day)			Iron (mg/day)			Vitamin A (RE mcg/day)		
	2004–2005	2010–2011	Change (%)	2004–2005	2010–2011	Change (%)	2004–2005	2010–2011	Change (%)
Total	2,204	2,305	4.6	20.0	19.5	**–2.5**	417	373	**–10.6**
Rural	2,176	2,232	2.6	20.2	19.5	–3.5	420	375	–10.7
Poorest	1,387	1,441	3.9	13.5	13.8	1.8	304	219	–27.9
2nd	1,857	1,895	2.1	17.8	17.4	–2.0	379	303	–20.0
3rd	2,211	2,245	1.6	20.9	20.0	–4.1	427	392	–8.2
4th	2,632	2,642	0.4	24.3	22.6	–7.3	467	468	0.1
Richest	3,269	3,431	5.0	28.5	27.2	–4.6	592	586	–1.0
Urban	2,423	2,704	11.6	18.4	19.5	6.3	393	360	–8.5
Poorest	1,712	1,838	7.3	15.5	15.6	0.6	350	210	–40.1
2nd	2,104	2,387	13.4	17.6	18.7	5.8	365	311	–14.8
3rd	2,457	2,791	13.6	19.1	20.5	7.3	375	392	4.5
4th	2,752	3,157	14.7	19.7	21.4	8.3	446	463	3.8
Richest	3,385	3,867	14.2	21.0	23.6	12.2	451	503	11.7
Requirement	**1,701**	**1,728**	**1.6**	**17.2**	**17.5**	**1.7**	**375**	**380**	**1.3**

Source: Authors' estimates based on IHS2 and IHS3 (NSO 2005, 2012a).

Note: RE = retinol equivalent

trend is common in many other developing countries and is often considered an early step in the nutrition transition. The nutrition transition is characterized by a shift away from relatively monotonous diets of varying nutritional quality toward an industrialized diet that is usually more varied and includes more processed food, more food of animal origin, more added sugar and fat, and often more alcohol. This transition is accompanied by a shift in the structure of occupations and leisure toward reduced physical activity and leads to a rapid increase in the prevalence of overweight and obese individuals, with implications for diet-related noncommunicable diseases and their associated healthcare costs (Popkin 1994).

IRON AND VITAMIN A

In urban areas, estimated changes in per capita access to iron appear to have been income-dependent and in line with estimated increases in nationwide red meat consumption. However, this does not hold true for rural areas where, counterintuitively, the highest declines were in wealthier households. Only the poorest rural quintile increased access to iron, based on our estimates. With respect to non-heme (that is, plant-based) iron, one partial explanation is the decreased consumption of pulses that occurred across income quintiles in rural areas due to rising rural prices of pulses. However, this does not explain the distribution across quintiles. One possibility is increased consumption of dried fish. When consumed whole, dried fish are an excellent source of iron. Further, it is possible that this food product, which may be considered an inferior good relative to increasingly expensive fresh fish, is consumed primarily by poorer households, with positive implications for iron intake.

Nationwide, estimated vitamin A consumption deteriorated sharply during the period 2004–2005 to 2010–2011, especially among poorer urban and rural households whose consumption patterns appear more price-sensitive to the significant price increases. This trend is not consistent with the nationwide increase in fruit and pumpkin consumption, both of which are sources of vitamin A, and is congruent with national decreases in dairy product and leafy green consumption, also sources of vitamin A. With respect to the latter, a line of inquiry that remains unexplored is whether high horticulture prices are creating incentives for farmers to sell more of their vegetables rather than retain them for their own consumption.

ESTIMATED CALORIE AND MICRONUTRIENT SHORTFALLS

Table 4 reports on Household Micronutrient Access indicators for calories,[10] iron, and vitamin A. Table 4 presents the share of households whose approximated calorie, vitamin A, and iron intakes are below the nutrient intake requirements of their members. The share of households whose consumption falls short of requirements is indicated for rural and urban areas and the country as a whole.

While access to calories improved from 2004–2005 to 2010–2011, significant differences exist in the levels and rate of decline in rural and urban areas. The number of rural Malawian households that failed to access sufficient calories changed from 40.5 percent to 36.7 percent. The improvement in urban households was far greater, changing from 30.9 percent to 20.6 percent. Figure 1, in Chapter 1, includes a district-level map of average estimated household calorie intake deficiencies.

TABLE 4 ESTIMATED SHORTFALLS IN CALORIE, IRON, AND VITAMIN A CONSUMPTION, BY RESIDENCE, 2004/2005 TO 2010/2011

	Calorie shortfall (%)			Iron shortfall (%)			Vitamin A shortfall (%)		
	2004–2005	2010–2011	%-point change	2004–2005	2010–2011	%-point change	2004–2005	2010–2011	%-point change
Total	**39.4**	**34.3**	**–5.1**	**44.1**	**48.6**	**4.5**	**62.0**	**69.9**	**7.9**
Rural	40.5	36.7	–3.8	42.6	47.7	5.1	61.8	69.8	8.0
Urban	30.9	20.6	–10.3	55.1	54.0	–1.1	63.1	70.8	7.7

Source: Authors' calculations with IHS2 and IHS3 data (NSO 2005, 2012a).

