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Does household participation in food markets increase dietary diversity? Evidence from rural Malawi

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ABSTRACT

Food markets have been found to be, in many settings, important in shaping diets and nutritional outcomes. However, more evidence and improved metrics are needed to understand these relationships. We examined relationships between food market participation and household dietary diversity in populations of rural Malawi facing hunger and poor nutrition. We analysed, using Poisson regression, survey data from 400 households in two districts of rural Malawi in post-harvest and lean seasons of 2017/18. We also developed a new metric of food purchases to support our examination of food market participation. The findings include clear associations between food purchase diversity and household dietary diversity, and suggest households engaging more with food markets are more likely to have diversified diets and better nutrition.

1. Introduction

Achieving food and nutrition security is a pressing global health issue for many countries, with implications for social and economic development. The urgency to address this challenge is reflected globally by Sustainable Development Goal (SDG) 2, which is to end hunger, achieve food and nutrition security, improve nutrition, and promote sustainable agriculture (United Nations General Assembly, 2015). Important for undernourished populations is improving nutrition by increasing consumption of a diversity of nutrient-dense non-staple foods, in addition to addressing hunger through increasing calories consumed. A more diversified diet is associated with several improved outcomes, for instance in regard to birth weight and child anthropometric status. The household dietary diversity score (HDDS) is widely used as a proxy indicator of dietary diversity and nutritional quality, as per guidance from the Food and Agriculture Organization (FAO) (Swindale and Bilinsky 2006; Kennedy et al., 2011).

People's food choices, and diets, are largely shaped by their food environments, defined as the link or interface that mediates people's food acquisition and consumption within the wider food system that includes agricultural production (Turner et al., 2018). Food environments comprise "the foods available to people in their surroundings as they go about their everyday lives, and the nutritional quality, safety, price, convenience, labelling and promotion of these foods" (Food and Agriculture Organisation of the United Nations 2016; Global Panel on Agriculture and Food Systems for Nutrition 2016). Accordingly, the role of food environments in shaping diets is gaining increasing policy attention.

In Malawi, problems with food- and nutrition-related health are clear. In 2017, approximately 61% of households – 66% in rural areas – were considered to have very low food security, defined as low quality, variety, quantity, and frequency of food consumption. This is an increase from reported 34% in rural areas in 2012 (NSO (National Statistical Office) 2017). In 2015–16, approximately 37% of children aged under five years were stunted or chronically malnourished, 3% wasted and 12% underweight. Only 25% of children aged 6–23 months old had minimum dietary diversity (NSO; ICF 2017). Maize dominates diets in Malawi, comprising over 50% of household calorie intake (Minot 2010). Although farming households in Malawi often produce a variety of foods or food crops (Kankwamba et al., 2018), maize is grown by nearly 90%

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of households with access to cultivatable land. As noted in Malawi, 'maize is life' (Smale 1995) or 'maize is life, but rice is money' (Tiba 2010). Agricultural production in Malawi is strongly shaped by its reliance on a single rainy season for household farming activities, and by the country's agricultural policies, as part of the strategy for achieving food security and raising incomes of rural households. Malawi's single rainy season strongly shapes agricultural production, food security, and diets (Ellis and Manda 2012). It results in high seasonal variability of food prices, with maize prices peaking in the lean season between January and March and falling to their lowest in the post-harvest season from April to August (Minot 2010; Chirwa et al., 2012; Ellis and Manda 2012; Gelli et al., 2017).

Since Malawi's independence in 1964, its strategy for achieving household food security has largely involved fertilizer and improved seed subsidies to smallholder farmers, with these subsidies focused on maize (Smale 1995). Following the 2004/05 food crisis, the government introduced in 2005/06 the Farm Input Subsidy Programme (FISP). The FISP initially provided subsidies on improved maize seeds and fertilizers, but in 2008/09 introduced legume seeds (Chirwa and Dorward 2013; Logistics Unit 2018) – to improve soil health through nitrogen fixing, as well as improving nutrition through dietary diversification based on own-farm production. Thus, the FISP was often considered to promote nutrition-sensitive agriculture through subsidising both maize and legume seeds. The FISP remained a major intervention in smallholder agriculture in Malawi (Chirwa and Dorward 2013) until 2020, when it was replaced by the Affordable Inputs Programme (AIP) which also has a focus (although not solely) on subsidies for maize seed and fertiliser.

