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Value chains to improve diets: Diagnostics to support intervention design in Malawi

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ABSTRACT

Governments and development partners looking to accelerate progress in addressing malnutrition have been examining how to use interventions in value-chains to improve diets. However, the links between interventions in value chains and diets involve a range of direct and indirect effects that are not yet well understood. We apply a mixed-method multisectoral diagnostic to examine potential interventions in food systems to improve diets of smallholder farmers in Malawi. We examine entry points for interventions involving public and private-sectors, and explore the methodological requirements for undertaking this type of multisectoral analysis. We find that although food consumption is dominated by maize, a range of nutritious foods are also being consumed; including leafy greens, fruits, chicken, dried fish, dried beans and peas, and groundnuts. Yet important deficits in nutrient intake remain prevalent in low-income households due to inadequate quantity of consumption. While increasing consumption through own-production is one potentially important channel to increase quantity of nutritious foods available (particularly fruits and leafy green vegetables), markets also play a potentially important role. Nutritious foods are available on markets year-round, although strong seasonality impacts the availability and price of perishable products. For beans, peas and groundnuts, supply appears to be available throughout the year, with price fluctuations relatively controlled due to storage capacity and imports. The capacity of markets to supply safe and nutritious food is limited by a number of issues, including poor hygiene; lack of infrastructure for storage and selling; limited information on nutrition, and weak coordination among sellers and producers. Other bottlenecks include: on-farm constraints for expanded production, consumers with limited purchasing capacity, intense competition among sellers and few services for sellers to increase volume of product sold during peak demand. The diagnostics identify the role of information-related interventions to optimize decisions related to food choices, involving a range of different foods and value-chains, that could potentially lead to short- and medium-term improvements in diets. Longer-term and more resource-intensive interventions are also identified, such as improving capacity for product differentiation, processing, storage, and market infrastructure across a different range of food chains, so as to maximise coherence between short- and long-term planning. The findings highlight the benefits of applying a strategic, food systems-based approach of identifying specific and complementary actions for both the public and private sectors that can improve the diets of low-income populations.

1. Background

Almost 20% of deaths worldwide are attributed to unhealthy diets, according to the Global Burden of Disease study (GBD 2017 Diet Collaborators et al., 2019). The promotion of food-based approaches is a key strategy for improving the quality of diets (Tontisirin et al., 2002).

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Improving diet quality can involve modifying food-consumption patterns, which in resource-poor settings are often monotonous and staple based, to be more diverse and nutrient rich (Arimond and Ruel, 2004). Because food systems include all food value-chain activities, resources, and infrastructure involved in food production, processing, transport, marketing, consumption, and disposal, they play an important role in shaping diets (CFS, 2014). Of particular relevance are food value chains in which smallholders play a key role as both consumers and suppliers of food. According to the Food and Agriculture Organization of the United Nations (FAO), smallholders produce four-fifths of the developing world's food (FAO, 2011). Smallholders also play a role in meeting the future demand for food from a growing, increasingly rich and urbanized population.

The food environment, defined as the "collective physical, economic, policy, and sociocultural surroundings, opportunities, and conditions that influence people's food and beverage choices and nutritional status" (Swinburn et al., 2013), is the interface among food systems, value chains, and consumers (Herforth and Ahmed, 2015). Five properties of the food environment are relevant in terms of their influence on diets: food availability, affordability, acceptability, nutrient content, and safety risk (Gelli et al., 2015). Food availability refers to physical availability, whereas affordability relates to price and consumer purchasing power, which are often determined along the value chains linking producers to consumers. Acceptability is related to the sociocultural norms associated with the consumption of food and the associated feeding practices and habits. Nutrient content and safety are two quality-related attributes of the food environment; the first is linked to nutrient and food component content (Drewnowski, 2005), while the second is linked to risks and exposure to pathogens or toxins.

Interventions and policies targeting elements of food value chains and the food environment are common (Herforth and Ahmed, 2015). The links among interventions in value chains, diets, nutrition, and health, however, involve a range of direct and indirect effects that are not yet well understood (Herforth and Ahmed, 2015; Pinstrup-Andersen, 2012; Popkin and Hawkes, 2016). Short-term gains may be offset by longer-term risks (e.g. pesticide use to increase yields on short term, resulting in health risk on long-term), and there is little research on how to manage the many trade-offs involved. The value chain for nutrition (VCN) framework identifies three interlinked pathways through which interventions in value chains could have an impact on diets (Gelli et al., 2015). These pathways are based on (1) leveraging demand; (2) supplying nutritious foods; and (3) enhancing nutrition-related value addition along a chain (De la Peña et al., 2018). These pathways are complex, span multiple domains, and are linked through interactions with the food environment. There is little rigorous evidence on how interventions in value chains affect other dimensions of the food system or how they might affect diets, nutrition, and health, also considering feedbacks and indirect effects across the system (Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013).

Development partners, including the World Food Programme (WFP), FAO, and the International Fund for Agricultural Development (IFAD), are examining the potential for interventions in markets and food value chains to increase the sustainability of their operations (CFS, 2016). The rationale for this approach hinges on seeking market linkages between demand-side interventions (e.g., food and cash transfers that are provided as part of WFP's food assistance, including activities such as general food assistance, supplementary feeding and school meals) and supply-side activities (e.g., providing technical skills and inputs to producer organizations to improve farming practices and increase output through supply-side partners) through the process of structured demand (Sumberg and Sabates-Wheeler, 2011).

In this paper, we apply an innovative multisectoral diagnostic to examine the entry points for potential interventions in food systems to improve the diets in a rural population in Malawi. The paper is structured as follows: We begin by describing the country context and the methods necessary to diagnose and contextualize dietary problems in target populations, prioritizing nutritious foods based on their relative and potential contribution to diets. We then assess constraints and intervention opportunities along these food chains, mapping the evidence from the diagnostics to a framework based on constraints in supply and demand for these specific foods. We conclude with a discussion of the implications in terms of intervention design and research gaps.