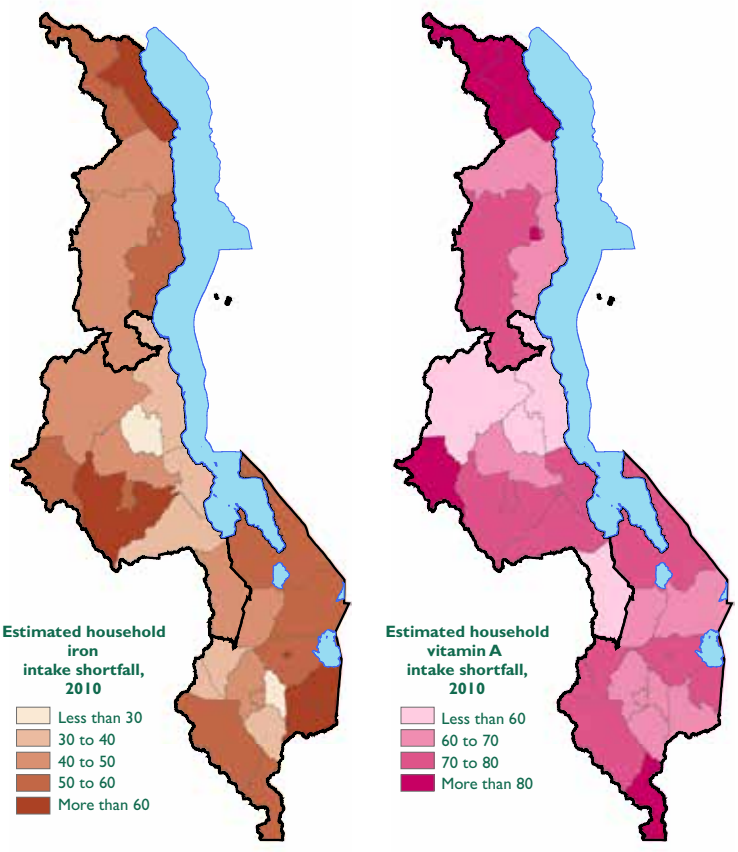
The picture looks different for micronutrients (Figure 11). A sharp increase in the rural iron shortfall rate (5.1 percentage points) caused the national shortfall to increase by 4.5 percentage points (offsetting a decrease of 1.1 percentage points among urbanites). Vitamin A shortfalls also increased sharply in both urban and rural areas, giving rise to a 7.9 percentage point increase in the share of households nationally with vitamin A intake below requirements. As above, while the reasons for this trend are difficult to tease out due to conflicting patterns of consumption between various vitamin A source foods, one partial explanation may be the steep price increase of green leafy vegetables and the concomitant sharp decline in their consumption.

SYNOPSIS OF FINDINGS AND CONCLUDING REMARKS

In this chapter, we present per capita food consumption estimates and associated changes in calorie and micronutrient access for Malawi between 2004–2005 and 2010–2011. The focus of the analysis is on the household income–consumption relationship and the role of relative prices in shaping this relationship; we do not explicitly consider the source of foods consumed, which instead is addressed in the following chapter on the relationship between crop production and consumption patterns of farm households.

Consistent with growth in GDP per capita, poverty declined across urban and rural areas. Somewhat surprisingly, except for the richest households, income growth was accompanied by an increase in food

FIGURE 11 AVERAGE ESTIMATED HOUSEHOLD IRON AND VITAMIN A INTAKE SHORTFALLS, BY DISTRICT, MALAWI, 2010



Source: Maps by M. Kedir Jemal, IFPRI, of IHS3 calorie deficiency analysis results (Verduzco-Gallo, Ecker, and Pauw 2014).

expenditure shares across all household expenditure quintiles. However, in absolute terms, per capita food consumption, calorie access, and household dietary diversity in Malawi increased nationwide and in both rural and urban areas, despite evidence of rising food prices. This rise in food prices, we argue, reflects a shift in consumption toward more costly food items. The consumption shift was made possible by two factors. First, given the price and supply dynamics of consumer goods in Malawi, households were seemingly able to reduce their budget allocation to nonfood items without sacrificing the quantity or quality of nonfood items, giving rise to the paradoxical outcome of rising food budget shares. Second, the small decline in the price of the major staple, maize, brought about significant income and substitution effects in consumption, allowing households to allocate a greater share of their food budgets to higher-quality food items.

Evidence suggests that the FISP, through raising maize yields and production, was an important contributing factor to rising incomes, declining maize prices, and, given the dominance of maize in the food basket, poverty reduction (Arndt, Pauw, and Thurlow 2016). Additionally, as argued before, the relative decline in nonfood prices played an important role in raising overall household welfare levels. Generally, however, the resulting ability of households to increase their budget allocation to food items, in both absolute and relative terms, led to dietary changes that did not appear to translate into generalized improvements in micronutrient access. Estimated Household Micronutrient Access for vitamin A declined in rural and urban areas, particularly among poorer quintiles, while estimated Household Micronutrient Access for iron declined significantly among most income quintiles in rural areas.

Considering these food consumption shifts in more detail, apart from the increase in consumption of a select number of foods for which we observed price increases, most consumption choices can be construed as consistent with the direction of changes in relative prices of food items. Particularly, as noted, a sharp increase in the consumption of calorie-rich maize can be linked to a decline in real maize prices. We also note a reduction in consumption of iron-rich pulses, specifically in rural areas, together with sharp increases in prices of pulses. Finally, the decline in vitamin A may be partially associated with a sharp decline in the consumption of green leafy vegetables, which have also become significantly more expensive in real terms and relative to other food products.

These changes suggest that substitution effects in food consumption may indeed have contributed to reducing the vulnerability of Malawian households to severe food insecurity—that is, calorie insecurity—but also contributed to increasing the risk of micronutrient malnutrition and related health consequences. The changes are disconcerting, especially considering the potentially harmful long-term effects of shortfalls in vitamin A and iron. Moreover, as both the NSO (2005, 2012a) and Pauw, Beck, and Mussa (2016) poverty estimates indicate that the most vulnerable families have been bypassed by recent reductions in income poverty, this leaves the poorest households that much more vulnerable to rising food prices and inflation. Conversely, the pattern among the highest income quintile appears to be overconsumption of calories. In line with global trends, it is likely that this pattern has been accompanied by increased intake of processed foods, including those high in sugar, sodium, and fat, with negative implications for nutrition and health.

Beyond raising incomes and educating households about the importance of healthy, balanced diets, these results suggest a need for economic incentives that alter relative prices of different food items in a way that will stimulate demand for those nutrient-rich foods for which consumption levels are currently inadequate. The recent experience in Malawi is remarkably like that of India during the 1970s and 1980s, when real cereal prices declined rapidly but those of mineral-rich products such as fruits, vegetables, lentils, fish, and other meat products increased. When faced with such price scenarios, Bouis (2013) argues in the context of India, poor consumers have little option but to consume more staples and fewer mineral-rich foods; in short, "the poor get priced out of good nutrition, and the price they pay is too high."

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).