As found in other low- and middle-income countries (LMICs), production for own consumption in Malawi appears less diverse than the crops grown by farming households, suggesting that own-farm production at household level may be a weak driver of dietary diversity (Sibhatu et al., 2015; Koppmair et al., 2017; Kankwamba et al., 2018). However, subject to income and other constraints, farming households have the opportunity to engage with an important aspect of local food environments which also influence dietary diversity: food markets.

Most households in rural Malawi do not produce enough food to last them from one season to the next and therefore rely on markets to access food (NSO (National Statistical Office) 2012; NSO (National Statistical Office) 2017). National surveys also show that nearly three-quarters of households do not have enough food throughout the year (NSO (National Statistical Office) 2017). Even though households produce insufficient food for own consumption, they still sell during post-harvest periods and engage with markets to buy food products during the lean season, referred to as 'distress selling' (Jayne et al., 2010; Carletto et al., 2017). The variability in maize availability in markets and seasonality in market prices have implications for food choices, consumption, and dietary diversity. This is the case not only in the lean season or at times when households are without enough maize, but also in the post-harvest season, when most rural households have improved liquidity owing to cash realized from crop sales (Jayne et al., 2010; Carletto et al., 2017).

In a review of studies of dietary diversity that included a measure of market access and production diversity, five of six studies found a statistically significant positive relationship between market access and dietary diversity in at least some models (Jones 2017). This generally positive relationship has led some to propose that development funding would be better spent improving market access for rural households rather than promoting diverse agricultural production (Koppmair et al., 2017; Ickowitz et al., 2019). Yet, these studies used different measures, complicating comparison, and metrics used to assess food market access are still crude.

In Malawi, a study by Jones et al. (2014) found a positive and significant relationship between farm production diversity and dietary diversity (Jones et al., 2014). Another study by Koppmair et al. (2017) found small but significant positive effects of farm production diversity on dietary diversity, whilst market participation was found to be a much more important determinant of household and individual dietary diversity (Koppmair et al., 2017). These studies in Malawi examined market participation in terms of existence of local markets and distance to the district market, rather than using evidence of actual market purchases.

Overall, these studies show a positive relationship between various proxies for market participation and dietary diversity, either through agricultural output sales or through food purchases. Comparing own food production with purchases, they show stronger income effects on dietary diversity, with incomes enabling households to have a wider choice, subject to availability, in food varieties. Nonetheless, this and other scholarship on the role of markets in shaping food acquisition, agricultural strategies and diets suggests there is a need for more evidence and improved methods of data collection and analysis to understand the relationship between market participation, food choices and dietary diversity in different contexts (Sibhatu et al., 2015; Koppmair et al., 2017; Kissoly et al., 2018; Zanello et al., 2019).

Figure 1 presents a conceptual framework of the relationships between agricultural interventions, market participation, food consumption, dietary diversity and nutrition and health outcomes. Agricultural interventions such as farm input subsidies and extension services of good agricultural practices can lead to increased agricultural production, which in turn can lead to increases in food production and incomes. This, however, depends on households' capabilities in terms of household assets and capital, and farming characteristics and technologies. Household assets and capital also enable households to engage in non-agricultural income-generating activities. We expect own-farm crop production and diversification to increase dietary diversity, and hence nutritional status of household members. Similarly, both agricultural incomes and non-agricultural incomes (including remittances) provide purchasing power for households to have options regarding food and non-food purchases. The income enables households to purchase a greater variety of foods in the market, which can lead to changes in food choices, dietary diversity and better nutrition and health outcomes. But these relationships are mediated by various factors including household characteristics, cultural and environmental factors, institutional and political economy factors, nutritional knowledge, infrastructure, market structure and seasonality.

