How effectively might agricultural input subsidies improve nutrition? A case study of Malawi's Farm Input Subsidy Programme (FISP)

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Abstract
Agricultural input subsidy programmes (AISP) are often considered an important means of improving agricultural productivity and food security in developing countries. However, the impact of AISP on food choice and nutrition is unclear, not least because staple crops targeted tend to be calorie-dense but nutrient-poor. AISP targeting maize, for example, may increase maize production and consumption and reduce intake of nutrient-rich foods. Alternatively, a fall in maize prices may enable consumers to purchase other goods including other food items. Using mixed-methods approaches, this paper examines the impact of a prominent AISP, Malawi's Farm Input Subsidy Program (FISP), on overall food choice. Qualitative data were collected through semi-structured interviews and focus-group discussions. Quantitative data were collected through household, individual and market surveys, and a discrete-choice experiment. Hypothesised impact pathways from AISP to food choice and dietary diversity, and prior literature, suggest Malawi's FISP could be contributing to improved dietary diversity. However, analyses from our surveys, discrete-choice experiment, interviews, and focus-group discussions do not suggest any significant FISP impact on food choices and dietary diversity. Our findings suggest this lack of impact could be due to how the FISP policy is designed/implemented – but that even with changes, as with the Affordable Inputs Programme which replaced the FISP in 2020, it may still be an inefficient means of addressing dietary diversity in rural Malawi. The results highlight issues needing consideration by policymakers and the agri-nutrition community to advance discussion/research for how best to design AISP and other public policy to address malnutrition in all its forms.

Keywords agricultural policy · agricultural input subsidy · diet · dietary diversity · nutrition · Malawi

1. Introduction

Malnutrition in all its forms, including undernutrition and micronutrient deficiencies as well as overweight and obesity, is a key factor shaping population health, and social and economic

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development globally (Popkin et al., 2020). Accordingly, addressing malnutrition is recognised in Sustainable Development Goal 2 (SDG2), which aims to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (United Nations, 2022). Furthermore, many of the other SDGs such as those aimed at achieving clean water and sanitation, renewable energy, education, and gender equality, are themselves affected by improvements in nutrition. Nutrition status is determined by a range of factors, but critically includes dietary quality and quantity (Reinhardt & Fanzo, 2014, United Nations Children's Fund (Unicef), 2013).

In low- and middle-income countries (LMICs), agricultural input subsidy programmes (AISP) are often considered an important policy driver for improving agricultural productivity and food security. They are a grant (or subsidized loan, if repaid below market prices) given to facilitate acquiring an agricultural input (for example, inorganic fertiliser or hybrid seeds) (Hemming et al., 2018). In these contexts, an AISP is expected to support poor farmers in being more able to afford the inputs and technologies needed to increase productivity, an important means of improving food security (Gordon, 2000). AISP were common in poorer rural countries in the 1960s and 1970s, but less so in the 1980s and 1990s (Hemming et al., 2018). In recent years, there has been a resurgence of interest in AISP, particularly in Africa, as a way to improve food security (Morris et al., 2007, Jayne & Rashid, 2013).

However, the impact of AISP on nutrition is unclear, moreso because often targeted are staple crops, which tend to be calorie-dense but nutrient-poor (Walls et al., 2018). The crops targeted by AISP are commonly maize, rice and wheat, although some countries have expanded their targeted crops to include nutrient-rich legumes (Houssou et al., 2017, Mason et al., 2013, Mason et al., 2016, Pan & Christiaensen, 2012). With this focus on staple crops, an AISP targeting maize, for example, may increase production and consumption of maize and hence reduce intake of nutrient-rich foods. Alternatively, if the AISP results in maize prices falling, it may provide consumers with more real disposable income to spend on other food items. Ruel et al. (2010) list responses in poor countries to price changes that contribute to nutritional outcomes. This list includes consuming staple foods of different quality and price, changes to overall food intake, changes in consumption of nutrient-rich non-staples, and changes in consumption of cheaper, high-calorie but low-nutrient foods. Caution is needed with comparing AISPs to the cash transfer literature, given the different pathways of dietary impact (cash transfers directly affecting purchases including food purchases through changes to household income, whilst AISP pathways are more indirect and occur through changes to the mix of own-farm and market-acquired produce, crop prices and incomes). However whilst evidence from the cash transfer literature generally shows that cash transfers increase dietary diversity (Bhalla et al., 2018, Harris-Fry et al., 2018, Schwab, 2020, Hidrobo et al., 2014), other studies in the area suggest that the associations are context-specific (Hoddinott et al., 2014, Schwab, 2020), with contrary evidence found in very low-income settings (Hoddinott et al., 2014). This shows the importance of understanding income/affordability pathways from AISP to food choice and nutrition, as we have explored in our research.

Figure 1 presents a framework of the links between agricultural interventions, agricultural production, food acquisition including through purchases, dietary diversity and nutrition and health outcomes. Agricultural interventions such as AISP, dependent on their characteristics of policy or programme design and implementation, can lead to changes in agricultural production, for example through changes to the mix of crops produced and increases in

production of some crops, as well as to changes in own food production. These changes in agricultural production can in turn affect household incomes, both agricultural and non-agricultural – however the changes depend on households' capabilities and assets, and farming characteristics and technologies. Own-farm crop production and diversification might be expected to increase dietary diversity, and hence nutritional status of household members. Similarly, both agricultural incomes and non-agricultural incomes provide purchasing power with which households may have improved options regarding food and non-food purchases. Increases to household income may enable the purchase of a greater variety of foods, which can lead to changes in food choices, dietary diversity and better nutrition and health outcomes. These relationships across the framework are mediated by various factors including household characteristics, social norms, institutional and political economy factors, infrastructure, market structure and seasonality (Matita et al., 2021a). Thus, with increased production associated with AISP, some people might consume more of their own production, but others may sell to local markets. This engagement with markets would reduce the real price of the targeted staple such as maize, and whilst it may increase the real incomes of net consumers of maize, it may reduce the incomes of net producers of maize. To understand this complex impact of the changes in the real price of maize, it is important to note that often smallholder farmers also acquire significant quantities of what they produce in markets. For example, in Malawi, 60% of maize producers are net buyers of maize (Bezu et al., 2014).

[Figure 1 about here]

This paper examines in detail the impact of a specific AISP implemented in Malawi (from 2005/06 to 2019/20), the Farm Input Subsidy Programme (FISP). We take a mixed-methods approach, drawing on data from two districts of Malawi, to examine the impact of the FISP, targeting mostly maize, on overall food choice. We also consider wider social, economic, and political influences on the relationships of interest. Key questions we sought to answer were:

- Does receiving the FISP lead to increased dietary diversity?
- Does a lower price of maize lead to increased dietary diversity?
- How do stakeholders perceive the impact of the FISP on dietary diversity?

1.1 Malawi's Farm Input Subsidy Programme

The introduction of the FISP followed a long history of food shortages and food insecurity in Malawi. This included food crises in 2001/02 and 2004/05, and a history of government subsidies in agriculture (Chinsinga and Poulton, 2014, Chinsinga, 2007). The FISP aimed to support agricultural production and smallholder incomes, primarily through increasing maize productivity (Lunduka et al., 2013, Arndt et al., 2015). It was administered through vouchers that enabled eligible households to purchase fertiliser, improved maize, and legume seed at reduced prices. Whilst legume seeds were also subsidised, the most common voucher types were for maize seed and maize fertilizer (Snapp and Fisher, 2015). Its size and scope changed over time, but the programme constituted approximately 10% of the national budget, and between 40% and 70% of the national agricultural budget (Ragasa & Mazunda, 2018, Chirwa & Dorward, 2013). It at times directly benefitted approximately four-fifths of Malawi's farm households (Chirwa and Dorward, 2013). In 2020, the new Malawi Government replaced the FISP with the Affordable Inputs Programme (AIP), which similarly subsidises the cost of fertiliser and a choice of improved seeds for maize, sorghum or rice, but a larger number of

smallholder farmers are eligible for participation in the programme than with the FISP (Matita et al., 2021a).