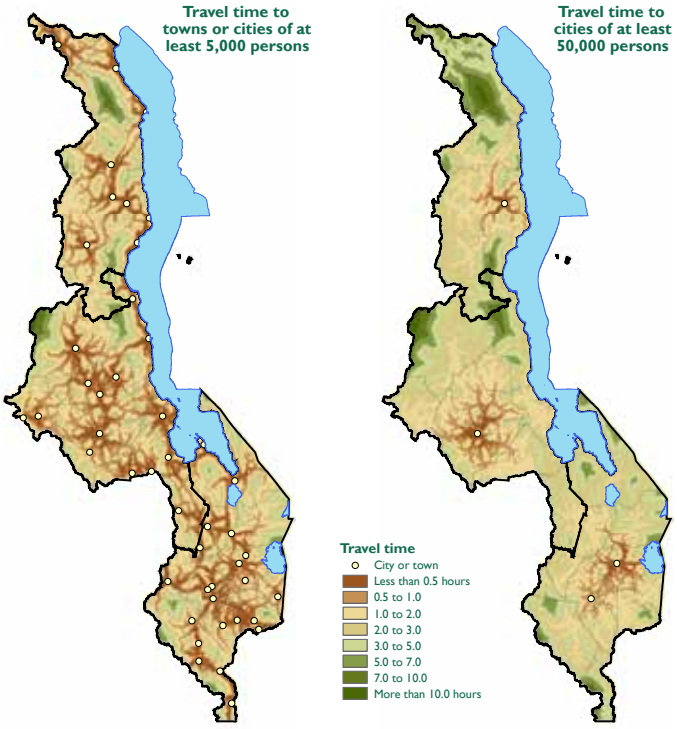
Regression results are shown in Table 6. The household head having received some formal education, the size of landholdings, access to subsidized fertilizer, and market participation are all positively and significantly associated with crop diversification. In addition to subsidized fertilizer, it is 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).

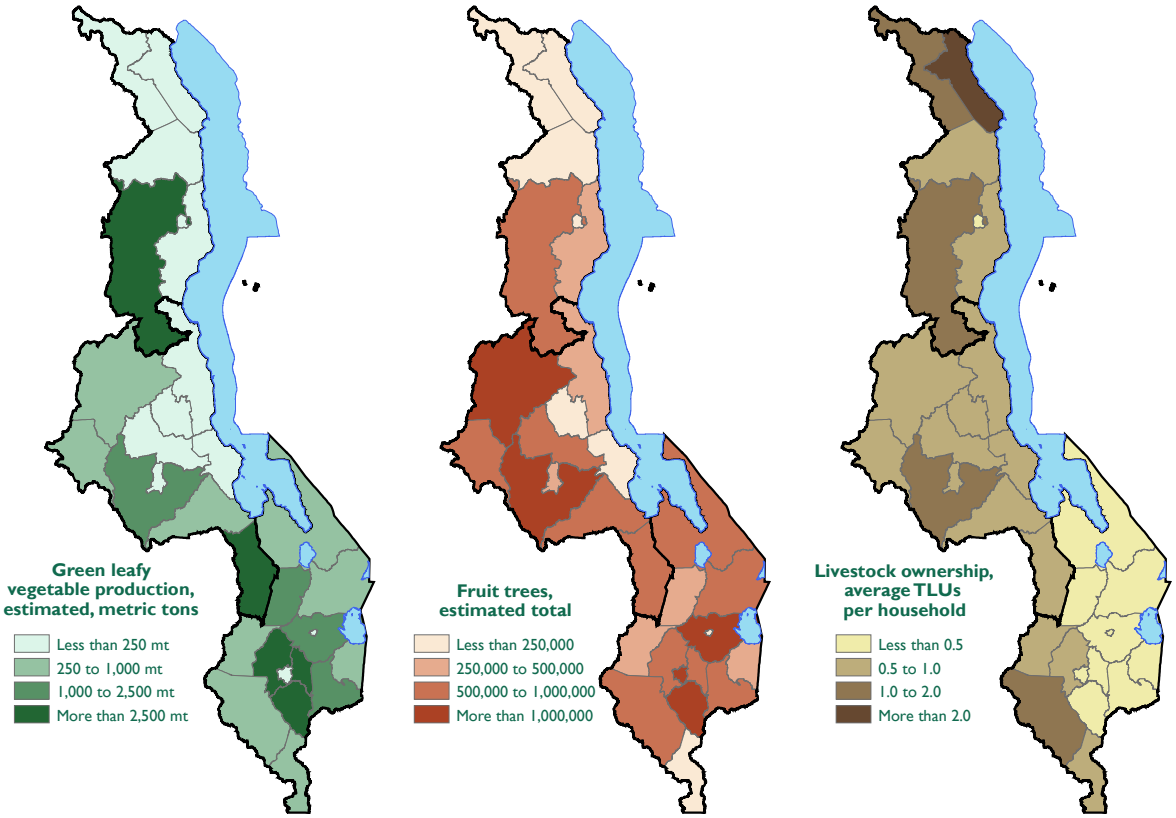
Both the HDDS and the MsHDDS showed a positive and significant association with production diversity, implying that when crops other than maize are grown (Figure 13), whether for market sale or for own consumption, this increases household food security and allows households to access a more diverse 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.

Chapter 6 IRRIGATED FARMING AND IMPROVED NUTRITION IN MALAWIAN FARM HOUSEHOLDS

Todd Benson

ABSTRACT: THIS CHAPTER PROVIDES SELECTED FINDINGS FROM AN ASSESSMENT OF whether increased use in the dry season of irrigated farming by smallholders in Malawi might improve household-level dietary diversity or child nutrition outcomes. We find no strong association between the use of irrigation by farm households in Malawi and the growth performance of those households' children. However, we do find that irrigating households tend to have more diverse diets than households that do not irrigate, leading to the hypothesis that irrigation enables households to produce a wider range of crops for home consumption than they can with purely rainfed production. In line with these results, we also find that irrigation reduces the negative effects of seasonal food insecurity. The insight we take from these findings is that one of the principal contributions that irrigation can make to improved nutrition outcomes, particularly for subsistence farming households, is to ensure reliable, year-round access to a diverse diet that facilitates access to micronutrient-rich foods, such as vegetables.