This study was part of a larger work programme investigating agricultural policy, food choice and dietary diversity in rural Malawi, as described elsewhere in forthcoming work (Drivers of Food Choice, 2021). In this study, we examine the relationship between engagement with food markets, or what we term 'food market participation' and dietary diversity in rural Malawi, accounting for covariates such as farm input subsidies and seasonality. We also make a methodological contribution to the literature in terms of measuring market participation through food purchases diversity, using the same food groups to collect data on diversity of household food purchases as well as household dietary diversity. This enabled us to calculate a 'food purchases diversity score' (FPDS), in a similar way to the household dietary diversity score (HDDS) (Swindale and Bilinsky 2006; Kennedy et al., 2011). Only a few studies have examined the relationships between food market participation and dietary diversity (Sibhatu et al., 2015; Koppmair et al., 2017; Kissoly et al., 2018; Zanello et al., 2019), impacts of seasonality (Sibhatu and Qaim 2018) and relationships between agricultural interventions and dietary diversity (Rajendranet al., 2017, Walls et al., 2018). Thus, this research makes an important contribution to the study of population nutrition, using transferrable methods which could help illuminate the impact of food market participation on household diets in various settings.

2. Methods

2.1. Study areas and sample design

The study uses household survey data collected from 400 rural

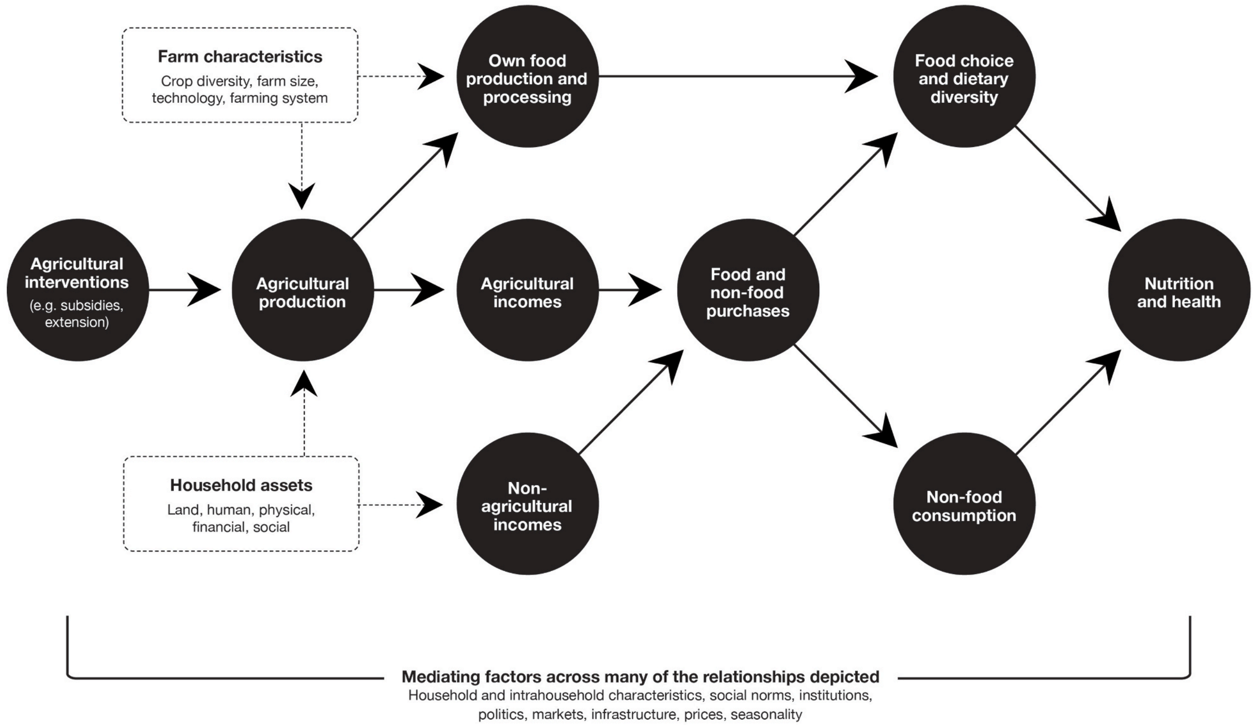

Figure 1. Conceptual framework linking agriculture, food purchases and dietary diversity.
Source: Adapted from Bellon et al. (2016) and Kumar et al. (2015).