Agriculture is critical to Malawi's economy, with around 85% of the population deriving their main livelihood from the sector, which also generates one-third of gross domestic product (Ecker & Qaim, 2011, Arndt et al., 2015, National Statistical Office (NSO), 2012). Maize is the predominant staple crop grown by smallholders (Arndt et al., 2015), accounting for 80% of smallholder cultivated land in 2011 (Food and Agriculture Organization of the United Nations (FAO), 2011). Malawian smallholder farmers experience low productivity, with less than 20% producing surplus for sale (World Bank, 2007). Maize is particularly vulnerable to drought (Arndt et al., 2015), and food-related shocks are devastating for people's wellbeing, with seasonal food shortages common (World Bank, 2007). Whilst figures fluctuate between years particularly due to weather events, between 1.0 and 6.7 million people have been considered food insecure in the lean seasons (October-March) between 2016 to 2019 (Government of Malawi, 2019).

Malawi has one of the lowest per-capita income levels globally, with 51% of the population and 57% of the rural population living below the national poverty line in 2016 (World Bank, 2022), and malnutrition poses a significant public health burden. Estimates from 2015/16 are that 37% of Malawian children aged under 5 years are moderately or severely stunted, 12% are underweight and 3% are wasted. Furthermore, 63% of children aged under 5 years and 33% of women aged 15-49 years were anaemic, and food consumption of only 8% of children aged 6-23 months met the standards for a minimum acceptable diet (National Statistics Office (NSO), 2017). In some districts, prevalence of acute malnutrition reaches 5% (Sassi, 2012). Addressing malnutrition is a key priority of the Malawi government (Meerman, 2008), and the core health issue that the FISP intended to address, alongside primary aims of improving agricultural productivity and alleviating smallholder farmer poverty.

Hypothesised impact pathways, conceptualized in Figure 1, from AISP to consumer behavior including food choice and dietary diversity suggest that the FISP could contribute to improved dietary diversity through promoting greater agricultural production, and lower maize prices – enabling increased expenditure on maize as well as non-maize food products. However, it could also simply result in greater maize consumption. Studies of the impact of FISP on maize production generally suggest some improvements in maize productivity, however the evidence does not support that the FISP led to reductions in maize price (Chirwa & Dorward, 2013, Lunduka et al., 2013) – a relationship affected by many factors including maize export bans and the role and influence of the Agricultural Development and Marketing Corporation (ADMARC), a government-owned corporation or parastatal (Aragie et al., 2018, Chirwa, 2009, Baulch & Botha, 2020). Several studies of FISP impact on dietary diversity suggest a possible (minimal) positive impact (Walls et al., 2018, Snapp & Fisher, 2015), although others have found less positive results (Matita et al., 2021a). The significant burden posed by malnutrition in Malawi, with implications for population health, and social/economic development – and the substantial resources given to the FISP – highlight the critical need to understand the impact of such an AISP on food choice and dietary diversity, beyond just the impact on consumption of the staple crop.

2. Methods

In this study – part of a larger work programme examining agricultural policy, dietary diversity and its wider context in rural Malawi (Matita et al., 2021b) – we undertook a mixed-

methods approach that included quantitative and qualitative analyses to explore the impact of the FISP and its proxies (e.g. maize price) on dietary diversity. We adopted four main approaches: 1) comparing dietary diversity of FISP beneficiaries and non-beneficiaries; 2) a discrete choice experiment (DCE) to investigate consumer food choice responses to a change in maize price; 3) examining seasonal changes in the price of maize and other foods to understand household decision-making (in the context of seasonality-induced price and availability changes); and 4) examining the perspectives of key stakeholders. This methodological approach enabled triangulation from various data sources/analyses and an in-depth understanding of FISP policy impact on dietary diversity and the context for this, in regard to the key research questions.

Data were collected through: (1) household and individual surveys; (2) market surveys; (3) focus group discussions (FGDs); (4) semi-structured key informant interviews; and (5) a discrete choice experiment (DCE). (See Appendices 1-5 for data collection instruments). We also analysed official government market data, sourced from the Ministry of Agriculture, Irrigation and Water Development.

The household and individual surveys, market surveys, FGDs and the DCE were undertaken in rural areas of two districts of Malawi: Lilongwe District in Central Malawi and Phalombe District in Southern Malawi. These districts were chosen for the different contexts that they represent: Lilongwe district with a farming system dominated by maize cultivation and Phalombe district with a more mixed farming system (Matita et al., 2021a, Fatch et al., 2021, Gumma et al., 2019, National Statistical Office (NSO), 2017). At the time of our fieldwork, the process of selecting programme recipients was undertaken randomly, at the level of central government (Basurto et al., 2020, Nkhoma, 2018, Dorward & Chirwa, 2013, Shively & Ricker-Gilbert, 2013). But the targeting was initially decentralised with village leaders allocating the FISP coupons within their communities, with some lack of clarity regarding the changes to the targeting of the FISP over time.

Data for household and individual surveys (Appendix 1) were collected from 400 households (200 in each district), at two time points – May 2017, representing a post-harvest season when maize prices are expected to be low, and February/March 2018 representing a lean season (usually October to March) with maize prices expected to be high. Data from household/individual surveys, market surveys, FGDs and DCEs were collected from four enumeration areas included in the FISP evaluation studies (Chirwa & Dorward, 2013) in one traditional authority in each of Lilongwe District and Phalombe District.[1] In each selected enumeration area, for the household and individual surveys, 50 households were randomly selected using a random-walk system. The second survey round successfully tracked 92.7% of respondents interviewed in the first round (93.5% in Lilongwe and 92.0% in Phalombe). In situations where a household was unable to be interviewed in the second round of data collection, we added the next household in the random walk as a replacement household – a standard approach undertaken in such informal settings (World Food Programme (WFP), 2004). FGDs were also undertaken at both time points, and the DCE only in the second time point – February/March 2018. Sample sizes (400 households, with 200 in each district) were selected based on previous experience undertaking similar analyses (Chirwa & Dorward, 2013), as figures that would provide sufficient power to detect statistically significant differences in key variables of interest, whilst also being realistic in the context of study resource constraints. The instruments were pre-tested prior to data collection in communities near the city of Zomba where the field workers were trained.

The household survey included questions about: demographics and household characteristics, including questions regarding household assets based on the Demographic and Health Surveys (USAID, 2022); agricultural activities undertaken by the household; food and non-food expenditure based on surveys conducted by the International Household Survey Network (International Household Survey Network, 2014); food obtained from non-purchased sources; food security based on the Household Food Insecurity Access Scale (HFIAS) (Coates et al., 2007); and a dietary assessment. The dietary assessment followed standard guidelines (24-hour recall) for measuring household and individual dietary diversity, and infant and young child (aged 2 years or younger) feeding practices (Kennedy et al., 2011, World Health Organization (WHO), 2010).

The official government market data are based on information collected from 72 large markets across Malawi. The markets are purposively sampled, based on several factors including their designations as being important local markets by the respective district councils. Some are daily markets; others are weekly markets. In total, data are collected from approximately 250 markets, but the publicly available information is based on the 72 markets considered significantly large. The information obtained, based on regular data collection, enables the reporting of monthly average prices of different commodities (Personal Communication, 2022).

The market survey (Appendix 2) was conducted in two markets commonly accessed in each traditional authority, at each time point. The price of all food items reported to have been consumed by respondents in the household and individual survey were collected, in the quantities in which people commonly purchase the particular food (kilograms, litres, 'pieces', and a standardized 'small cup' (600 mL) and 'large cup' (1500mL)).

The DCE was undertaken to understand how food choices would respond to a change in the price of maize (Appendix 3). It is described in greater detail in forthcoming work, but in brief, involved simulating the context in which participants would normally make choices among a set of competing food alternatives. This was achieved by systematically varying levels (prices and quantities) of attributes (foods) to produce multiple choice scenarios or food 'baskets'. Participants were asked to indicate their preferred food basket in each scenario, and the observed utility of foods and prices modelled in a standard probabilistic econometric framework. We selected, based on dietary information from the community interviews and FGDs in Round 1 of data collection, five food types: maize, rice, cabbage, small dried fish, and a soft drink, at three possible levels (prices) each. Maize was included, as the staple crop of particular interest, rice as an alternative to maize, cabbage as a less commonly consumed but widely available vegetable, small dried fish as a protein and animal-source food that is relatively commonly consumed but often unaffordable, and a soft drink to represent the increased prevalence of highly processed foods and beverages (particularly soft drinks) in rural Malawi. The foods do not represent a comprehensive diet – rather, they represent dietary options that a person/household may make, given the constraints of this type of experiment that gave us the opportunity to select only a limited number of foods for comparison. Both the choice of food types and prices were based on data obtained during the first round of fieldwork in May 2017. One set of five tasks had maize at a higher price (400 MK/kg), and the other had maize at a lower price (100 MK/kg). Total basket prices were shown to respondents alongside the quantities of items in the basket; each basket had an overall value of 900-1100 MK. We displayed three hypothetical baskets in each task, using an unlabelled design where each alternative represented a comparable basket. Participants could opt-out of choosing a basket; if they did so, a forced choice task from the three baskets

was asked immediately afterwards. The five attributes of the DCE, different food types, and their levels are shown in Table 1, and Figures 2a, and 2b show an example of how choice tasks were presented to respondents.