2. Methods

2.1. Country context

The FAO classifies Malawi as a low-income food deficit country with 37 percent of children aged 6–59 months moderately or severely stunted, 3 percent wasted; 12 percent are underweight and 5 percent overweight (c). The latest nationally representative survey also found that 63 percent of children aged 6–59 months and 33 percent of women age 15–49 were anaemic, and food consumption patterns in only 8 percent of children aged 6–23 months met the standards for a minimum acceptable diet (Malawi Demographic and Health Survey, 2018). Agriculture is the mainstay of the Malawin economy, with 94 percent of rural and 38 percent of urban populations engaged in agriculture (Jones et al., 2014), principally as smallholders with landholdings of less than 1 ha. Smallholder production is concentrated in maize, which accounted for 80 percent of smallholder-cultivated land in 2011 (IFAD, 2011). Due to repeated production failures over the past two agricultural seasons, approximately 2.8 million people in Malawi were food insecure in the 2016 lean season, which was between October 2015 and March 2016 (Government of Malawi (GoM), 2015; UNICEF, 2015). Food insecurity was most acute between January 2016 and harvest time in March of that same year.

2.2. Multisectoral diagnostic

This mixed-methods paper builds on the diagnostics described in Gelli et al. (2015) to understand the role of food systems and market-based interventions in improving diets. These diagnostics link a set of dietary problems of target populations to constraints in the supply and demand for specific foods; these problems can potentially be addressed through coordinated, multilevel interventions. Step 1 focuses on the target population, characterizing their dietary patterns, diet quality preferences, and likely gaps and constraints in nutrient and food intake. It also examines the relative contribution of different foods to total intake (by nutrient), identifies priority foods or missing foods (e.g. nutritious foods not currently consumed), and describes issues related to food-sourcing patterns and potential market demand for foods. Initial criteria for prioritization of foods include the nutritional quality of foods and their relative contribution to the diet, including both actual and potential under- and over-consumption perspectives relative to dietary recommendations (Gelli et al., 2015). The assessment of food intake provides the entry point for value chain analysis and identification of value chain constraints and opportunities related to nutrition and food security (step 2). Step 2 involves capturing the key features of the value chains of the nutritious foods prioritized during step 1, including major actors, scale, providers of inputs and services, market size, and sources of raw material. The selected chains are then examined for bottlenecks and potential risks in the production, processing, distribution, final sale, and other nutrition- or food safety–related value addition. In step 3, the analysis findings are mapped against a supply-and-demand framework to examine the implications of addressing specific food chain constraints for a basket of foods prioritized by the dietary assessment, as part of the development of a coherent strategy aimed at improving diets of low-income populations. This last step also provided the basis for the prioritization of interventions, based on potential costs, impacts and feasibility criteria.

This mixed-methods study draws on multiple rounds of data collection, including household surveys, market surveys and in-depth

household case studies.

2.3. Household survey data

Two rounds of household surveys were analyzed for this study, including a baseline survey from a cluster randomized control trial of a preschool-based intervention (Gelli et al. 2018) and a follow-up from an impact evaluation of lean-season food transfer (Gelli et al., 2017). The study protocol is published elsewhere (Gelli et al., 2017b). Briefly, the baseline survey was undertaken in the postharvest season (September 2015) while the follow-up survey occurred during the subsequent lean season (February 2016). Data were collected from within 60 communities randomly selected among food-insecure villages in the Zomba district in Southern Malawi. Based on power calculations for the trial, within each community, 20 households with children in the target 3- to 6-year-old age group were randomly selected for interviews, for a total of 1,200 households.

The survey included child-, caregiver-, household- and village-level data collection. A comprehensive survey at household level was undertaken using a structured questionnaire. The food consumption module of the questionnaire included data on which foods the household had consumed in the past seven days. Quantity and units were recorded for all food items consumed, including purchases, transfers and food consumed from own production. Value (or cost) in Malawin kwacha (K) was also recorded for food items purchased. The kilogram quantities of different food items that the household had consumed over the past seven days were converted into the nutrient content of energy, protein, iron, vitamin A, and zinc, using the FAO food composition table adapted for Malawi; daily nutrient values were calculated using adult equivalents (Fiedler et al., 2012). Household dietary diversity and food variety scores were calculated based on methods employed by Hatløy et al. (2000), Steyn et al. (2006), and Swindale and Bilinsky (2006).

Child dietary diversity (for preschoolers) and household dietary diversity were measured with the use of the DDS, calculated as a count of the number of food groups consumed by children in the 24-h assessment (Steyn et al., 2006; Swindale and Bilinsky, 2006) and in a household food-consumption 7-d recall (Fiedler et al., 2012). Twelve food groups were included (the scale of the scores was 0–12). It is important to highlight that no indicator for dietary diversity has yet been validated for preschool age group; current validated indicators for dietary diversity exist for children aged 6–24 mo (WHO, 2008) and for women (FAO, 1996). At the household level, we also used the household food variety score, calculated as a count of the number of individual food items that households reported consuming in the previous week (Swindale and Bilinsky, 2006). Trained enumerators used electronic tablets with computer-assisted personal interview software to collect the survey data.

2.4. Market surveys

Market surveys were undertaken in the five major markets in the study area: Zomba City, Thondwe, Songani, Jali, and Mayaka (Table 1). Each market was visited once or twice, during which in-depth interviews were carried out, for a total of 47 market seller interviews. Efforts were made to include in the interviews each food type available. Sellers were selected at random within their food type category. Where multiple selected products were sold by the same seller, data were collected for all the selected products being sold that day by the seller. Interviews lasted approximately 20 min and were undertaken using a semi-structured questionnaire. Topics included the year-round availability of foods, food sourcing, volumes sold, buyer types and sale prices, services provided and value-addition, cost of trading, and marketing challenges.