households in two districts of rural Malawi in the post-harvest (May 2017) and lean season (Food and Agriculture Organisation of the United Nations, 2016). These seasons typically represent periods of relatively low prices of maize and high prices of maize, respectively. The data come from four rural enumeration areas (an enumeration area being the geographic area canvassed by one census representative, consisting of approximately 300 households) in one traditional authority in each of Lilongwe and Phalombe Districts (Malawi is divided into 28 districts and into approximately 250 traditional authorities). Lilongwe District is characterised by a farming system dominated by maize cultivation whilst Phalombe District has a more mixed farming system. The traditional authorities were randomly sampled from a list of traditional authorities included in FISP evaluation studies (Chirwa and Dorward 2013) and four enumeration areas included in FISP evaluation were selected for study. In each selected enumeration area, we randomly selected 50 households using a random-walk system. Fieldworkers were assigned a starting location central to the enumeration area, and each fieldworker was instructed to walk in a different direction from this central location, interviewing 'the person who makes the decisions about food preparation for the household' at every *fifth* household encountered – with this sampling interval determined based on estimated population and required sampling within each area.

The second round of data collection (Food and Agriculture Organisation of the United Nations, 2016) followed the same households as for the first round (May 2017), with replacements from their nearest neighbour for households not located. The second-round survey successfully tracked 92.7% of respondents interviewed in the first round (93.5% in Lilongwe and 92.0% in Phalombe) representing 7% attrition which compares well with follow-up from similar surveys. There were no significant differences in household characteristics between those that participated in one and both rounds of the survey except for the age of household head. The replacement household heads were significantly younger (at the 5 percent level of significance); aged on average 39 years compared to 44 years.

The household survey included questions about: demographic and household characteristics, including participation in the FISP, and household assets based on the Demographic and Health Surveys (USAID); agricultural activities undertaken; food and non-food purchases (over the past seven and 30 days) based on surveys conducted by the International Household Survey Network (International Household Survey Network 2014); food obtained from non-purchased sources; and a dietary assessment.

With household characteristics, we asked about gender of household head, age of household head, education of adult respondent (person mainly responsible for preparing food in the household), household size and assets. Since the FISP has been implemented for many years, we asked households whether they had ever participated in it and whether they had benefited from the FISP in the study reference season (2016/17 or 2017/18 seasons). Information on ownership of 15 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, motor-cycle, animal drawn cart, car and boat with motor.

With agricultural activities undertaken, we obtained information about households growing own maize, legumes (beans, groundnuts, other legumes).

With household dietary diversity, we included all food groups consumed by household members in the home or prepared in the home for consumption by household members outside the home over a 24-hour period. Foods consumed outside the home that were not prepared in the home are not included.

With food purchases, we asked about different foods purchased by the household over the last 7 days and 30 days. Both time periods were included, so as to identify foods purchased regularly and in a time period more comparable to that for dietary diversity, as well as less regularly and for comparison with the shorter time period given the novelty of this measure. A shorter 24-hour period, as for dietary diversity, would not have been appropriate for identifying food purchases.

2.2. Analytical approach

Our analytical approach follows that of existing studies

(Thorne-Lyman et al., 2010; Rashid and Smith 2011; Jones et al., 2014; Sibhatu et al., 2015; Koppmair et al., 2017) that have linked dietary diversity scores to own-farm production, participation in food markets, and household and farm characteristics. Using our unbalanced panel data (given some households were not surveyed in each period, as described above) and Poisson regression, we estimated the following relationship:

$$HDD_{it} = \alpha_1 + \beta_1 FPD_{it} + \beta_2 S_{it} + \beta_3 FISP_{it} + \sum_{j=4}^{k} \beta_j H_{jit} + \sum_{j=1}^{k} \gamma_j FP_{jit} + \varepsilon_{it} \quad (1)$$

where for household i at time period t, *HDD* is household dietary diversity, *FPD* is the measure for food purchases diversity, *S* captures seasonality, *FISP* is a variable capturing participation in the farm input subsidy programme, *H* is a vector of household and demographic characteristics, *FP* is a vector of farming characteristics and ε_{it} is the random error term.