[Table 1 about here]

[Figures 2a and 2b about here]

Semi-structured interviews (24 in total, to reach data saturation) were undertaken with participants from key stakeholder groups with an interest in population nutrition and related health, or in agriculture. These participants included national policymakers from the Ministry of Health and Ministry of Agriculture, Irrigation and Water Development (6 interviews with 7 individuals); district-council respondents from Lilongwe and Phalombe Districts (7 interviews); local non-state actors (5 interviews); and village chiefs in Lilongwe and Phalombe Districts (6 interviews). We recruited individuals for interview from within the organisations of interest based on prior contacts or from approaching the organisation and asking to speak to someone best placed to discuss the issues.

In each district, we received permission from traditional heads (chiefs or village heads) to undertake FGDs (16 in total, to reach data saturation). The traditional heads organized for a group of adults of different ages (18 years and over) in the villages to attend the FGDs. Sixteen FGDs of 8-12 adults were undertaken – two groups for male participants and two groups for female participants – in each of the two districts and at each time point.

The interview guides for the semi-structured interviews and FGDs (Appendices 4 and 5) were informed by the Policy Triangle framework for understanding policy processes (Walt & Gilson, 1994), and domains of the Shiffman and Smith framework for analysing political prioritisation (Shiffman & Smith, 2007), and covered questions relating to participants' view of the FISP and its aims, how FISP policy is made, key actors and stakeholders involved with the FISP and their role and influence, the impact of the FISP on nutrition, and the wider context for the FISP including political, economic and social context.

We analysed the qualitative data using thematic content analysis, and both an inductive and deductive approach to coding based on the six domains previously described. The analysis is largely reported elsewhere in forthcoming work, and in this study, we highlight in particular respondents' views of: nutrition in Malawi; the impact of the FISP on nutrition and diets; and any problems with FISP policy design or implementation. Coding was conducted in nVivo (Version 12). To ensure consistency and transparency in the coding process, the coded extracts were imported into Word documents and organized according to the main themes to identify patterns across interviews and between actor types.

With quantitative data from the household and individual surveys, we undertook regression analyses using Stata® software to understand key relationships based on prior hypotheses including as depicted in Figure 1. We undertook Poisson regression with dietary diversity as the dependent variable and controlled for household characteristics as for other studies on production/market-participation/dietary-diversity links (Matita et al., 2021a, Thorne-Lyman et al., 2010, Rashid & Smith, 2011, Jones et al., 2014, Sibhatu et al., 2015, Koppmair et al.,

2017). These covariates include gender of household head, age of household head, education of adult respondent (person mainly responsible for preparing food in the household), household size and household assets. We measured our dependent variable, household or individual dietary diversity (recommended for use by the FAO and validated as a proxy of nutritional quality (Kennedy et al., 2011)) as the count of the number of food groups consumed by the respondent (for individual dietary diversity (IDD)) or any member of the household (for household dietary diversity (HDD)) using 24-hour recall. HDD includes only food prepared and consumed in the home by household members, whereas individual dietary diversity includes all foods eaten by the individual, irrespective of where they were prepared or consumed (Kennedy et al., 2011). The twelve food groups that are used to calculate HDD score are: cereals; roots and tubers; vegetables; fruits; meat, poultry and offal; eggs; fish and other seafood; legumes, nuts and seeds; milk and milk products; oils and fats; sweets; spices, condiments and beverages. The nine food groups that are used to calculate the IDD score are: starchy staples; dark green leafy vegetables; other vitamin A rich fruits and vegetables; other fruits and vegetables; organ meat; meat and fish; eggs; legumes, nuts and seeds; milk and milk products (Kennedy et al., 2011). We constructed the asset index using weights generated from the principal-component factor method (Howe et al., 2012, Poirier et al., 2020). Information on ownership of 16 assets was collected from households: electricity, television, radio, computer, refrigerator, traditional paraffin lamp (*koloboyi*), paraffin lamp, bed with mattress, sofa set, watch, mobile phone, bicycle, motorcycle, animal drawn cart, car, and boat with motor. None of the respondents owned a computer and thus we dropped it from the principal-component factor analysis. First factor loadings were used as weights for the asset index.

With the market survey data on food price, we have included food prices in our results where we had three or more measurements for a particular food item in comparable units for each of either Phalombe District or Lilongwe District. Thus, where there were three or more measurements in the same unit in each of Phalombe District and/or Lilongwe District in each period, we calculated the average of these three (or more) measurements.

We analysed the DCE data, using a d-error-minimising efficient design to generate two sets of five DCE tasks, and a modified Federov algorithm in NGENE software. We used predicted probability analysis to explore how maize prices might affect dietary diversity, simulating the probability that a basket with only maize would give the same utility as a basket with one of the other items in the DCE.

Interview guides were developed, translated, and amended with support of our field workers, and piloted prior to use in the study. Participants provided informed consent prior to interviews and FGDs. In most cases this consent was provided in written form; in some cases, for FGDs, participants provided consent with an ink thumb print. Ethical approval was provided by Malawi's National Committee on Research Ethics in Social Sciences and Humanities and the London School of Hygiene and Tropical Medicine.

Together, the different data types and analyses provide a nuanced understanding of policy impact and its context.

3. Results

We present descriptive statistics of our surveyed households, followed by our key results, which directly relate to our key research questions:

- Does receiving the FISP lead to increased dietary diversity?
- Does a lower price of maize lead to increased dietary diversity?
- How do key stakeholders perceive the impact of the FISP on dietary diversity?

3.1 Descriptive statistics of participating households

Table 2 presents descriptive statistics relating to participating households. Respondents to the survey, who were 'the person who makes the decisions about food preparation for the household', were almost all women – 97% female in May 2017; 98% female in February/March 2018. Average age of household heads was 43 years old. Household heads were predominantly men; 34% of household heads were women in May 2017 and this increased to 40% in February/March 2018, with differences statistically significantly ($p=0.10$). Average household size was 4.7 members and over two-thirds of respondents had ever attended school. Household wealth as indicated by the asset index is significantly lower in the lean season (0.23) than the post-harvest season (0.35).

Average household dietary diversity score over the two seasons is 4.1 with a standard deviation of 1.5, implying consumption of four out of twelve food groups. The HDD score was significantly lower ($p=0.01$) in the lean season (3.75) than in the post-harvest season (4.37). The same significant pattern held for the IDD score, which fell from 3.17 (of 9 food groups) in the post-harvest season, to 2.48 in the lean season ($p=0.1$). In terms of food security, we found that households had an average of two meals per day in the week prior to the survey irrespective of data collection period. About 74% of respondents worried that their household would not have enough food in the four weeks prior to the survey, increasing to 83% of households in the lean season. Meat consumption in the past week was also rare, with 76% of respondents reporting that the household did not consume any meat in the past week.

The farm input subsidy in the 2016/17 and 2017/18 agricultural seasons was received by an average of 39% of the study sample. At least 72% of the sample reported having ever participated in the FISP since its commencement in 2005/06. However, there is a significant reduction ($p=0.05$) in the proportion of households ever receiving the subsidy between the two survey rounds (post-harvest period of the 2016/17 agricultural season and the lean period of the 2017/18 season). The reduction in the 'ever' participated in 2017/18 season is possibly due to a higher number of replacement households in the second round being non-beneficiaries of the programme. There were no statistically significant differences between FISP beneficiary households and non-beneficiary households except for with the age of the household head – beneficiary households had relatively older household heads. With respect to being a recipient of the FISP in the past, significant differences were observed with respect to age of the household head, gender of the household head, schooling of the respondent and household dietary diversity. Households that had 'ever' been FISP beneficiaries had higher dietary diversity relative to those that have never participated in the programme ($p<0.05$).