Nine key informant interviews were conducted with persons and organizations engaged in the trading, processing, and distribution of selected products or who had extensive knowledge of the overall conditions in which the production and trade of these products was carried out. These persons and organizations were located in southern Malawi, either in Blantyre (Malawi' second largest city and the next main market after Zomba) or in and around Zomba, and were identified through discussions with project partners at the University of Malawi.

2.5. Household case studies

In-depth interviews with household members were undertaken to generate qualitative case studies on food preferences, sourcing, and marketing in the survey population. Nine households from three villages were purposively sampled from the household survey population based on a maximum variation approach to ensure that households differed on a variety of characteristics. The household baseline survey data were used to identify households with varying levels of food insecurity (using the Household Food Insecurity Access Scale). Additional criteria included proximity to markets and female-headedness. A total of 38 in-depth interviews were undertaken with women (n = 19), men (N = 12), and adolescents (n = 7). The data were translated, transcribed, and thematically coded using NVivo 11. An a priori code list based on the interview modules was revised and expanded after an open coding exercise by the co-authors. Coded data were inputted into framework matrices for thematic and explanatory analysis. Final interpretations were discussed and revised by the co-authors.

3. Results

3.1. Characterizing diets and prioritizing foods

Table 2 summarizes the breakdown of average food quantities consumed per capita by food group across all households and for households in the lowest quintile (in both the postharvest and lean seasons). Average per capita food consumption amounts to a total of 1 kg of food per day; with households from the lowest-expenditure quintile only consuming on average 40 percent of that amount. We estimate that 36 percent of all households consume less than 1,800 calories per capita per day in the postharvest season, rising to 46 percent of households in the lean season (not reported). In households in the lowest-expenditure quintile, the estimated per capita daily consumption of pulses is 28 g and of animal-source foods, 18 g, compared

Table 1
Traders interviewed in markets in the Zomba district, Malawi.

Market	Sex		Number of traders per food type					
	Female	Male	Live chicken	Groundnuts	Pulses	Avocado	Dried fish	Leafy greens
Jali	4	5	3	2	2	1	0	1
Mayaka	5	2	0	1	2	1	1	2
Songani	3	4	1	0	2	1	2	1
Zomba City	4	3	0	0	1	2	2	2
Thondwe	10	7	2	1	4	4	2	4
Total	*26*	*21*	*6*	*4*	*11*	*9*	*7*	*10*

Table 2
Estimated average equivalent daily food consumption per adult (in grams and % of daily total) by food group: For all households and for households in the lowest-expenditure quintile in postharvest and lean seasons, Zomba district, Malawi.

Food group	All households		Lowest quintile	
	Postharvest	Lean season	Postharvest	lean season
Cereals (g)	652 (66%)	581 (57%)	255 (68%)	238 (60%)
Roots and tubers (g)	39 (4%)	23 (2%)	5 (1%)	4 (1%)
Legumes, nuts, and seeds (g)	75 (8%)	67 (7%)	19 (5%)	18 (5%)
Vegetables (g)	137 (14%)	159 (16%)	57 (15%)	79 (20%)
Fruits (g)	40 (4%)	66 (6%)	19 (5%)	23 (6%)
Meats (g)	7 (1%)	4 (0%)	1 (0%)	0 (0%)
Fish and seafood (g)	14 (1%)	11 (1%)	5 (1%)	2 (0%)
Eggs (g)	8 (1%)	3 (0%)	1 (0%)	0 (0%)
Milk and dairy (g)	2 (0%)	2 (0%)	0 (0%)	0 (0%)
Oils and fats (g)	12 (1%)	7 (1%)	3 (1%)	2 (1%)
Sugar, honey, and sweets	23 (2%)	55 (5%)	4 (1%)	23 (6%)
Condiments (g)	16 (2%)	11 (1%)	7 (2%)	7 (2%)
Total (g)	*1,025*	*988*	*375*	*396*
Households (n)	*1,199*	*1,103*		

to an average household consuming 60 g and 76 g of these foods, respectively. Animal-source foods, including meat (3 g per day), eggs (1 g per day), and fish (5 g per day), are largely missing from the food-consumption patterns of the poorest households.

While qualitative case study respondents reported a preference for animal-source foods—particularly chicken, eggs, and small fish—they said that their cost limited consumption. For their own livestock, they balanced the need for food against the need maintain productive assets in deciding when to slaughter. In addition, social norms that require sharing of slaughtered animals in the community at times dissuaded consumption of larger livestock such as goats, which were generally reserved for celebrations. Purchase of animal foods was reportedly rare for the case study households: only four households mentioned purchasing small quantities of animal protein, such as small fish, when they could afford it.

Fig. 1 presents the ratio of the estimated nutrient availability for iron, zinc, and vitamin A of household food consumption by AE divided by the estimated average requirement (EAR), across two seasons, suggesting that important deficits in nutrient intake are likely in low-income households, with these deficits appearing to be fairly constant throughout the post-harvest and lean seasons.

A further breakdown of nutrient consumption by foods consumed further highlights the role of maize as the main vehicle for nutrient delivery (Fig. 2). Although food consumption is dominated by maize, a range of nutritious foods are also being consumed; including leafy greens, fruits, chicken, dried fish, dried beans and peas, orange-fleshed sweet potato and groundnuts. However, maize consumption accounts for approximately three-quarters of the energy, iron, and zinc availability and two-thirds of protein availability across both seasons. This is not because maize is particularly nutritious; rather, these figures are driven by the large share of maize consumed relative to other foods in the diet. The only exception is for vitamin A, where nutrient availability is driven by the intake of leafy greens, other vitamin A–rich vegetables, and mangoes.