Expansion of irrigation is a recurrent objective of the agricultural development plans formulated by successive governments in Malawi. The Greenbelt Initiative was launched in 2010 with the goal of irrigating a million hectares of land; the initiative remains in place (Chinsinga 2016). Reports in the Malawian press suggest that any savings from modifications to the design of the Farm Input Subsidy Program (FISP) since 2014 have targeted irrigation as the principal subsector into which these funds will be channeled. More intensive and continual use of Malawi's water and agricultural land resources is expected to increase and stabilize production of food and export crops, thereby increasing farm incomes, spurring growth in the agriculture sector, and enabling the country to more reliably meet the increasing food needs of its growing population.

In addition, irrigation should allow for a more diverse set of crops to be grown throughout the year, with significant expansion desired particularly in the production of micronutrient-rich vegetables and fruit. With increasing use of irrigation across the country, Malawians will gain greater access to more food and a more diverse range of foods. The nutritional status of young children and other vulnerable groups should improve as a result. Conceptually, this nutritional argument to build support for expanding investments in irrigation in Malawi seems reasonable; however, little empirical evidence from Malawi or elsewhere exists to confirm whether irrigation improves nutritional status.

PLAUSIBLE IMPACT PATHWAYS

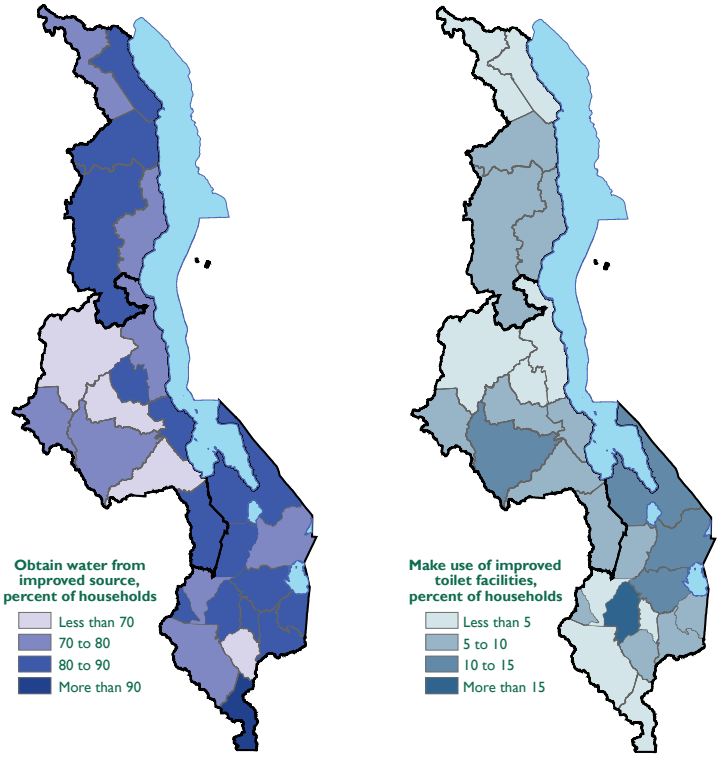
Several direct pathways through which irrigation can be hypothesized to affect the nutritional status of farm households are as follows:

- Irrigation can improve food security—an immediate and underlying determinant of nutrition—by increasing agricultural production per unit area. Particularly in climates with sharply seasonal rainfall patterns, such as Malawi's, irrigation enables exploitation of arable land for production throughout the

year, significantly increasing the amount of food that a farm household can produce in a year from the same area (von Braun, Johm, and Puetz 1994).

- Irrigation in the dry season may improve dietary quality by enabling production of a broader diversity of crops year-round. For example, vegetables are commonly produced in many of the small, traditional irrigated plots in Malawi. Of the almost 1,300 irrigated plots reported on by Malawi's Third Integrated Household Survey (IHS3), 40 percent were used, at least in part, for vegetable production, while 58 percent were used for staple crops (primarily production of maize for green maize consumption) (NSO 2012a). Vegetables are important sources of vitamin A and iron—both of which are lacking in many Malawians' diets. With irrigated production of such micronutrient-dense crops, household dietary diversity might increase, resulting in improved micronutrient intake, with subsequent reductions in the incidence of health problems linked to micronutrient deficiencies (Burney and Naylor 2012).
- Finally, the indirect income effects of irrigation on nutrition are potentially significant. If irrigation is used to produce marketable, higher-value crops, and local markets can offer producers good prices for those crops, subsequent increases in purchasing power may be used to better meet the food, health, and sanitation needs of household members. Further, if a significant portion of this income is controlled by women—for example, via the sale of horticultural crops traditionally grown by women—additional nutritional benefits may be realized, as the resources and income flows that women control have been shown to have disproportionately positive impacts on nutrition (Smith et al. 2003; World Bank 2005; Herforth and Harris 2014).

FIGURE 14 DISTRICT-LEVEL MAPS OF PERCENTAGE OF HOUSEHOLDS OBTAINING DRINKING WATER FROM AN IMPROVED SOURCE AND OF HOUSEHOLDS USING IMPROVED TOILET FACILITIES



Source: Maps by M. Kedir Jemal, IFPRI, of 2010 Malawi Demographic and Health Survey results.

METHODS

To better understand the impact that irrigation might have on the nutritional status of Malawian smallholders, we used data from the IHS3 of 2010–2011 to investigate whether irrigation was significantly associated with the height-for-age of children in IHS3 sample households and whether there was a significant association between irrigation and the dietary diversity of surveyed households.

The IHS3 is a national household consumption survey administered by the National Statistical Office (NSO) of Malawi between March 2010 and March 2011. The survey included a household questionnaire on a range of topics, including income, food and nonfood consumption, demographics, education, asset holdings, and employment, as well as data collection on the height and weight of young children (six months to five years) from surveyed households. The latter were used to calculate height-for-age Z-scores (HAZ) as a measure of stunting. Stunting is caused by long-term insufficient nutrient intake and frequent infections.