[Table 2 about here]

3.2 Does receiving the FISP lead to increased dietary diversity?

Table 3 examines the association between receiving the farm input subsidy with measures of dietary diversity, based on data from household and individual surveys. The three types of

FISP beneficiary status explored are being a current FISP beneficiary (in the 2016/17 agricultural season), having been a FISP beneficiary in the past (prior to 2016/17, with the rationale for the inclusion of this being that past beneficiaries may experience sustained benefits to current agricultural production from this past support (Ricker-Gilbert & Jayne, 2017)), and never having been a FISP beneficiary. In the univariate model, there was a general pattern with both household and individual measures of dietary diversity, in that FISP beneficiaries in the past had the highest dietary diversity, followed by FISP beneficiaries in 2016/17, then those who had never been FISP beneficiaries.

[Table 3 about here]

Table 4 presents poisson regression results of the household and individual dietary diversity score for being a FISP beneficiary in 2016/17, and being a FISP beneficiary in the past, compared with never being a FISP beneficiary. In this multivariate analysis, we find no statistically significant association between being a FISP beneficiary and individual or household dietary diversity. A limitation is that the analysis does not account for selection bias into the FISP. Such selection bias should be considered in the context of changes to the targeting of the FISP over time. The targeting was undertaken through random allocation by central government in 2016/17, following targeting at a community level in earlier time periods with reports of chiefs favouring kin (Basurto et al., 2020, Shively & Ricker-Gilbert, 2013). Such bias would likely result in higher correlations of being a FISP beneficiary with dietary diversity in earlier time periods than in the later 2016/17 period – an association found in the univariate analysis but not in the multivariate analysis. Table 1 of Appendix 6 shows consistent statistically significant differences between FISP beneficiaries and non-beneficiaries only for age of household head for the measures of FISP used. With this analysis our measure of wealth, the asset index, does not differ for the two groups. Other studies using the propensity score matching (PSM) technique have also been unable to definitively show dietary diversity of the FISP (Ragasa & Mazunda, 2018).

[Table 4 about here]

3.3 Does a lower price of maize lead to increased dietary diversity?

As discussed earlier, prior evidence does not support that the FISP has led to reductions in maize price, a relationship also affected by many factors (Chirwa & Dorward, 2013, Aragie et al., 2018, Chirwa, 2009, Baulch & Botha, 2020). However, the FISP is designed to reduce maize price, and if the FISP *did* in fact lead to a lower maize price, might this lower price of maize lead to increased dietary diversity? Thus, this section focuses on market-mediated (via price changes) impacts of the FISP on dietary diversity. In an experimental setting using data from the DCE, we found that demand for maize increases as maize price decreases. When maize price is 250 MK/kg, a basket with one unit of maize provides the same utility as a basket of the other foods. Where maize is priced lower, the DCE data suggest that the quantity of maize bought will increase. Thus, in this experimental setting, we find that a lower maize price will not lead to increased dietary diversity – in fact it could lead to further declines in dietary diversity as demand for maize increases.

[Figure 3 about here]

The impact of a lower maize price on dietary diversity resulting from seasonal fluctuations in the price of foods can also be explored using observational data. We examined this in a stepwise process, based on data sourced from official government statistics, and our household, individual and market surveys. Given the role of maize in Malawian diets, and the reductions in dietary diversity during the lean agricultural season, if there are differences in seasonal change in maize price between Lilongwe and Phalombe Districts, we would expect a larger decline in dietary diversity in the district with the greater increase in maize price. However, this expectation should be considered in regard to the finding above from the discrete choice experiment (Figure 3), in which a greater increase in maize price may be expected to a small extent to lead to greater dietary diversity.

First, we explored seasonal variation in maize price in Malawi nationally, and in Lilongwe and Phalombe Districts, using official statistics from the Ministry of Agriculture, Irrigation and Water Development. Figure 4 presents data showing these seasonal variations between 2015 and 2018, with prices often lower in May than in February/March, but with this seasonal pattern largely masked by significant annual variation in price. Furthermore, the data show that maize prices in Phalombe District are often higher than the national average, and maize prices in Lilongwe District often lower than the national average.

Such differences by district may be explained by the more remote location of Phalombe District, and its lower levels of infrastructure and market connectivity. A considerable literature shows that where infrastructure is more limited, food shortages and food price spikes are more common (Harvey & Savage, 2006).

[Figure 4 about here]

Using these official statistics, Table 5 shows how from 2015 to 2016, across Malawi as a whole and in Lilongwe District, maize price increased substantially (130.3% and 111.2%, respectively) between the post-harvest and lean seasons. However, the increase was not so great in Phalombe District (84.6%). From 2016 to 2017, the increase was not so great across all areas of the country (16.3% nationally). From 2017 to 2018, the increases were small across Malawi (a 5.1% increase, with no increase (0.1%) in Lilongwe District) but increased by 50.0% in Phalombe District. Thus, it appears that whilst maize prices in Lilongwe District more closely follow national averages, Phalombe District demonstrates a different pattern of peaks in maize price and is to a greater extent driven by local changes in maize supply and demand.

[Table 5 about here]

Second, we explored how seasonal variation in maize price in official government statistics related to the data on maize and other food price that we collected in our market surveys. We found that the large increase in maize price in Phalombe District (50%) compared with Lilongwe District (0.1% increase) from the official government data described in Table 4 are reflected in our market-survey data. Whilst in our data the overall cost of foods in markets of Lilongwe and Phalombe Districts *combined* increased by 6.0% between post-harvest and lean

seasons, the maize price increased by 38.7%. Table 6 shows, for a smaller subset of foods, that this increase was driven by the increase in maize price in Phalombe District (an increase of 46.2%) rather than Lilongwe District (for which we did not have enough data points to record a change in price, but for those data points we had, there was no price increase).

For the items for which we have data, there was a larger increase in price in Lilongwe District (4.5%) than in Phalombe District (2.6%). However, this does not take into account that maize price increased markedly in Phalombe District but not Lilongwe District.

[Table 6 about here]

Third, we explored the correlation between the seasonal maize price data from our market surveys and dietary diversity in the two districts. Given the considerable increase in maize price in Phalombe District, we would expect a larger decline in dietary diversity in Phalombe District than in Lilongwe District. Table 7 shows the average IDD and HDD scores for all sample households in Lilongwe and Phalombe Districts across the two time periods. Dietary diversity was higher in Phalombe District than in Lilongwe District in both time periods. As suggested from data in Table 6, these dietary diversity changes are driven by increases in the price of non-maize foods in Lilongwe District and increases in the price of non-maize foods as well as a marked increase in the price of maize in Phalombe District. However, Table 7 shows larger declines in dietary diversity in Phalombe District than Lilongwe District, but only for HDD, not for IDD. The reasons for this difference are unclear – and based on this, and limitations including the lack of sufficient data points regarding change in maize price in Lilongwe District, the conclusions regarding impact of actual seasonal maize price on dietary diversity area unclear.

[Table 7 about here]

3.4 How do key stakeholders perceive the impact of the FISP on dietary diversity?

To further understand the impact of FISP on dietary diversity, and particularly, the context for this impact, we examined our qualitative data from FGDs with people in villages of the two districts, and from semi-structured interviews with other key stakeholders. The results are presented under three headings, as follows.

Nutrition in Malawi

The interviews and FGDs confirmed the poor food and nutrition situation for most rural Malawians. Dietary diversity is very poor, particularly in the lean season when food security is also a critical issue. At this time, many families regularly have just one meal a day – and some do not eat at all.

> *"Nutrition is a very big problem in Malawi. To eat six food groups a day is a big problem at village level. Some food groups are missed. Six food groups is ideal, it's the recommendation in Malawi. Every person should eat at least six food groups a day." (KII 13, District Council respondent)*

"Like this time we don't have enough food we can eat once a day so our bodies tend to get smaller and with farming it just gets worse." (FGD 10 of women, Lilongwe district, lean season)

"[A diverse diet means] vegetables, meat, having tea in the morning and afternoon as well as eating fruits. [Everyone laughs]. For us we don't because we cannot manage. It is because some of the foods are expensive." (FGD 10 of women, Lilongwe District, lean season)

Impact of the FISP on nutrition and diets

The lack of benefit of the FISP on dietary diversity largely found in the analyses above was, to a considerable extent, reflected in the perspectives of key stakeholders.

Community participants were mostly negative about the FISP, perceiving minimal impact on their nutrition. Some spoke about problems such as the late issuing of coupons, and the problems FISP creates in communities. Others commented that income from maize has little benefit given the relatively higher prices of other food commodities.

"It helps poor people to access cheaper fertilizers and seeds, but they do not access the help, but rather well-to-do people." (FGD 01, men, Lilongwe).