The qualitative case studies provide insights into the drivers of these diet patterns. While most households would prefer to regularly consume foods from different food groups—including pulses, vegetables, and animal source protein—household budgetary limitations, market dynamics (prices and availability), and seasonality of production and income severely limit their consumption. Furthermore, maize, particularly in the form of maize flour for use in *nsima* (thickened patties of maize porridge), dominates collective perceptions of household food security. Thus, maize is seen as a requirement, whereas other preferred food items may be viewed as luxuries: "*I see that this is because it is in our culture. . . . Food is maize, but others require money*" (male respondent, Village 6). Other nutrient-dense foods such as mango and avocado, are less preferred and are used as coping foods. In times of extreme shortage, unripe mango may be substituted for maize and avocado is given to children as a snack in order to "soothe" their hunger when other more preferred snacks are not available: *"It helps when you have sugar (so) you can make tea, and kids have that with the avocado. . . . If they were crying of hunger, they stop crying"* (female respondent, Village 5).

3.2. Food sourcing

Fig. 2 also summaries the results on the share of food consumed from own production by food item from the household-level survey data analysis. The differences across the seasons in this indicator show that the role of markets varies both by food item type and by season. While the production-to-consumption pathway is important for a range of foods that make up the household diet in rural Malawi (particularly for nutritious foods such as fruits and leafy green vegetables), markets also play an important role, particularly for maize during the lean season.

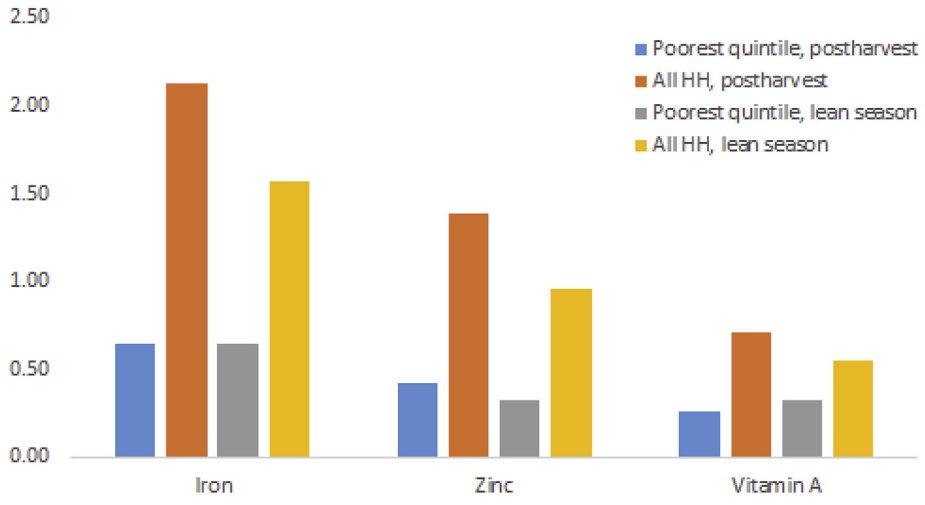

Fig. 1. Ratio of the estimated nutrient availability for iron, zinc, and vitamin A of household food consumption by (AE) divided by the estimated average requirement (EAR), across two seasons: For all households (n = 1,199) and for households in the lowest-expenditure quintile, Zomba district, Malawi..

	Post harvest						Lean season						
Food	Calories	Protein	Iron	Vitamin A	Zinc	Share consumed from production	Calories	Protein	Iron	Vitamin A	Zinc	Share consumed from production	Δ (LS-PH)
Maize	0.73	0.68	0.75	0.02	0.75	0.59	0.80	0.77	0.78	0.06	0.82	0.15	-0.45
Rice	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.07	0.06
Other Cereals	0.03	0.03	0.03	0.01	0.03	0.32	0.01	0.01	0.00	0.00	0.01	0.09	-0.23
Cassava	0.01	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.10	-0.10
Potato	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	-0.07
Sweet Potato (inc. OFSP)	0.00	0.00	0.00	0.02	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.12	-0.06
Beans and Soya	0.02	0.03	0.03	0.00	0.03	0.39	0.03	0.06	0.06	0.00	0.05	0.42	0.03
Peas	0.02	0.04	0.03	0.01	0.03	0.68	0.01	0.02	0.02	0.00	0.02	0.41	-0.27
Groundnut	0.02	0.04	0.02	0.00	0.03	0.18	0.01	0.01	0.01	0.00	0.01	0.19	0.01
Tomato	0.02	0.03	0.03	0.20	0.02	0.08	0.00	0.00	0.01	0.05	0.00	0.15	0.08
Pumpkin	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.01	0.06	0.01	0.74	-0.11
Leafy Green Vegetables	0.01	0.01	0.02	0.14	0.01	0.60	0.02	0.04	0.05	0.60	0.02	0.93	0.33
Other Vegetables	0.02	0.04	0.05	0.44	0.03	0.17	0.01	0.02	0.04	0.16	0.03	0.45	0.28
Banana	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.01	0.00	0.61	0.21
Mango	0.02	0.01	0.01	0.13	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.71	-0.10
Other Fruits	0.00	0.00	0.00	0.01	0.00	0.54	0.03	0.02	0.02	0.04	0.02	0.62	0.09
Eggs	0.00	0.00	0.00	0.01	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.54	0.18
Fish	0.01	0.05	0.01	0.00	0.02	0.03	0.00	0.02	0.00	0.00	0.00	0.03	0.00
Meat	0.00	0.01	0.00	0.01	0.01	0.39	0.00	0.00	0.00	0.00	0.00	0.51	0.12
Dairy	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.17	0.12
Fats and Oil	0.04	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.23	0.22
Sugar and Sweets	0.02	0.00	0.01	0.00	0.00	0.13	0.03	0.01	0.01	0.00	0.00	0.27	0.14
Condiments	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.04	0.04

Fig. 2. Share of total nutrients consumed by food for all households (n = 1,199) for energy, protein, iron, zinc, and vitamin A and share of consumption from own production, across two seasons, Zomba district, Malawi. Notes: OFSP = Orange Fleshed Sweet Potato; PH = postharvest; LS = lean season.