We measured our dependent variable, household dietary diversity (*HDD*) using the household dietary diversity score (HDDS), prescribed for use by FAO and validated as a proxy of nutrition quality (Swindale and Bilinsky 2006; Jones et al., 2014), as the count of number of food groups consumed by any member of the household using 24-hour recall. Thus, the HDDS reflects HDD, on average, among all household members. The twelve food groups that are used to calculate HDDS 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. We used HDDS aggregated categories rather than the individual dietary diversity score, as the HDDS better matches food consumption with our food purchases data.

Our model has three key independent variables of interest. First, our methodological contribution is the food purchases diversity score (*FPDS*), for which we constructed a food purchases diversity score as the count of number of food groups purchased by the household in the past 7 and 30 days. As with the HDDS, this measure does not reflect the quantity purchased, the diversity within a food category or the level of processing of foods purchased by households. With attaining the information on food purchases for the FPD, we also did not distinguish between purchases for home consumption, resale, or a combination of the two. However, in contrast to other studies on the relationship between market participation and dietary diversity, FPDS measure captures incidence of purchases using the same food groups as for measurement of food consumption. Second, we investigate the effects of seasonality, *S*, on dietary diversity, using a dummy variable equal to 1 for data collected in the lean season and equal to zero for data collected during the post-harvest season. Third, the role of the FISP is captured by inclusion of a dummy variable, *FISP*, which is equal to 1 if a household participated in the program. The dummy capturing 'ever' participation in FISP is intended to capture the long-term effects of FISP for households that were not beneficiaries in the agricultural seasons covered in the study. Our model therefore includes participation in the FISP in two ways: having ever been a beneficiary and being a beneficiary in the 2016/17 or 2017/18 seasons.

There are two sets of covariates. First, we control for household characteristics, including gender of household head, age of household head, education of adult respondent (person mainly responsible for preparing food in the household), household size and assets. We constructed the asset index using weights generated from the principal-component method. Ownership of 15 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, motor-cycle, animal drawn cart, car and boat with motor. None of the respondents owned a television and thus we dropped it when computing the asset index. The first component loadings were used as weights for the asset index in both first and second round data. Second, we include variables representing farming characteristics such as dummies for households growing own maize, legumes (beans, groundnuts, other legumes).

The data were analysed using STATA version 14.

3. Results

3.1. Descriptive statistics

Table 1 presents household characteristics and other descriptive statistics of variables used in the regression analysis. The average HDDS over the two seasons was 4.1 with a standard deviation of 1.5, implying consumption of four food groups out of twelve possible groups. The dietary diversity score was lower in the lean season than in the post-harvest season and the difference was statistically significant ($p = 0.01$). There was slightly higher diversity in purchased food groups than in consumed food groups as measured by the HDDS, with an average of 5.5 food groups over the two seasons, but there were no statistically significant seasonal differences although purchases are slightly higher in the lean season.

The farm input subsidy in the 2016/17 agricultural seasons was received by an average of 39% of the study sample. Since the programme started (in the 2005/06 agricultural season), at least 72% of the study sample had ever participated in the programme. However, there was a reduction in the proportion of households ever receiving the subsidy between the post-harvest season (2016/17 agricultural season) and the lean season (2017/18 agricultural season), with the difference being statistically significant ($p = 0.05$). The reduction in the ever participated in the 2017/18 season may be due to the higher number of replacement households in the second round that had ever been beneficiaries of the programme, replaced by non-beneficiaries. The average age of household heads was 43 years. Household heads were predominantly male; 34% of household heads were female in May 2017 and this increased to 40% in February 2018, with differences statistically significant ($p = 0.10$). The average household size was 4.7 members and most respondents (~70%) had ever attended school. The asset index showed no significant differences between the two periods.