For the 9,750 surveyed households that reported undertaking agricultural activities, an additional agricultural questionnaire was administered. Of these households, 1,132 (11.6 percent) reported producing crops in the dry season by using irrigation. Irrigating households were identified as those for which information on farm plots used during the dry season and the crops grown in them was recorded in IHS3 agricultural questionnaire module "Ag-Module K: Plot Details—Dry (Dimba) Season." Rudimentary technologies are generally used for irrigation. Watering cans are used by 81 percent of irrigating households to irrigate their crops, most drawing water from wells or nearby surface water sources by hand. (Less than 7 percent of irrigating households in the sample supply water to their plots using pumps, whether motorized, treadle, or hand pumps.) Ten percent rely on flood irrigation. The balance use hose pipes or sprinkler or drip irrigation systems. Irrigating households are distributed across the country, but with somewhat higher prevalence in Central Region. While 35.6 percent of the farm households in our analytical sample are in Central Region, 45.6 percent of irrigating households are located there. The corresponding shares for Northern Region are 16.4 percent of farm households and 13.5 percent of irrigating households, while for Southern Region, these figures are 48.0 percent and 40.9 percent, respectively.

Our analysis used data from this agricultural subsample, differentiating between irrigating and nonirrigating farm households. Our analyses were not weighted, but standard errors were corrected for by the clustered design of the sample.

The first analytical method used to examine associations between irrigation and improved nutrition was a means comparison. The objective in the means comparison analysis was to identify any statistically significant differences in the characteristics of young children or their households based on whether the household engaged in irrigation or the child was stunted.

Our second analytical method was to identify through regression analysis whether any irrigation-related factors were significant determinants of nutritional status. We used two indicators as outcome variables in our regression analyses: HAZ scores for young children and Household Dietary Diversity Scores (HDDSs) for households.

HAZ scores were computed by comparing the height-for-age of each child aged 6 to 60 months in the subsample to the WHO's 2006 child growth norms, as described in Chapter 2. Anthropometric information was collected from 5,908 children in the farm households in our sample.[11] Of these, 763 (12.9 percent) were members of households practicing some irrigated farming.

An HDDS was calculated for each sample household based on a simple counted score of whether household members consumed any food from each of 12 food groups over the previous seven days. This was constructed from IHS3 recall data on food expenditures and household consumption, as described in Chapter 2.

Two regression approaches were used—ordinary least squares (OLS) regression for modeling the HAZ score of young children and Poisson regression for modeling farm households' HDDSs. The HDDS is a count variable for which the Poisson regression

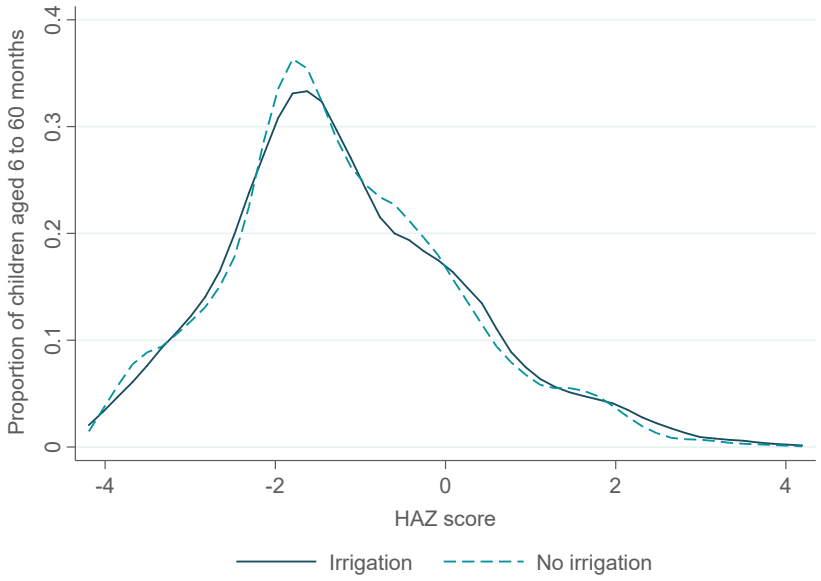
model is appropriate. For each regression, among the independent variables used were several reflecting the use of irrigation by the sample household. Our interest was whether the coefficients for these variables were statistically significantly different from zero. We also controlled for demographic and socioeconomic characteristics, agricultural and agroecological characteristics, and institutional factors. For the models looking at household dietary diversity, we also included fixed-effect variables for the month when the sample household was interviewed. This allowed us to investigate seasonal differences in dietary diversity between irrigating and non-irrigating farm households.[12]

FINDINGS

For our initial means comparison, we found virtually no difference in the distribution of HAZ scores between young children in irrigating households and those in non-irrigating households (Figure 15). These results were confirmed in the regressions. None of the models found a statistically significant association between irrigated farming-related variables and the HAZ scores of young children. These findings do not negate the expectation that irrigated farming, through its impact on the food consumption and incomes of farm households, is of considerable benefit to the nutrition of young children in those households. However, it does indicate that the pathways through which irrigated farming can lead to improved child growth are more complex and indirect.

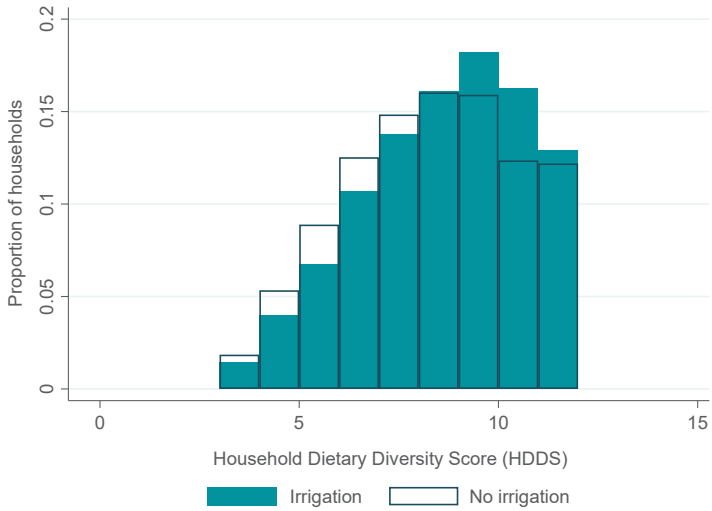
Conversely, on average, we found that irrigating households tend to have more diverse diets than households that do not irrigate (Figure 16), suggesting that irrigation enables households to produce a wider range of crops for home consumption than they can with purely rainfed production. This hypothesis was also supported in our regression results. In our models, a statistically significant result was obtained across all specifications for the variable on household production of irrigated vegetables. In the most tightly controlled model (which included variables for district and monthly seasonal effects), production of irrigated vegetables was found to increase dietary diversity by 2.7 percent. In contrast, the production of irrigated staple crops and the proportion of household land that was irrigated did not significantly affect household dietary diversity.