The qualitative case studies confirmed that households assess a range of criteria when deciding whether to consume or sell their own produce; including considerations on food security, financial needs, pricing and demand, and the need for insurance against shocks. Respondents also reported market behaviors based on food preferences that may ultimately be detrimental to household diets: For example, selling homegrown fresh nutritious foods such as vegetables and legumes to acquire maize meal. Households commonly purchase maize or, in extreme cases, maize chaff in the lean season once stocks run out. As a means of coping with scarcity while maintaining preferences, households purchase smaller quantities of maize flour from local markets, which is consistent with the results described in Fig. 2; this finding reflects the importance of markets for poor households. This buy-as-you-go approach encourages more frequent purchases but at much increased prices.

Wetland (*dambo*) garden dry season cultivation is also reported as an important source of food—and income, when sold—for households; such cultivars include legumes (pigeon peas, cowpeas, beans), green vegetables (rape, pumpkin leaves, mustard greens, cabbage, lettuce), tubers (sweet potato, cassava), and other vegetables (onions, okra, turnips, tomato). *Dambo* gardens play a pivotal coping role in household food security—particularly during times of drought—and are essential once upland crops are harvested, sold, or consumed (Wood and Thawe, 2013).

3.3. Market analysis

Limited infrastructure for food marketing prevails across all sampled markets. With few exceptions, markets lack toilets and reliable access to water or sheds to protect against sun and rain. Other studies have identified poor handling practices (e.g., washing vegetables with dirty water) and direct exposure to sun (temperature abuse) during retail in Malawi as factors that contribute to contamination and microbial proliferation, as well as to the leakage of vitamin content and other nutrients (Mngoli et al., 2014 ; Amoah et al., 2006). Even where improved marketing infrastructure is available, actors reported often not using it. Organizers of the Songani market, for example, described how sellers refuse to use existing cement-floored sheds to sell fish, fruits, and vegetables, preferring to sell on the ground along roads and footpaths, where they are physically closer to potential buyers, suggesting that future infrastructure development should be combined with efforts to change the behaviors of market actors. While the local government charges market sellers a fee of US$0.15 (K100) per market day, the respondents reported that the fees collected are absorbed to finance activities outside the market, rather than being reinvested in infrastructure development.

Sellers also described how the sale of crops from own production is common among farming households. For many of the foods examined, the majority of product available in markets is sourced from nearby smallholders. In some cases, producers sell their own products (e.g., avocados and leafy greens) directly to consumers, to local businesses, and to larger scale intermediaries. In other cases, intermediary vendors were reported to purchase products (e.g., live chickens) at the farm gate and sell in the market directly to various types of buyers.

Barriers to sale for smallholders relate to the lack of profitability of transactions. Respondents reported weak negotiating power, particularly over price setting. Households are usually price takers, while vendors or buyers set or negotiate the prices: "*As poor people in the villages, we have no power to set prices for our products; whatever the price they set, we go by it*" (female respondent, Village 1). Farmers cannot afford the wait to sell due to pressures from perishability of produce, seasonal availability, and the need for purchasing food for their own household. Other barriers include cost or time requirements of transport to market, production side constraints (e.g., small harvests, land scarcity, and pests), and seasonal price variations.

A pervasive complaint reported is of vendors pressuring households to sell, offering unfair prices, or tampering with weighing scales: *"[Vendors] dupe us; they dupe us because, … for instance, if you went there with leafy vegetables, they will tell you that they buy vegetables at four [pieces] for K5. But if you go in the afternoon, you will buy four [pieces] for K20, while the same person bought from us at four [pieces] for K5"* (male respondent, Village 5). Price negotiation is more likely with those buying at the village level between other farming households. This negotiation is rarely reported as occurring with vendors, representing a power differential in bargaining. However, most households in the in-depth interviews still reported using vendors to minimize transaction costs. Wholesale is deemed preferable to households because all produce can be sold at once. Households regard retail as more profitable but more risky, as it requires selling in smaller amounts and at a greater time cost and does not guarantee that all crops will be sold.

Table 3
Most important marketing challenge as reported by sellers (n = 39) in Zomba district, Malawi.

Challenge	Number of sellers reporting as biggest challenge
Low demand/excess supply	20
Lack of regular customers	11
Lack of capital/limited stock	7
Irregular demand (majority of sales at end of the month)	3
Low-quality product (e.g., discolored leaves due to lack of fertilizer, small fish size)	3
Lack of transportation	2
Total	39

For pulses and other nonperishables (e.g., maize and groundnut), large-scale traders in Malawi have the capacity to source considerable volumes from smallholders and to engage with nongovernmental organizations (NGOs) and governments for the provision of food assistance. Interviews with traders did not uncover actions to identify and reduce aflatoxin levels in these crops. With the exception of pigeon pea, formal exports of many of these crops are limited due to government-imposed export restrictions in the case of maize and international restrictions in the case of groundnut, both due to aflatoxin levels (Pauw and Edelman, 2015; Edelman and Aberman, 2015). Larger-scale traders engage directly with independent intermediaries, rather than with smallholders, which keeps costs low but also reduces options for addressing safety and traceability.

Processors and traders have attempted to organize smallholders for the sourcing of quality and safe groundnuts. While the final products were mainly for sale outside the local area, the experiences highlight the potential for smallholders and downstream processors and traders to respond to the demand for safe food. The Blantyre-based Project Peanut Butter, a small business which evolved from a donor support initiative, provide quality groundnut-based products (Project Peanut Butter, 2019). The relatively high costs of these groundnut products, due to high overhead and imported dried milk and other food ingredients may present problems for other buyers. Unlike commodity traders and conventional groundnut processors, Project Peanut Butter has in-house capacity to test for aflatoxin. Regardless, over the last two decades the National Smallholder Farmers' Association of Malawi (NASFAM) organised thousands of smallholders into a cooperative for the sale of high-quality products in national and international markets. Advances were achieved in terms of reducing aflatoxin levels and building links with foreign buyers. The NASFAM case benefited from extensive external support which may be difficult to replicate (Chirwa et al., 2005). Because NASFAM focuses on higher-value markets the potential for it to have an impact on local consumption is likely to be limited. Furthermore, NASFAM has not been able to export groundnuts to international markets in recent years. Food assistance providers have attempted to source groundnuts on a small scale through producer groups; however, those groups have struggled to respond to the relatively demanding terms (e.g., formal registration, access to bank accounts, ability to emit formal invoices, capacity to deliver relatively high volumes over time) of the buyers.