The dominant crop cultivated was maize, either local variety or improved varieties. On average, over the two agricultural seasons covered by the study, 51% and 61% of households cultivated local maize and hybrid maize, respectively. Combining local and improved maize varieties, 97% households over the two seasons cultivated maize. With respect to pulses, 76% of households cultivated at least one type of pulse over the two agricultural seasons. Groundnuts and beans were cultivated by 29% each while other pulses were cultivated by 62% of households. Cultivation of groundnuts increased significantly ($p = 0.10$) to 32% in 2017/18 agricultural season from 27% in 2016/17 agricultural season. Cultivation of other pulses, however, fell significantly ($p = 0.10$) from 67% in the 2016/17 agricultural season to 57% in the 2017/18 agricultural seasons.

Figure 2a and b presents the proportion of households in Phalombe and Lilongwe that purchased and consumed foods in different food groups in the high price (lean) and low price (post-harvest) season. As shown in Figure 2a, in the post-harvest season, more than half of households purchased food in the following food categories: oils and fats (63%), fish and other seafood (61%), spices, condiments and beverages (60%), and vegetables (59%). The fewest market purchases were in milk and milk products (4%), sweets (16%), eggs (21%) and fruits (22%). In the lean season, there was a slight decrease in the purchase of oils and fats, and fish and other seafoods. However, there was a marked increase in purchase of spices, condiments, beverages, and cereals. Cereals purchases doubled, from 27% in the post-harvest season to 54% of households purchasing them in the lean season.

As shown in Figure 2b, cereals, vegetables, and spices, condiments and beverages were consumed by more than half of households in both seasons. As mirrored in purchase data, the prevalence of consuming spices, condiments and beverages increased markedly between post-

Table 1
Descriptive statistics of model variables.

Variable	All (n = 800)		Post-harvest season (n = 400)		Lean season (n = 400)		t-statistic
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Household dietary diversity score	4.06	1.55	4.37	1.80	3.75	1.18	5.7548***
FPDS (over past 30 days)	5.51	2.42	5.41	2.48	5.61	2.36	−1.199
FPDS (over past 7 days)	4.29	2.43	4.31	2.36	4.27	2.50	0.189
FISP beneficiary in 2016 or 2017 (0/1)	0.39	0.49	0.38	0.49	0.39	0.49	−0.3626
FISP beneficiary ever (0/1)	0.72	0.45	0.75	0.43	0.68	0.47	2.0391**
Age of household head (years)	43.3	16.81	42.86	16.72	43.73	16.9	−0.7319
Female headed household (0/1)	0.37	0.48	0.34	0.47	0.40	0.50	1.8346*
Household size	4.67	1.90	4.60	1.87	4.74	1.93	−1.0233
Respondent ever attended school (0/1)	0.70	0.46	0.69	0.46	0.71	0.45	−0.6187
Household asset index	0.23	0.32	0.24	0.32	0.23	0.33	0.6577
Cultivated local maize (0/1)	0.56	0.50	0.56	0.50	0.57	0.50	−0.3562
Cultivated hybrid maize (0/1)	0.61	0.49	0.64	0.48	0.59	0.49	1.3797
Cultivated groundnuts (0/1)	0.29	0.46	0.27	0.44	0.32	0.47	−1.7098*
Cultivated beans (0/1)	0.29	0.45	0.28	0.45	0.30	0.46	−0.5461
Cultivated other pulses (0/1)	0.62	0.43	0.67	0.47	0.57	0.50	2.9136***
Cultivated at least a legume (0/1)	0.76	0.43	0.76	0.43	0.77	0.42	−0.4985
Lilongwe district (0/1)	0.50	0.50	0.50	0.50	0.50	0.50	–

Notes: FPDS = Food Purchases Diversity Score. The t-statistic relates to the difference between post-harvest and lean seasons. *** Statistically significant at 1% level; ** statistically significant at 5% level; * statistically significant at 10% level. (0/1) indicates dichotomous variable equal to 1 for the included category, otherwise equal to 0 for the base category.

harvest and lean seasons. The consumption of cereals and vegetables remained largely unchanged, between the two periods, nevertheless the prevalence of consuming other food categories fell, indicating a reduction in dietary diversity.