FIGURE 15 DISTRIBUTION OF CHILDREN'S HAZ SCORES, DISAGGREGATED BY WHETHER HOUSEHOLDS ENGAGE IN IRRIGATED AGRICULTURE



Source: Author's analysis of IHS3 data (NSO 2012a).

FIGURE 16 HISTOGRAM OF HOUSEHOLD DIETARY DIVERSITY SCORES FOR MALAWIAN FARM HOUSEHOLDS, DISAGGREGATED BY WHETHER HOUSEHOLDS ENGAGE IN IRRIGATED AGRICULTURE



Source: Author's analysis of IHS3 data (NSO 2012a).

The addition of monthly fixed-effect variables to the HDDS model provided useful insight into how irrigation can reduce the negative effects of seasonal food insecurity on the diversity of diets consumed by farm households. Many Malawians experience a hungry season every year in the months just prior to and during the rains (October through March) before green maize, groundnuts, and other early crops are mature enough for consumption or sale. During this season, food stocks run low, food prices increase, and food consumption decreases. The rainy season is also a period of intensive agricultural work with higher energy needs, coupled with greater exposure to infectious diseases due to wet conditions (Wijesinha-Bettoni et al. 2013). Because women are actively involved in agriculture—especially during the busy planting season—and children are especially susceptible to infections, the nutrition status of these vulnerable groups is negatively affected (Figure 17).

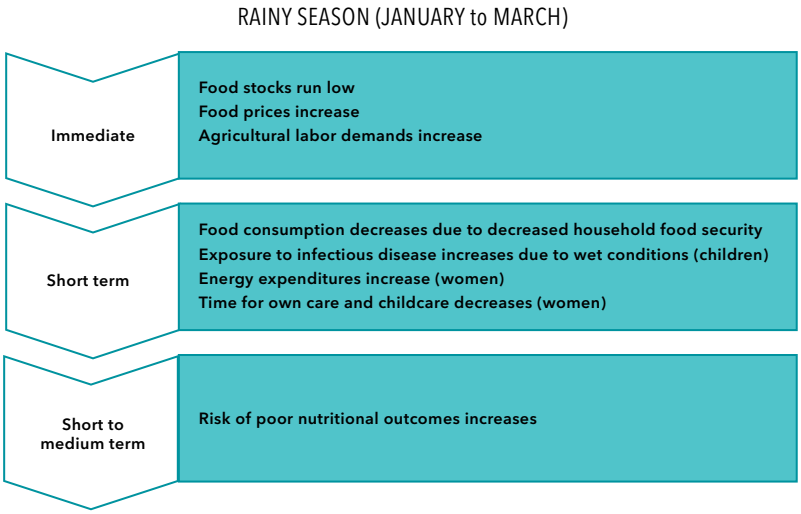
Our modeling of the association between irrigation and HDDS provides some insight into how irrigation reduces these seasonal effects. When the model was adjusted to include monthly fixed effects, a pattern of seasonal food insecurity was clearly reflected in the dietary diversity scores for the non-irrigating households subsample. Scores for this group were lowest in the "hungry season" months of February and March.

In contrast, no significant seasonality in the diversity of household diets was evident in the models developed from the irrigating households subsample. The insight we take from this result is that one of the principal contributions that irrigation can make to improved nutrition outcomes—particularly for subsistence farming households—is to ensure reliable, year-round access to a diverse diet that facilitates access to micronutrient-rich foods, such as vegetables.

DISCUSSION

There is some merit in using nutritional arguments to support increased public investment in irrigation in Malawi. The analyses reported on here provide no evidence that irrigation has adverse effects on nutrition. However, our models did not generate any evidence that irrigation can be a significant determinant of improved child nutritional status—we found no strong association between the use of irrigation by farm households in Malawi and the growth per-

FIGURE 17 EFFECTS OF THE RAINY AND HUNGRY SEASON, THROUGH A NUTRITION LENS



Source: FAO (2014).

formance of children in those households. Using improved child nutrition outcomes as a development objective to support the expansion of irrigation is a vague argument at best. A stronger argument may be made, however, for the contribution of irrigated farming to the diversity of foods consumed by farm households, particularly because irrigation was shown to be an important component in reducing seasonal food insecurity.

Women and children—the two populations most vulnerable to malnutrition—are highly susceptible to the effects of seasonality. Increased exposure to infections, decreased caloric intake, and increased energy expenditure can all increase risk of malnutrition during these periods. Indeed, seasonal availability of and access to different foods were identified as constraints to successful infant and young child feeding interventions by WHO and UNICEF (Daelmans et al. 2009). As such, the contributions that irrigated farming make to mitigating seasonal food insecurity are far from negligible from a nutrition perspective (von Braun, Johm, and Puetz 1994).

That said, as demonstrated by our analyses, the pathways through which irrigated farming can lead to improved nutrition outcomes are indirect and difficult to assess empirically. Though increased use of irrigation can contribute to household food security, it must be recognized that household food security does not ensure improved nutrition. A broader range of equally necessary determinants—sanitation, access to clean water and healthcare, and adequate care and feeding practices for all household members—must also be in place.

Chapter 7 CONCLUSIONS: THE KEY ROLE OF AGRICULTURE IN ACHIEVING BETTER DIETS IN MALAWI

Jody Harris and Noora-Lisa Aberman

THIS REPORT COMBINES INTERNATIONAL EVIDENCE WITH NEW PRIMARY AND SECONDARY analyses of Malawian data to understand the different pathways linking agriculture, food security, and nutrition for households in Malawi and to illuminate different dimensions of these links. In addition to outlining different theoretical and methodological approaches to studying these connections, this report provides evidence on the role of commodity production, food prices, agricultural diversification, and irrigation in changing household food security and access to different nutrients, as well as impacts on individual diets and nutrition. This chapter provides a summary of the empirical chapters, draws out some key themes, and suggests some implications for Malawi and other countries with a large agriculture sector that concurrently face issues of food insecurity, hunger, and malnutrition.