"We eat just to ease hunger. We do not have choices of food for there are limited foods available here. We only have nsima available here. It's hard to sell even one bag of maize to buy other foods like chips or meat, if you have harvested a few bags of maize." (FGD 01, men, Lilongwe).

"Sometimes beneficiaries may not have bumper yields as the inputs come late." (FGD 02, men, Lilongwe).

Village chiefs were the most positive about the FISP impact, citing benefits to agricultural productivity, income and nutrition.

"They give us different kinds of food so that we diversify our diets for example like maize it does not have a lot of nutrients so they want us to add soya and beans." (KII 06, village head, Lilongwe).

District Council participant, national-level and NGO participant views in regard to the benefit of the FISP were fairly mixed.

"… recently there has been an increase of the adoption of these other legumes, at smallholder consumption level because at first I think farmers were just relying on growing maize and then tobacco; but now I think with … this FISP programme, farmers are able to grow different kinds not only soya beans maybe pigeon peas and they can grow a lot of groundnuts they can grow a lot of other legumes which is because I think the introduction of FISP programme." (KII 21, NGO respondent).

"In the selection it should be those that are productive farmers but they are not too poor then there will be high production, but currently … the way we have implemented FISP this year has affected the production in that production has been low now if production has gone low; it means that money at household level has been reduced, food intake has been reduced. And even their nutritional status has been affected ok, negatively because if you produce less then you are going to eat less, right?" (KII 08, District council respondent).

"It is creating problems in the communities but it is also creating dependency." (KII 12, District council respondent)

Any issues with FISP policy design or implementation

Whilst some participants explained how the FISP could benefit participants, many expressed concerns. These concern were in regard to: policy design, e.g. in regard to the targeting of farmers; creation of a 'dependency' on coupons, and the problems it creates in communities; and policy implementation, e.g. in regard to the late issuing of coupons and poor coordination, and the sharing of coupons in communities.

4. Discussion

Hypothesised impact pathways from AISP to food choice and dietary diversity, and evidence from much of the cash transfer literature showing positive associations with dietary diversity (Bhalla et al., 2018, Harris-Fry et al., 2018, Schwab, 2020, Hidrobo et al., 2014), suggests that Malawi's FISP should have contributed to improved dietary diversity. This is because the FISP should result in greater agricultural production, and lower maize prices – and because in the post-harvest season there is increased dietary diversity in rural Malawi (Matita et al., 2021a, Gelli et al., 2017). However, prior evidence that the FISP has *not* led to reductions in the price of maize suggests that the FISP may not have led to changes to dietary diversity (Chirwa & Dorward, 2013). The quantitative and qualitative analyses from our surveys, key informant interviews and FGDs do not suggest that the FISP has impacted on food choices and dietary diversity in any significant way. This is the case in the quantitative analysis even when controlling for household wealth and other characteristics. Furthermore, the quantitative evidence from our DCE suggests that even if the FISP had *led* to a lower price of maize, this would not have led to increased dietary diversity.

Our experimental data suggest that even if the FISP resulted in lower maize price, people would still buy more maize, and less of other products. This may reflect a cultural norm of narrow food preferences relating predominantly to the consumption of *nsima* (made from maize), but this has also been questioned in the literature (Tiba, 2010, Vaughan et al., 2018, Aberman et al., 2015). Our qualitative data suggest that respondents would like to consume more diverse diets, and that buying more maize would be to 'ease hunger', reflecting the extreme poverty, food insecurity and nutritional deficit of dietary energy in this population. In a context where consumers are also producers, and where maize is the main food crop that can also serve as a source of income for families, a decline in maize price is a disincentive to sell therefore leading to less revenue. This is consistent with the 'low maize productivity trap' narrative used to describe the situation in Malawi (Chirwa & Dorward, 2013), and the situation consequently results in less dietary diversity especially among low-income earners as also observed by Gelli and colleagues (2020). This issue is emphasized by the comment from an FGD participant that maize is considerably cheaper than other foods, and comments regarding the extreme food insecurity and hunger this population experiences. However, the lack of dietary impact found in this study could also be due to the way that the FISP policy is designed and implemented. The interviews and FGDs raise several issues relating to policy design and implementation that may help explain this lack of impact, such as sharing of coupons, delays in programme implementation, and poor policy coordination – also reflecting findings from others (Chirwa & Dorward, 2013, Nkhoma, 2018, Chinsinga, 2012).

This important finding – that even when maize prices are substantially lower people would buy more maize rather than diversifying their diets – is in fact compatible with previous studies in Malawi and with more nuanced studies of the impact of cash transfers. It is in line with considerable evidence regarding food insecurity and energy deficits in Malawi and the challenges to increasing dietary diversity in Malawi beyond a predominance of maize (Matita et al., 2021a, Tiba, 2010, Ferguson et al., 1993, Flax et al., 2021). A range of nutritious foods are commonly consumed in Malawi, but not in adequate quantities, with diets dominated by maize (Gelli et al., 2020). Verduzco-Gallo et al. (2014) found substantial increases in daily per capita maize consumption (by more than 40 grams in urban areas and 60 grams in rural areas) associated with the FISP (Verduzco-Gallo et al., 2014), and Matita et al. (2022) showed challenges to crop diversification beyond maize, even with legume subisidies provided as part of the FISP (Matita et al., 2022). Cash transfer studies have also found that food quantity concerns dominate food quality concerns for very poor, rural beneficiaries (Schwab, 2020, Hoddinott et al., 2014). Schwab 2020 found 'a strong desire for greater dietary diversity even at low consumption levels' – a desire also reflected in our interview data, in which rural people also spoke about being unable to afford such diverse diets. In terms of further comparison with the cash transfer literature, the finding in our study of dietary *undiversification* even at lower maize prices is supported by findings from Hoddinott et al. (2014), who concluded, based on their findings in rural Niger, that direct cash transfer impact on dietary diversity in middle-income countries may not be replicated in settings where income is much lower – and where considerable seasonal variation in grain prices and food deficits is common (Hoddinott et al., 2014).

Our data of district-level differences in food price and dietary diversity suggest that a larger decline in dietary diversity could be expected in Phalombe District than in Lilongwe District due to the markedly greater peak in maize price. However this was the case for household measures of dietary diversity but not for IDD measures. This may be due to limitations of the data, however it could also have another explanation. For example, Phalombe District has a more mixed approach to crop production than Lilongwe District, which is more strongly focused on maize (Fatch et al., 2021, Matita et al., 2021a, Gumma et al., 2019, National Statistical Office, 2017). Based on this, it could be expected that to markedly influence dietary diversity, a larger increase in maize price would be needed in Phalombe than in Lilongwe Districts, where diets are less diversified. In low-crop-diversity environments such as Lilongwe Districts, diets should be more sensitive to change as people switch resources to maintain consumption of cereals. However, as the FGD participants commented, 'switching' diets away from maize is difficult to achieve, even when other products are available, due to price constraints.

Overall, our data find low levels of dietary diversity in rural Malawi, and considerable seasonal variation. Average HDD levels in our study are approximately half of the average of over 8 food groups reported in several studies (Jones et al., 2014, Verduzco-Gallo et al., 2014) based on national samples but similar to an average of 4.2 reported in Koppmair et al. (2016) for a sample survey of smallholder farmers in central and southern Malawi.

Important limitations to our analysis include dietary diversity measured by examining food groups rather than higher-quality dietary/nutritional indicators (beyond the scope of the study resources), and conducting this work over a single agricultural year, and one with less seasonal maize price variation at a national level than in previous years (although considerable maize price variation in one of our study districts – and we did take measurements from two seasons within the agricultural year). The study sample is also

relatively small and covers just two districts of Malawi. Furthermore, we examined impact on dietary diversity, rather than a range of outcomes on the causal pathway to dietary diversity. We have also focused on maize, however the FISP includes legume seed as well as fertilizer – an area we have examined elsewhere (Matita et al., 2022). The DCE results are influenced by choice of food types included, e.g. groundnuts were not included in the experiment. We should note that in the univariate model (but not the multivariate model), we found a general pattern suggesting positive FISP impact on both HDD and IDD, in that FISP beneficiaries in the past had the highest dietary diversity, followed by FISP beneficiaries in 2016/17, then those who had never been FISP beneficiaries. This suggests a need for further analysis, including in regard to FISP intensity (e.g. for how many years households received vouchers), as also observed by others (Ricker-Gilbert & Jayne, 2017)). Furthermore, it is worth reflecting, when considering the qualitative results, on participant bias in responses provided – for example with stakeholders who receive benefit from the programme as it runs currently to provide supportive responses, and those in villages with difficult livelihoods and need for further support to downplay any benefit that they may receive. However, we have brought together several data sources to provide a nuanced perspective on FISP impact on dietary diversity, taking a different approach to those modelling studies undertaken in this area. Whilst our approach has limitations, any modelling of government policy impact on public health outcomes also has challenges and contains assumptions.