3.4. Market sellers' needs and capacities

Volumes brought to the local markets by respondents were low due to transport limitations—usually about as much as could be carried on a bike or in one's arms. Average volumes brought to market per day during the interviews included 115 avocados, 18 live chickens, and leafy greens that filled half the volume of a 50 kg sack. Higher quantities were reported for pulses, reflecting that some relatively larger volume sellers had options to store bags of beans and peas in houses located near the market. Market sellers reported few and relatively small marketing costs—mainly market fees (US$0.10–0.17 per day) and transport costs (a low of US$0.32 for leafy greens to a high of US$3.50 for pulses). Transport involved hiring of bicycles to carry products to market. Larger scale sellers engaged in beans and peas were the only traders who reported the use of hired trucks. There was no indication that traders engaged in coordination among themselves or with producers or market officials to reduce the costs and risks for selling.

Relations between sellers and their suppliers generally did not entail more than the exchange of product and information regarding market conditions. In a few cases, sellers reported engagement with suppliers on production or packaging. This likely reflected that competition in markets was based on price over all other considerations. Groundnut sellers reported selling inputs to growers. In addition, sellers reported limited value-added to the products they sold. In the case of beans and peas, fish, and groundnuts, drying was reported—likely because the seller purchased from nearby farmers following the harvest and then dried the products. Cleaning of product was common among sellers of perishable products. Few sellers engaged in product labeling or bagging. A small fraction of the sellers received credit for their operations, and this was usually a one-off credit for 3–6 months, with high interest rates for the purchase of products from farmers and traders.

Table 3 presents the biggest challenges for marketing the selected products, as reported by interviewed sellers. The majority of the respondents reported lack of demand for their products, as well as competition among sellers to sell their products. In the case of the Zomba market, there was mention of irregular demand, as many consumers were paid at the end of the month, meaning that sales during most other times were limited. Several sellers reported lack of capital for purchasing inputs, while lack of capital for purchase of agricultural inputs was reported by three producers/sellers of leafy greens. Despite the scarcity of transportation for all the sellers, only two sellers reported lack of access to transportation services as their biggest challenge.

3.5. Supply and demand conditions

The supply and demand of the selected foods is influenced by variations in income during the year, as well as by marked seasonality in some cases, with strong price fluctuations as summarized in Table 4.

3.6. Identifying intervention options

The final step of the diagnostic broadens the focus from a single food chain perspective to the range of priority foods relevant to diets, identifying intervention options based on prevailing supply and demand conditions (Table 5).

Although groundnuts are consumed throughout the year, high levels of aflatoxin contamination are a major health risk for consumers. Consumers are generally willing and able to purchase groundnuts, and there is high availability in markets during most parts of the year. The main consumer-related issues involve sorting and grading, which are likely to result in low-income consumers being exposed to foods with higher levels of aflatoxin. The main constraints along this food chain involve gaps in the regulatory environment and quality assurance around aflatoxin, as well as limited capacity coupled with weak incentives for smallholders to invest in improved production. Interventions likely to address these constraints include developing and testing third-party quality assurance and strengthening the capacity of processors to minimize food safety concerns.

Beans and legumes are consumed in low volumes, and increased consumption would improve diet quality. Consumers are willing to prioritize the purchase of such foods when funds are available, but there is limited supply and availability during certain parts of the year. Although consumers are willing to purchase and prioritize beans and legumes over other foods (except maize), they face limited purchasing capacity during peak demand periods. Production bottlenecks limit availability during certain periods of the year, and there are limited

Table 4
Overview of supply and demand conditions for selected foods in markets in Zomba district, Malawi, 2015.

Food	Description
Leafy green vegetables	Demand is low during the early months of the year, as households tend to grow leafy greens in their gardens. Demand picks up midyear, as income improves following the maize harvest and stocks from own gardens dwindle. Sellers who are also growers (without irrigation) have a small window in which to sell the greens (January–April). Demand is greatest toward the end of the year. Prices increase 25%–50% during periods of peak demand. Leafy green vegetable production is supplied mainly by farmers who sell their own produce in nearby markets.
Fish	Dried fish is available year-round; however, fish harvests generally decline during the hottest months of the year. Sellers purchase stocks of dried fish from fishermen and from fish traders. In some cases, sellers travel to Lake Chilwa by bicycle to purchase fish. Demand is lowest during the months prior to the maize harvest (February–March). Following the maize harvest in April, demand picks up, with June and July being the peak selling period. Prices vary markedly during the year, according to fish type, fish size, and fish availability, with prices fluctuating from 25% to over 200% during the year.
Beans and peas	Dried beans and peas are available throughout the year, with demand peaking in the months following the maize harvest and at the end of the year (for festivities). Supplies of these products are derived mainly from traders and farmers in neighboring communities. In some cases, larger-volume sellers hire trucks and purchase beans at the border between Malawi and Mozambique. Prices for red beans (the most common bean at the market during the time of data collection) vary by 25%–50% during the year.
Avocado	Avocado sales are marked by strong seasonality. For most of the year, there is little avocado on the market. Avocados begin to appear on the market just before the major maize harvest, when rural households have limited resources to purchase. Sales peak in April and May and then collapse. Small amounts of avocado that may appear after May are sold by traders who have access to fruits from other regions. Prices vary from 100%–300% during the short production season. Lack of access to motorized transport and storage options help explain the highly localized and seasonal trade in avocado.
Chicken (local variety)	Live chicken is available throughout the year by local traders. However, demand is limited during most of the year. Rural households tend to purchase more chicken following the maize harvest, from April to July. Demand peaks in December, as rural households purchase chicken for end-of-year festivities. The price of chicken is roughly 75%–100% greater during peak season, as compared to off-season. The majority of sellers purchase their supplies of chicken directly from farmers in nearby communities.
Groundnut	Groundnut is available during most of year. In many cases, groundnuts sold in the markets are sourced directly from farmers in nearby communities and are then stored by market sellers for subsequent sale in local markets. Demand peaks during the final quarter of the year, as rural households have consumed most of their own production by then and seek to purchase seed for the next year's production. Price varies considerably between peak and off-season (roughly 300%).

incentives for traders to engage in supplying local markets. For these constraints, intervention options include innovation in production technologies to expand availability and improved coordination and other measures (e.g., storage) with traders to reduce costs.