There are several key pathways through which agriculture and food systems affect food security, diets, and nutrition (Gillespie, Harris, and Kadiyala 2012), and these can often be leveraged alongside traditional agriculture-sector goals of productivity, income, and growth. Good nutrition is important—for national development, individual development, and healthy societies—and requires both adequate quantity of food (calories) and adequate quality of diets (nutrients to grow the body). The issue of dietary quality—meaning diets that include safe and hygienic foods from as many food groups as possible, providing a variety of nutrients in addition to calories—is often missing in food security work, but is the chief concept linking agriculture and food systems with nutrition outcomes. As such, of all the indicators along all the pathways reviewed here, diverse diets are a key outcome to measure the success of most agricultural programs and policies, if an impact on population well-being is desired (Herforth and Harris 2014).

Measurement of the effects of agriculture on diets and nutrition is often limited by the data disconnect, whereby household agricultural and economic data often do not exist in the same datasets as individual dietary and health data. But this can be remedied: wherever possible, the measurement of individual diets (disaggregated by population groups) should be included in household agricultural surveys.

Malawian diets traditionally focused on maize as a key staple food, and, as such, reflect many traditional diets around the world that rely on starchy staple foods to provide enough calories for daily activity (Latham 1997). Interviews with Malawian households, however, reveal a preference for diverse foods in addition to maize, once maize requirements are fulfilled. Nutrition per se may not be a priority for Malawian households, but diversifying their diets is, and this is an important precursor to improved nutrition that the agriculture sector can address. The barriers to accessing more diverse and aspirational foods were predominantly reported by households to be linked to a lack of availability of different foods and a lack of finance to access different foods, given that maize sufficiency is the primary goal and household budgets are limited.

In Malawi, poverty is decreasing overall, but inequality is increasing. Expenditure data show that households across most wealth groups are spending a larger share of the household budget on food than in the past, despite generally declining maize prices, largely due to the effects of the Farm Input Subsidy Program (FISP) on maize yields and production (Arndt, Pauw, and Thurlow 2016). While we might expect this to result in improved access to more diverse and nutrient-rich foods,[13] we find that this is not the case for poorer Malawian households. In particular, poor households are consuming fewer vegetables. Changes toward purchasing more diverse and nutrient-rich foods are found to be constrained by high prices of nutrient-rich foods compared with energy-rich staples; thus, while food security (measured as access to calories) may be improving, nutrition security (measured as access to nutrients) is getting worse.

One potential approach to accessing diverse diets for increased nutrients is for agricultural households to diversify production, thus leveraging the pathways to improved nutrition though own production (through consumption of more diverse production) or increased income (through sale of surplus and purchase of diverse foods). These results also show that the FISP is a driver of production diversification. As has been found in other countries (Masset et al. 2011), diversification of production in Malawi is associated with increased household access to diverse foods. Crucially, it is also associated with increased access to micronutrients for households that diversify production beyond just maize. Another potential approach to increasing access to more nutrient-rich foods is through increasing irrigation, which can promote the production of nutrient-rich, but water-intensive, fruit and vegetable crops. Irrigation, from simple manual irrigation to larger infrastructure projects, can increase productivity and crucially reduce seasonal gaps in production, again operating through the own-production or income pathways to improved diets. While associations are not found between irrigation use and child nutritional status, irrigation is associated with improved household access to diverse foods and a reduction in seasonal food insecurity.

Both diversification and irrigation are policy objectives for the Government of Malawi, and both have the potential to improve diets through the supply side, making diverse nutritious foods available for more of the year. Food prices for these nutritious foods will also fall if production increases, which, along with increased consumption of home-produced foods, would allow Malawians to achieve their aspirations for more diverse diets. Getting farther along the pathways toward nutrition impact requires convergence with other sectors to cover the food, health, and care determinants of improved nutrition (Ved and Menon 2012); the role of the agriculture sector is to focus on improving the availability of and access to diverse nutritious foods.

Agricultural policy in Malawi, as in many countries regionally and globally, calls for diversification of agricultural production as a key component of its approach to development. Most important for nutrition outcomes will be how diversification is implemented. Diversification among different staple grain and root crops can be an important food security strategy, for instance, but is unlikely to lead to dietary diversification across different food groups for a range of nutrients. Diversification into cash crops will only lead to improved diets if diverse foods are available and affordable in the market, so that increased incomes can be spent on them. Diversification into production of nutrient-rich fruits, vegetables, and animal-source foods is important to drive availability and access, but gaps still remain in our understanding of the nuances of these pathways. Furthermore, while there is evidence that promoting staple productivity, for example though the FISP, can promote crop diversification and can even allow income from excess maize to be used to purchase other nutritious foods, the poorest Malawians do not appear to be benefiting in this way and thus require additional support to improve their diets.

In this report, we have started to disentangle the nutritious and less nutritious crops that are kept and consumed, those that are bought and sold, and the production systems that drive this. However, further research is needed to understand by which pathways these crops best improve diets, whether through own consumption, increased incomes, im-

proved market availability, a focus on women as key to both production and nutrition, or a combination of these. Furthermore, the gendered and intra-household effects of production on diets require more research; we need a better understanding of the effects on diets of production of different crops, such as different nutritious foods and cash crops; and we need to understand the differences in outcomes between these foods being available on a subsistence basis and being available in markets. However, to start to answer these questions we need individual dietary data available in the same dataset with agricultural data, which, as is the case in many countries, are currently not available in nationally representative data sources in Malawi.

In addition, while our results indicate that irrigation can begin to address the seasonal availability of diverse foods, other important aspects of seasonal availability of nutritious foods must be explored. Initiatives to leverage nutritious value chains to improve nutrition are likely hindered by the extreme seasonality of perishable nutritious foods, such as fruits and vegetables. When foods are in season, markets are flooded, decreasing marketability and profits; out of season, these foods disappear from the market. An assessment of traditional and modern approaches to perishable food preservation and processing, and their feasibility to narrow seasonal availability in Malawi, would be extremely valuable.