Our analysis highlights the challenge of achieving dietary diversification in a population facing poverty and persistent food insecurity. An important implication of this analysis is the importance in situations of extreme food insecurity of addressing food shortages and hunger, before or at least alongside issues of dietary diversification – and the potential synergies with addressing multiple types of malnutrition. This is an implication consistent with prior literature describing the compatibility of addressing the different malnutrition types (Poole et al., 2021, Walls et al., 2019), and is expanded upon further in a related empirical analysis by Matita et al. (2022). Our analysis also highlights the 'gap' long recognized by policy analysts between policy expectations on the part of policy makers, and actual policy implementation (Pressman & Wildavsky, 1973), and raises the need for greater attention to issues of policy implementation and how best to achieve intended policy objectives from government decision-makers.

The FISP has recently been replaced by the AIP, a similar subsidy programme but with greater reach. However, our study suggests that the AIP design, with a similar focus on maize and the addition of sorghum and rice, is unlikely to be an improvement on the FISP, and while, as with the FISP, it has the potential to address food security, it would similarly be unlikely to address dietary diversity in rural Malawi. However, as with the FISP, attention to improving issues of policy implementation has the potential to improve policy outcomes.

This work has relevance to addressing malnutrition, and through this, issues of social and economic development, in rural, low-income populations of low-income countries in Malawi and beyond. It suggests that improving dietary diversity in such settings requires engagement with wider nutritional and other characteristics of the targeted population including in regard to food security, and that whilst a well-designed and implemented AIP programme may be part of this mix, it is likely that other complementary approaches to addressing malnutrition will also be needed. The likely importance of income and food affordability in shaping nutritional outcomes suggests that AISPs may not be the only or even the best way to address malnutrition in Malawi. Cash transfer and other social support systems may also have great potential, alongside the role of functioning markets (Matita et al., 2021a). This research

particularly highlights the need for: further research regarding AISP nutritional impact; and greater discussion including with policymakers and the wider agri-nutrition community about the relationships and synergies between addressing multiple food and nutritional objectives, and how best to design AISP and other public policy to address malnutrition in all its forms.

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Authors' contributions HL and DJ conceptualised the study. HW, DJ, MM and MQ undertook the analysis. All authors contributed to the interpretation of results. HW led the writing of the manuscript, with contribution from all authors.

Data availability The data for the study are available upon request from the corresponding author.

Declarations

Ethics approval Ethical approval was provided by Malawi's National Committee on Research Ethics on Social Sciences and Humanities and the London School of Hygiene and Tropical Medicine.

Conflicts of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Table 1 DCE attributes (price of a basket, and contents of a basket) and their levels (different prices and quantities)

No	Attribute	Attribute level
1	Price of a basket	900, 950, 1000, 1050, 1100 (Malawian Kwacha)
2	Contents of a basket	Maize - # of cups; 1 large cup costs MK150 or 400/kg - (1, 2, 3, 4 cups) Cabbage - 1 medium sized head costs MK150 - (0, 1 heads) Rice - ½ a small cup costs MK250 - (0, 1 cups) Small dried fish - ½ a small cup costs MK150 - (0, 1 cups) Frozy - 1 bottle cost MK200 - (0, 1 bottles)

Table 2 Descriptive statistics of household and individual characteristics

Variable	All households		FISP beneficiary 2016/17		FISP non-beneficiary 2016/17		Ever FISP beneficiary		Never FISP beneficiary		Post-harvest season		Lean season	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Female respondent (proportion)	0.97	0.18	0.96	0.01	0.97	0.01	0.97	0.17	0.96	0.21	0.95	0.22	0.98**	0.131
Age of household head (years)	43.30	16.8	44.93	16.89	42.26 **	16.69	45.87	17.3	36.84***	13.62	42.86	16.7	43.73	16.90
Female headed household (proportion)	0.37	0.48	0.39	0.49	0.35	0.48	0.39	0.49	0.30**	0.46	0.34	0.50	0.40*	0.50
Household size (number)	4.67	1.90	4.73	1.91	4.63	1.90	4.68	1.97	4.64	1.72	4.60	1.90	4.74	1.90
Respondent ever attended school (proportion)	0.70	0.46	0.67	0.47	0.72	0.45	0.68	1.97	0.75*	0.43	0.69	0.50	0.71	0.50
Household asset index[2]	0.23	0.33	0.23	0.31	0.23	0.33	0.24	0.31	0.23	0.35	0.35	0.30	0.23***	0.30
Household dietary diversity Score (number)	4.06	1.55	4.03	1.48	4.07	1.60	4.14	1.56	3.86**	1.53	4.37	1.80	3.75***	1.20
Individual dietary diversity score – adult (number)	2.83	1.08	2.80	1.04	2.84	1.10	2.85	1.10	2.77	1.03	3.17	1.20	2.48*	0.80
Number of meals for household per day over past week (number)	2.10	0.49	2.14	0.51	2.12	0.45	2.13	0.47	2.11	0.47	2.13	0.60	2.08	0.40
Worried in past four weeks that household would not have enough food (proportion)	0.75	0.43	0.73	0.44	0.76	0.43	0.75	0.43	0.75	0.43	0.65	0.50	0.83***	0.40
- Often (> 10 times)	0.33	0.47	0.33	0.47	0.33	0.47	0.33	0.47	0.34	0.47	0.23	0.40	0.41***	0.50
- Sometimes (3-10 times)	0.40	0.49	0.38	0.49	0.42	0.49	0.40	0.49	0.42	0.49	0.34	0.50	0.45***	0.50
- Rarely (1-2 times)	0.26	0.44	0.29	0.45	0.25	0.43	0.27	0.45	0.24	0.43	0.42	0.50	0.15***	0.40
FISP beneficiary in 2016/2017 season (proportion)	0.39	0.49	-	-	-	-	0.53	0.50	0.01	0.11	0.38	0.50	0.39	0.50

FISP beneficiary ever (proportion)	0.72	0.45			0.54	0.50	-	-	-	-	0.75	0.40	0.68**	0.50

Note:
[1] Statistical test were conducted to compare the mean between post-harvest and lean seasons for the different variables. *** Statistically significant at 1% level, ** statistically significant at 5% level, * statistically significant at 10% level.
[2] The household asset index includes the 16 variables applying to the household or anyone within the household: electricity (5.3%), radio (23.1%), television (0.8%), refrigerator (0.3%), koloboyi (5.0%), paraffin lamp (9.8%), bed with mattress (4.9%), sofa set (2.0%), watch (3.4%), mobile phone (32.5%), bicycle (42.1%), motorcycle (2.0%), animal drawn cart (0.5%), car (0.4%), boat with motor (0.1%).

Table 3 Univariate associations of receiving the farm input subsidy with dietary diversity measures

	FISP beneficiary in 2016/17				FISP beneficiary in the past[1]				Never a FISP beneficiary				Statistical significance (p-values)					
	Post-harvest season (A)		Lean season (B)		Post-harvest season (C)		Lean season (D)		Post-harvest season (E)		Lean season (F)		A vs C	C vs E	A vs E	B vs D	D vs F	B vs F
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD						
Household dietary diversity score																		
- all	4.27	1.8	3.80	1.1	4.45	1.8	3.79	1.1	4.12	1.8	3.62	1.3	0.078	0.507	0.109	0.891	0.240	0.345
- Lilongwe District	3.82	1.8	3.48	1.0	3.86	1.8	3.47	1.0	3.74	1.8	3.29	1.1	0.766	0.775	0.659	0.865	0.259	0.252
- Phalombe District	4.84	1.6	4.25	1.1	4.94	1.7	4.08	1.2	4.81	1.4	4.08	1.4	0.512	0.926	0.656	0.161	0.603	0.891
Individual adult dietary diversity score																		
- all	3.13	1.2	2.48	0.7	3.17	1.2	2.49	0.8	3.17	1.1	2.23	0.8	0.537	0.967	0.802	0.781	0.670	0.845
- Lilongwe District	3.06	1.1	2.25	06	3.11	1.2	2.30	0.7	3.15	1.1	2.21	0.6	0.493	0.804	0.607	0.134	0.308	0.651
- Phalombe District	3.22	1.2	2.82	0.9	3.23	1.2	2.65	0.9	3.19	1.1	2.73	1.0	0.988	0.890	0.904	0.081	0.448	0.879