Animal-source foods (especially dried fish and chicken) and leafy greens are available in markets, but consumption is low; increased consumption would improve diet quality. These animal source foods (fish in particular) are preferred by consumers. However, consumers show low willingness to pay due to insufficient budgets. In addition, nutritious wild foods (including some leafy green vegetables) are seen as coping foods and are not preferred. The main constraints involve producers and sellers with limited opportunities to expand or add value to production due to limited effective demand. In this context, subsidies or social transfers (e.g. cash, food or vouchers) are required to facilitate consumption in critical periods (e.g., lean season); in addition, chain actors should be supported to reduce costs of production and trading and information campaigns could be created to increase acceptability.

Nutritious fruits (e.g., mangoes and avocados) are not consumed in significant amounts throughout the year due to limitations on both the supply and demand side; increased consumption would improve diet quality. These fruits are not typically purchased due to budget constraints and highly seasonal availability. The low willingness to pay for fruits is also due to household preferences toward consumption of staples, as well as the fact that fruits are relatively expensive during off-peak seasons, adding further deterrence to year-round consumption. The main market constraints involve lack of storage and transport facilities for highly perishable products. In addition, limited demand increases risk for production developments and other investments. Only a few processors and distributors are engaged in the sector. Interventions include creating information campaigns to increase acceptability; supporting chain actors to process or store to extend shelf life; investing in local marketing infrastructure; and offering subsidies or social transfers to facilitate consumption when in season (e.g., through school meals).

4. Discussion

This mixed-method study involved a multisectoral diagnostic to identify potential interventions in value chains to improve the diets in Malawi. Several important considerations are apparent from the analysis: Firstly, the findings highlight the benefits of applying a strategic value-chain approach in identifying specific and complementary actions for both the public and private sectors that can improve the diets of low-income populations. The diagnostics identify the role of information-related interventions (e.g. social marketing or public information campaigns) to optimize decisions related to food choices, involving a range of different foods and value-chains, that could potentially lead to short- and medium-term improvements in diets. Longer-term and more resource-intensive interventions are also identified, such as improving capacity for product differentiation, processing, storage, and market infrastructure across a different range of food chains, so as to maximise coherence between short- and long-term planning. Longer term infrastructure investments are particularly relevant in contexts more isolated from markets and roads, as households in these areas purchase fewer foods and have less diverse diets and higher food insecurity (Sibhatu et al., 2015; Stifel and Minten, 2017).

This portfolio approach allows for coherently “connecting the dots” between policies, programs and markets, whilst also identifying gaps and missing links that if addressed could potentially lead to more efficient and effective investments aimed at improving diets. In this particular case in rural Malawi, the findings also highlight that addressing seasonal, short-term effects is critical to improving diets, particularly for low-income households. In this context, food stores and spending power are highly constrained in the lean season, when food insecurity peaks; improving diets during this period would thus largely focus on alleviating financial constraints through subsidies and social protection interventions (e.g., food, cash or vouchers) for substantive, short-term improvements. In the harvest season, when farming households’ financial constraints are less binding, the public-sector emphasis can focus on nutrition-related behavior change communication (BCC) to bridge any knowledge gaps to optimize food choices and nutrition, and rely on markets to respond to the demand for nutritious foods from consumers. In turn, during the planting season, production support activities around a basket of nutritious foods could be used to strengthen the supply side, completing an intervention cycle that could be repeated yearly to shift the food system towards delivering healthier foods.

4.1. A strategic view aimed at improving diets of low-income populations

The benefits of a developing a strategic approach aimed at

Table 5
Interventions to improve consumption of nutritious foods in low-income households in Zomba district, Malawi.

Dietary change	Demand and supply characteristics	Consumer-related issues	Main constraints	Implications for intervention design
Groundnuts are consumed throughout year, but high levels of aflatoxin contamination are a major health risk.	Consumers are willing and able to purchase, and there is high availability in markets during all or part of the year.	Sorting and grading issues are likely to result in low-income consumers being exposed to higher levels of aflatoxin.	There are gaps in the regulatory environment and quality assurance, as well as limited capacity and weak incentives to invest in improved production.	Develop and test third-party quality assurance; strengthen capacity of processors to minimize food safety concerns.
Beans and legumes are consumed in low volumes; increased consumption would improve diet quality.	Consumers are willing to prioritize purchase when funds are available, but there is limited availability during some parts of the year.	Willingness to purchase and prioritize over other food (except maize), consumers with limited purchasing capacity during peak demand periods	Production bottlenecks limit availability during certain periods of the year; there are limited incentives for traders to engage in supplying local markets.	Innovate production technologies to expand availability; improve coordination and other measures (e.g., storage) with traders to reduce costs.
Animal-source foods (especially dried fish) and leafy greens are available, but consumption is low; increased consumption would improve diet quality.	There is low consumption, despite a generally high degree of availability in local markets.	Although preferred, there is low willingness to pay due to insufficient budget; nutritious wild foods are seen as coping foods and are not preferred.	Producers and sellers have limited opportunities to expand or add value to production due to limited effective demand.	Offer subsidies/social transfers to facilitate consumption in critical periods (e.g., lean season); support chain actors to reduce costs of production and trading; create information campaigns to increase acceptability.
Nutritious fruits (e.g., mangoes and avocados) are not consumed in significant amounts throughout the year due to limitations on both the supply and demand side; increased consumption would improve diet quality.	Low consumption due to budget constraints or because they are not preferred; there is also high seasonal availability.	Low willingness to pay for fruits, with a preference for the consumption of staples; fruits are relatively expensive during off-peak seasons, adding further deterrence to year-round consumption.	There is a lack of storage and transport facilities for highly perishable products; limited demand increases risk for production developments and other investments; few processors and distributors engaged in sector.	Create information campaigns to increase acceptability; support chain actors to process or store to extend shelf life; invest in local marketing infrastructure; offer subsidies/social transfers to facilitate consumption when in season (e.g., school meals).