Finally, broadening the range of nutritious foods emphasized for production, consumption, and marketing can potentially broaden the diversity of nutritious foods available in the market, minimize the market glut of the more common seasonal foods, and improve dietary diversity. As such, we need a better understanding of the contribution of native, wild, and foraged foods to diets, how markets are affected when those foods are available, and the extent to which there are high-potential foods in this category that can be promoted to improve diets. In addition, a shift away from a maize-centric definition of food security—by Malawian people and policy makers—is necessary to better conceptualize and facilitate agriculture's contribution to ending undernutrition.

This report summarizes what we know and what we still need to learn about the links between agriculture, food security, diets, and nutrition in Malawi. If households prefer diverse diets, as suggested in the work presented here, then demand for nutritious foods will increase as availability increases and prices fall. But for this to happen, the agriculture sector needs to maintain focus on agricultural diversification across food groups, with policy backed up by resources and implementation, and improved diets as a key (and measured) outcome.

NOTES

1 This figure is distinct from estimates of child stunting drawn from the 2010–2011 Third Integrated Household Survey (IHS3). These indicate a prevalence of stunting in children under five of 30 percent. However, the information on child stunting in the IHS3 is not wholly consistent internally or with results from similar datasets for Malawi, including the Demographic and Health Survey series (Verduzco-Gallo, Ecker, and Pauw 2014; also see Chapter 6 of this report).

The analyses in this report were undertaken primarily with official national datasets from 2010–2011: the IHS3 and the 2010 Malawi DHS. While this report was being finalized, the report for the 2015–2016 Malawi DHS was published (NSO and ICF Macro 2017). This more recent DHS report shows a strong decrease in stunting rates since the earlier 2010 Malawi DHS. According to this most recent survey, the prevalence of stunting in children under five years of age has fallen to 37 percent, down from 47 percent in 2010.

2 The conceptual underlying determinants of nutrition outcomes are food (security and quality), health (services and environment), and care (of young children, including feeding) (UNICEF 1990).

3 Recent comprehensive reviews on metrics for assessing agriculture-nutrition links include Jones et al. 2013; Leroy et al. 2015; and Pangaribowo, Gerber, and Torero 2013.

4 As opposed to aggregated food groups, as is done in computing the individual dietary diversity scores discussed later.

5 For example, on average, individuals who belong to households that report consuming relatively high quantities of vitamin A–rich fruits and vegetables likely ingest more beta-carotene than those who do not.

6 See https://en.wikipedia.org/wiki/Livestock_grazing_comparison.

7 Significant post-harvest losses of food crops in storage also can motivate a pattern of crop sales by farm households immediately after harvest with purchases of the same commodities by the households later in the year. The traditional preference for semi-flint kernel types of maize in the food systems of Malawian households reduced the significance of post-harvest storage losses, as such maize types are not as susceptible as other types to attack by weevils, grain borers, and other pests of stored grain. However, many of the hybrids developed more recently for Malawian conditions have softer (dent or semi-dent) kernels, do not store quite as well, and initially were seen as cash crops to sell soon after harvest rather than as food crops to put in storage for consumption later in the year (Smale 1995). Recently, the use of storage pesticides by maize producers has been shown to be positively associated with their adoption of improved maize varieties, whether for home consumption or for storage for later sale (Ricker-Gilbert and Jones 2015). Improved storage technologies for maize reduce the risks of post-harvest losses for farmers planting higher-yielding varieties of maize that are also more susceptible to storage pests.

However, it should be noted that maize, even modern varieties, stores quite well in Malawi; national estimates are that only between 1.4 and 2.9 percent of maize is lost post-harvest (Kaminski and Christiaensen 2014). Moreover, an estimated 80 percent of the post-harvest losses in maize for smallholder farmers in Malawi occur during crop harvest and transport operations or in processing, not in storage (Ambler, de Brauw, and Godlonton 2017).

8 Although agriculture can also affect nutrition via increased (for example, zoonoses) or decreased (for example, improved access to clean water) risk of infectious disease.

9 A related publication by Beck, Mussa, and Pauw (2017) presents a stepwise decomposition of the differences in poverty estimates obtained by the NSO and by Pauw, Beck, and Mussa (2016). As they explain, the alternative poverty results are not meant to challenge official numbers or set a gold standard for poverty measurement. Instead, their paper illustrates the importance of methodological assumptions in poverty measurement. Ultimately, judgment about whether any poverty estimates are reasonable

is partly subjective and depends on the degree to which one agrees with the analysts' methodological assumptions.

10 While calories are macronutrients, not micronutrients, the indicator for calorie shortfall is calculated the same way as for micronutrients.

11 The quality of the anthropometric data in the IHS3 data has been called into question as these data differ significantly from those in Malawi's 2010 Demographic and Health Survey (DHS), which was implemented at about the same time (see Chapter 2). A reviewer of this document highlighted that in the reviewer's own research significant regional differences were found in the anthropometric data in the IHS3, with, in particular, Northern Region showing a pattern in height-for-age Z-scores for children under five years of age that is skewed right, with few observations falling below the -2.0 Z-score level threshold that defines stunted children. This pattern is not seen in the anthropometric data from other regions in the IHS3 data or in the 2010 DHS anthropometric data for Northern Region.

Northern Region subsamples in our analytical data are relatively small. Farm households from Northern Region make up 16.4 percent of the farm household sample; 13.5 percent of the irrigated farming sample; 18.2 percent of children for whom we have anthropometric data; and 13.2 percent of children from irrigated farming households for whom we have anthropometric data. Given that Northern Region households do not make up an unduly large share of the sample for the analytical dataset that we take from the IHS3, our results should provide reasonably reliable inferences on the strength of associations between irrigated farming and nutritional outcomes at the national level.

Moreover, in this analysis measurement error of prevalence rates was of less concern than the difference in means between irrigating and non-irrigating households. As such, we report on IHS stunting data here, but with this important caveat about their internal consistency in terms of quality.

12 The detailed empirical analysis for this study is presented in Benson (2015).

13 Such as the concept of the Farm Input Subsidy Program (FISP) helping to "fill the maize basket," allowing farmers to expand production to other crops or sell excess maize to purchase other foods, as found in Snapp and Fisher (2014).

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