Note: The table presents univariate associations of FISP beneficiary status with dietary diversity, and tests for mean differences. SD = standard deviation

[1] 'FISP beneficiary in the past' refers to any time in past, not limited to the 2016/17 agricultural season

Table 4 Poisson regression estimates with dietary diversity score as the dependent variable

	FISP beneficiary in past vs. Never a FISP beneficiary		**FISP beneficiary in 2016/17 vs. Not a FISP beneficiary in 2016/17**		**FISP beneficiary in 2016/17 Vs. Never a FISP beneficiary**	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Household dietary diversity	0.036	(0.044)	-0.013	(0.037)	0.017	(0.047)
Individual dietary diversity	-0.003	(0.050)	-0.013	(0.044)	-0.013	(0.056)
N	800	-	800	-	534	-

Note:

- *** Statistically significant at 1% level, ** statistically significant at 5% level, * statistically significant at 10% level.
- The table presents poisson regression estimates from panel data with dietary diversity as the dependent variable – dietary diversity at household level and at individual level. We contrast in columns the results for respondents that have ever been FISP beneficiaries and non-beneficiaries. The models control for age and gender of the household head, education of the respondent, size of household and wealth measured by the asset index. The models are overall significant judging by the Wald Test. The standard errors are included in parentheses.

Table 5 Average changes in the price of maize between the post-harvest and lean seasons (May, and the following February/March)

	Average changes in the price of maize		
	Nationally	**Lilongwe District**	**Phalombe District**
2015/16	130.3% increase	111.2% increase	84.6% increase
2016/17	16.3% increase	7.1% increase	3.9% increase
2017/18	5.1% increase	0.1% increase	50.0% increase

Source: Ministry of Agriculture, Irrigation and Water Development

Table 6 Average price of foods (Malawian Kwacha; MK) in the post-harvest and lean seasons (May 2017, February/March 2018), and the % change in price, Lilongwe and Phalombe Districts

		Post-harvest season		**Lean season**		**Percentage change by season (Lean season, compared to post-harvest season)**	
		Lilongwe District	**Phalombe District**	**Lilongwe District**	**Phalombe District**	**Lilongwe District**	**Phalombe District**
Small fish (small cup)		312.5	350	325	266.7	4.0%	-2.4%
Tomatoes (small cup)		175	-	182.5	-	4.3%	-
Bread		376.7	-	377.5	350	0.2%	-
Ripe guava (piece)		-	16.7	-	23.3	-	4.0%
Maize (dried)		-	86.7	-	126.7	-	46.2%
Groundnuts	(small cup)	-	400	-	316.7	-	-2.1%
	(large cup)	-	800	-	716.7	-	-10.4%
Cooking oil (litre)		1037.5	966.7	1150	850	10.8%	-12.1%
Soft drink		220	-	225	230	2.3%	-
Onions (small cup)		262.5	-	262.5	116.7	0.0%	-
Salt (large cup)		-	366.7	-	350	-	-4.5%
Rice	(small cup)	-	266.7	-	258.3	-	-3.1%
	(kg)	633.3	-	662.5	666.7	4.6%	-
Eggs (piece)		85	83.3	86.7	93.3	2.0%	12.0%
Sweets (piece)		10	-	10	10.0	0.0%	-
Hot chips (small cup)		200	-	237.5	-	1.9%	-
AVERAGE CHANGE						***4.5% increase***	***2.6% increase (but a 2.5% decrease with maize price excluded)***

Note: Average prices presented for items with three or more measurements in the same unit in each time period, in each of Phalombe District or Lilongwe District.

Table 7 Dietary diversity scores by location, May 2017 and February/March 2018

Dietary Diversity Score (DDS)	Post-harvest season		Lean season		Change in DDS between the two seasons			
					Phalombe District		Lilongwe District	
	Phalombe District	Lilongwe District	Phalombe District	Lilongwe District	% change	Absolute change	% change	Absolute change
Individual DDS (9 food groups)	3.22	3.13	2.68	2.27*	16.8%	0.54	27.4%	0.86
Household DDS (12 food groups)	4.92	3.82*	4.09	3.41*	16.8%	0.83	10.9%	0.42

Note: Superscripts *, **, *** represents statistically significant differences between Phalombe and Lilongwe at 1%, 5% and 10% levels, respectively.

41 **Fig. 1** Conceptual framework linking agricultural interventions, food acquisition, nutrition and health

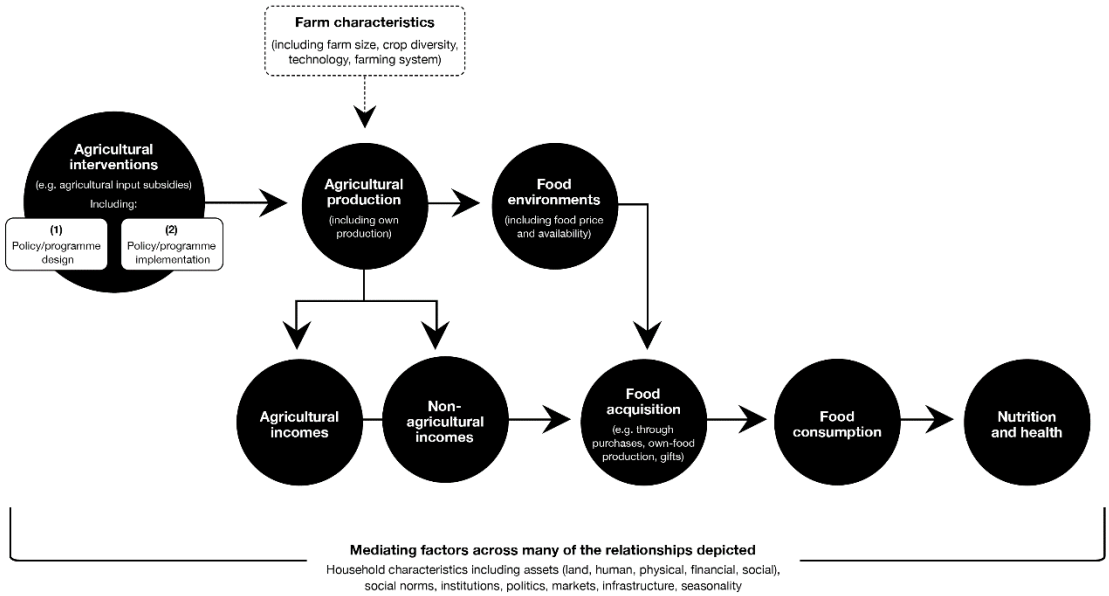

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Fig. 2a An example of the choice tasks presented to respondents – *high* maize price scenario

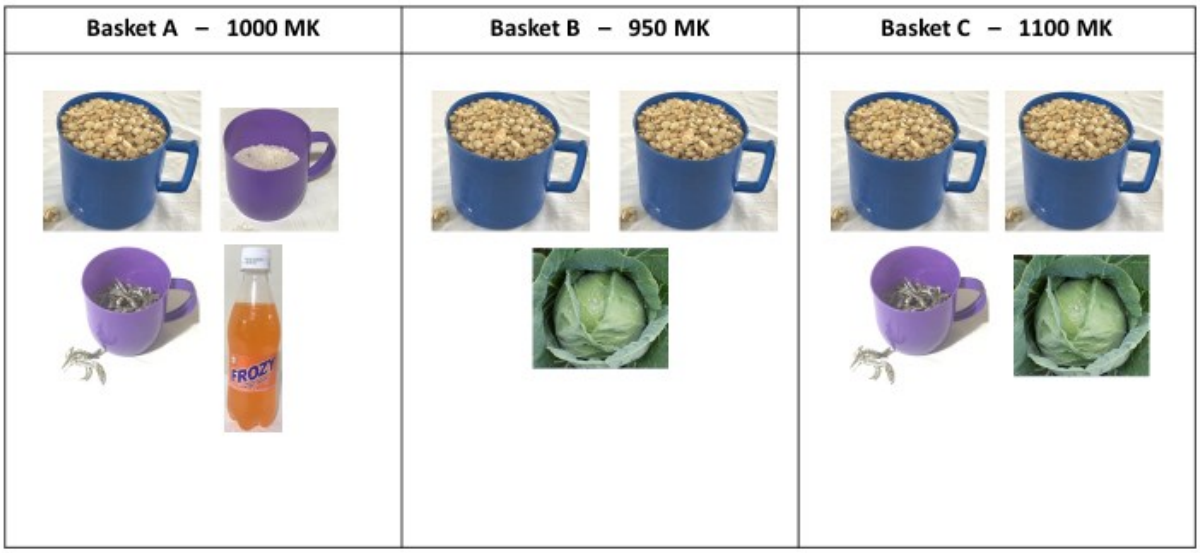


Fig. 2b An example of the choice tasks presented to respondents – *low* maize price scenario