improving the diet quality of low-income populations in Malawi can be illustrated further by drawing on rigorous evidence from two concurrent impact evaluations using the same longitudinal data set included in this analysis. The first involves a quasi-experimental study aimed at assessing the impact of lean season food transfers on household food security, diets, and the nutrition status of young children (Gelli et al., 2017a,b). Food transfers are, in the framework used in this analysis, an example of a public sector intervention that can be used to alleviate demand side constraints across range of value chains. The evaluation estimated that the effect of food transfers on food expenditure was K36 per day per capita, corresponding to an increase of 19 percent from baseline. Highly significant effects were found on children's dietary diversity score, corresponding to an increase of 15 percent. The evaluation also found evidence that the increases in dietary diversity involved foods that were not included in the transfer (including vegetables and dairy, for example), suggesting that households were able to use their increased resources to prioritize consumption of nutritious foods also supplied by markets. These findings suggest that during the lean season in food-insecure settings, where important declines in food security, diet quality, and nutrition status are present, alleviating resource constraints through food transfers can have a protective effect on diets of low-income populations, and potentially alleviate demand-side constraints on the market for nutritious foods. In parallel, a cluster randomized control trial evaluated the impact of an integrated agriculture and nutrition intervention aimed at improving household production diversity; maternal nutrition knowledge and practices; and children's diets, anthropometry, and development (Gelli et al. 2018). The nutrition component of the intervention included behavior change activities to involve caregivers in the preparation and planning of meals, and to promote optimal household feeding and caring practices through community groups, aiming at increasing the demand for nutritious foods. The agriculture activities focused on improving nutritious food production and on promoting food diversification by using community gardens as demonstration plots. Agricultural support activities also included provision of inputs (i.e. ten chicks per household and seeds) and trainings on nutritious food production (animal source foods, vitamin A rich staples such as orange maize and orange–fleshed sweet potato, legumes, fruits and green leafy vegetables) aimed at enhancing the supply of nutritious foods. The trial found that after 12 m, the intervention improved nutritious food production, production diversity, maternal knowledge, nutrition practices at the household level, the diets of pre-schoolers and linear growth in their younger siblings (Gelli et al. 2018). Interestingly, there was evidence that BCC from the intervention also had a positive effect on dietary diversity for children after 6 m, during the lean season, driven by consumption of nutritious foods. However, the BCC had a smaller effect on dietary diversity than the food transfers during the same period (BCC impact coefficient 0.32, compared to food transfer impact coefficient 0.80), suggestive of the presence of both resource and knowledge constraints during this lean season period. However, unlike the effects from food transfers, the effects of the integrated intervention on diets were sustained at 12 months during the post-harvest period, when household financial resources were less constrained than during the lean season.

This evidence highlights the potential opportunity to modify existing social protection interventions in Malawi to optimize the impact on diets by enhancing public- and private-sector linkages. For example, during the planting season, the current Fertilizer Input Subsidy Program, which provides fertilizer inputs for smallholders mainly focusing on maize, could be systematically broadened to provide inputs for nutritious crops including beans, sweet potatoes, and leafy green vegetables. During the lean season, the food transfers could systematically integrate intensive BCC to optimize household food choices, maximizing their potential effectiveness, as identified in a rigorous impact evaluation for Bangladesh (Ahmed et al., 2016). Also during the lean season, public procurement programs like the existing school

meals program, could be modified to purchase leafy green vegetables on markets, providing demand from public procurment on village markets where these foods are highly available and where sellers face a lack of buyers. In the postharvest period, public procurement could continue, accompanied by BCC to improve food choices, providing a steady demand for food system transformation.

4.2. Limitations

This study has several strengths, including the mixed-method design combining two rounds of large-scale surveys with in-depth interviews and focus group discussions. There were also some important limitations. Firstly, the findings are limited to the study population in Zomba district, southern Malawi and, as such, have potentially limited external validity. However, food security conditions in the study population are comparable with those across much of rural Southern Africa, spanning different agroecological zones and making these results relevant to contexts across the region (Gelli et al., 2018). Secondly, the data presented on micronutrient availability is based on household-level food consumption adjusted by adult equivalents (AE). As such, it's not a validated measure of micronutrient intake and these results must be interpreted with caution. However, a recent study directly compared probability-based estimates of intakes and the prevalence of inadequacies as estimated by the 24-hr recall and those calculated using the AE approach for energy and vitamin A, iron, zinc, and calcium (Sununtnasuk and John, 2017). The study found in 97% of cases, individuals had the same estimated prevalence of adequate or inadequate nutrient intakes using 24HR and AE-based estimates, highlighting the potential for AE estimates to serve as meaningful proxies for nutrient intakes.

5. Conclusions

In conclusion, the diagnostics provided in this analysis highlight the potential benefits of designing a strategy to address the challenge of low-quality diets through value chain interventions. Such multifaceted descriptive work is critical for determining the priorities, synergies and trade-offs of different possible interventions. However, because food systems and preferences may be highly localized, there may be a need to repeat descriptive work in multiple areas of a particular country. Further research is required to understand the applicability and relevance of these diagnostics in other contexts, including those where markets play a more significant role in shaping diets than in rural Malawi.

Conflicts of interest

None.

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Appendix A. Supplementary data

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