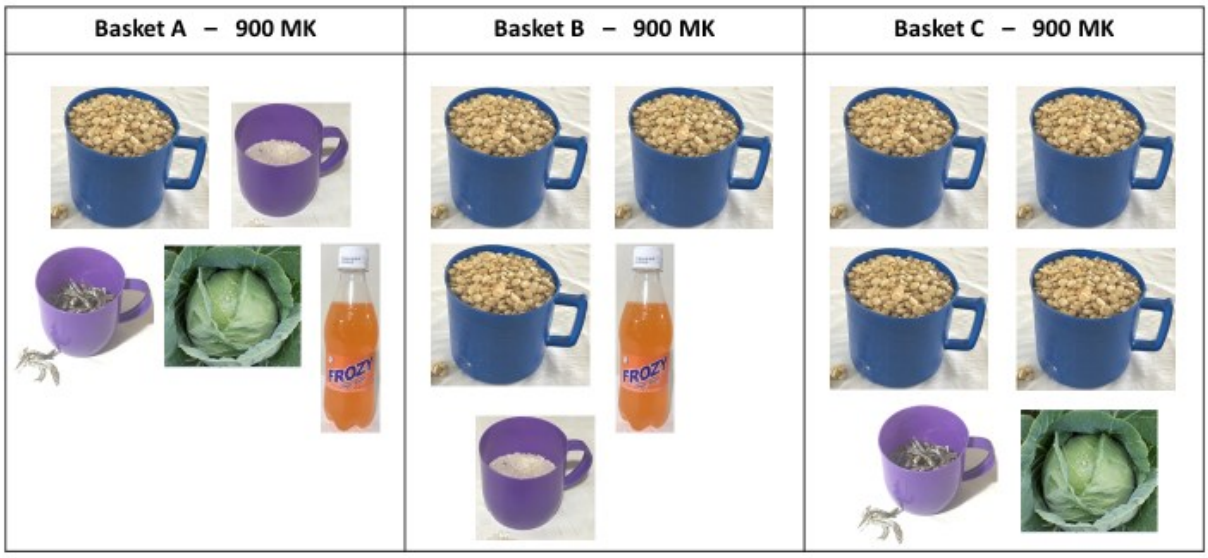


Figure 3 Change in demand for maize and non-maize products (cabbage, rice, small dried fish, soda) with increasing price of maize, compared with a maize price of 150 MK/kg

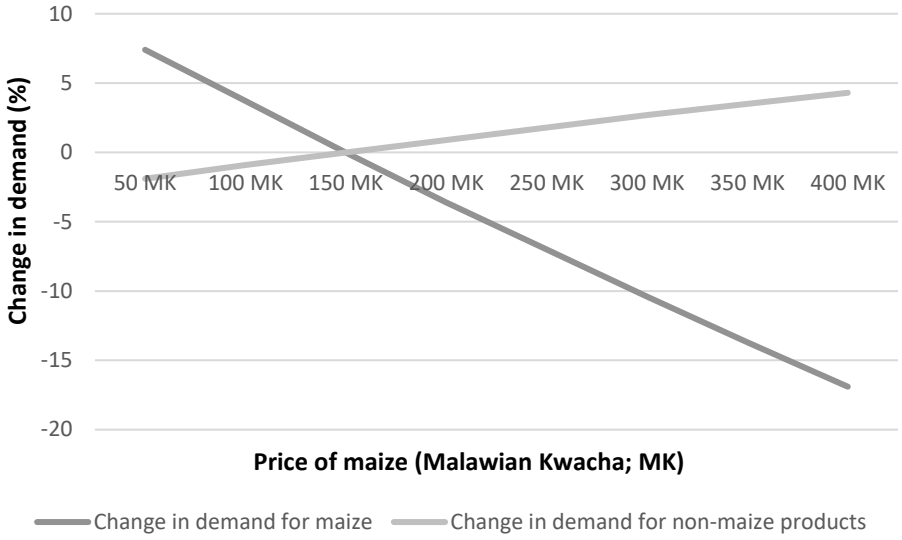
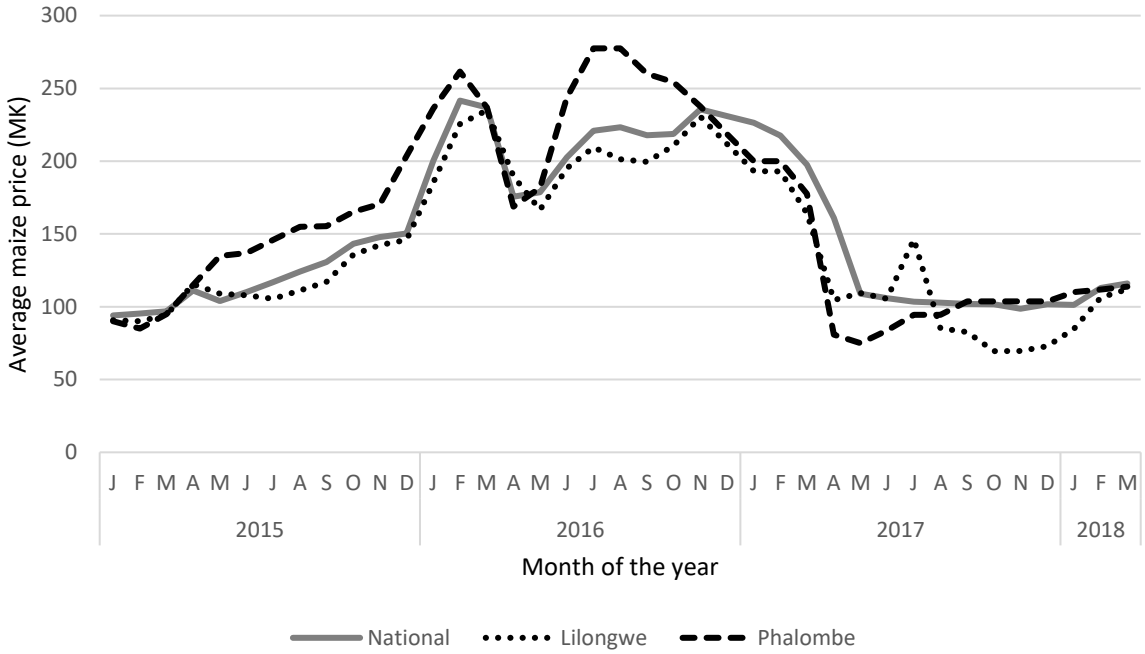


Figure 4 Average maize prices in Malawi nationally, and in Lilongwe and Phalombe Districts, 2015-18



Notes: The months of the year are indicted by the first letter of each month.

Source: Ministry of Agriculture, Irrigation and Water Development, from market surveys in study districts

Biographies

Helen Walls is Associate Professor of Global Health and Food Systems at the London School of Hygiene and Tropical Medicine. She is a public health researcher who uses mixed methods approaches to understand the structural determinants of population health, with a research focus on food systems and nutrition. Helen undertook a PhD at Monash University in Australia and has worked in public health in New Zealand regionally and with the Ministry of Health, and with the World Health Organization.

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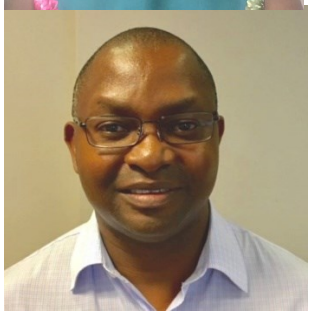

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Richard Smith is Deputy Pro-Vice Chancellor at the University of Exeter Medical School and Professor of Health Economics. He was previously at the London School of Hygiene and Tropical Medicine, where he served as Head of the Department of Global Health & Development, and as Dean of the Faculty of Public Health & Policy. His research interests include work on nutrition and non-communicable disease.