Figure 3 shows the relationship between household dietary diversity and food purchases diversity over the past 7 days. The data show a positive relationship, with households that did not purchase any food having an average dietary diversity of less than three, while those that purchased food in 12 groups having an average dietary diversity of more than six. The pattern of association suggests a positive relationship between incidence of food purchases over the past 7 days and household dietary diversity with significant pairwise correlation statistic of 0.4114 at 1 percent level.

3.1.1. *Determinants of household dietary diversity*

Table 2 presents unbalanced panel Poisson regression results of the HDDS on FPDS and other independent variables, in two models of different specification of capturing FISP participation and cultivation of legumes. We also tested validity of random effects versus fixed effects models and using the Hausman tests our preferred model is the fixed effects in all specifications. Overall, in all the models, F-statistics show that we reject the hypotheses that all the parameter estimates are equal to zero ($p = 0.01$). We have presented results for food groups purchased in the past seven days, which seemed an appropriate timeframe for consideration of food purchases but is different to the 24-hour period for which dietary diversity was assessed. We did also question respondents about food group purchase over a 30-day period and obtained similar results [Tables 4 and 5 in the Supplementary Materials]. There was a strong and statistically significant positive relationship ($p < 0.01$) between household dietary diversity and food purchases diversity in all models (except Model 2 in Table 2), suggesting positive effects of food market participation on dietary diversity, and between household dietary diversity and seasonality. Seasonality was also an important factor affecting dietary diversity and we find a statistically significant ($p < 0.01$) negative relationship between lean season and dietary diversity. This relationship holds regardless of the specification. Hence, other things being equal in the lean season, household dietary diversity was expected to be 0.16 times lower than in the post-harvest season.

Further, we find in Table 3 showing Poisson regression results by season that whilst seasonality was important in explaining dietary diversity, the margin of food purchases effect is more pronounced during the harvest season compared to lean season. Cultivation of local maize as well as at least a legume crop or other pulses is only significant in the harvest period in influencing dietary diversity possibly reflecting potential stock-outs from own food production experienced in lean periods.

4. Discussion

Overall, using a novel, more rigorous approach than previous studies, one that measures actual food purchased and diversity in this rather than other less direct proxies of food market participation, we found a clear association between food market participation and household dietary diversity in rural Malawi. Our findings suggest households in rural Malawi that engage more with food markets are more likely to have more diversified diets. We also found that dietary diversity was lower in the lean season in which most households experience food shortages from own production and reduced household income, whilst also facing higher prices of the staple maize – findings corroborated by others (Ndekhaet al., 2000; Gilbert et al., 2017), and in our forthcoming work (Drivers of Food Choice, 2021).

However, we did not find evidence of associations between cultivation of legumes or participation in the FISP with dietary diversity. This finding regarding the cultivation of legumes is at odds with some studies which have reported that farm production diversity in Malawi is associated with dietary diversity (Jones et al., 2014; Sibhatu et al., 2015; Koppmair et al., 2017; Sibhatu and Qaim 2018). However cultivation of legumes is but one measure of farm production diversity, and the estimated effects of farm production diversity on dietary diversity have in some studies been found to be small and context-specific (Sibhatu et al., 2015; Koppmair et al., 2017; Sibhatu and Qaim 2018). In keeping with our study, for example, Koppmair et al. (2017) found that access to food markets was more important for dietary diversity than diverse farm production (Koppmair et al., 2017). Although the FISP has been implemented to promote nutrition-sensitive agriculture by providing legume seeds in addition to improved maize seed and fertiliser, this does not appear to have particularly affected food choices and dietary diversity in any significant way. A full discussion of the reasons for this are outside of the scope of this paper, and we discuss our mixed-methods evidence on this in forthcoming work (Drivers of Food Choice, 2021).

Across the two seasons, we found that average household dietary diversity was four out of a possible twelve food groups. This is low by

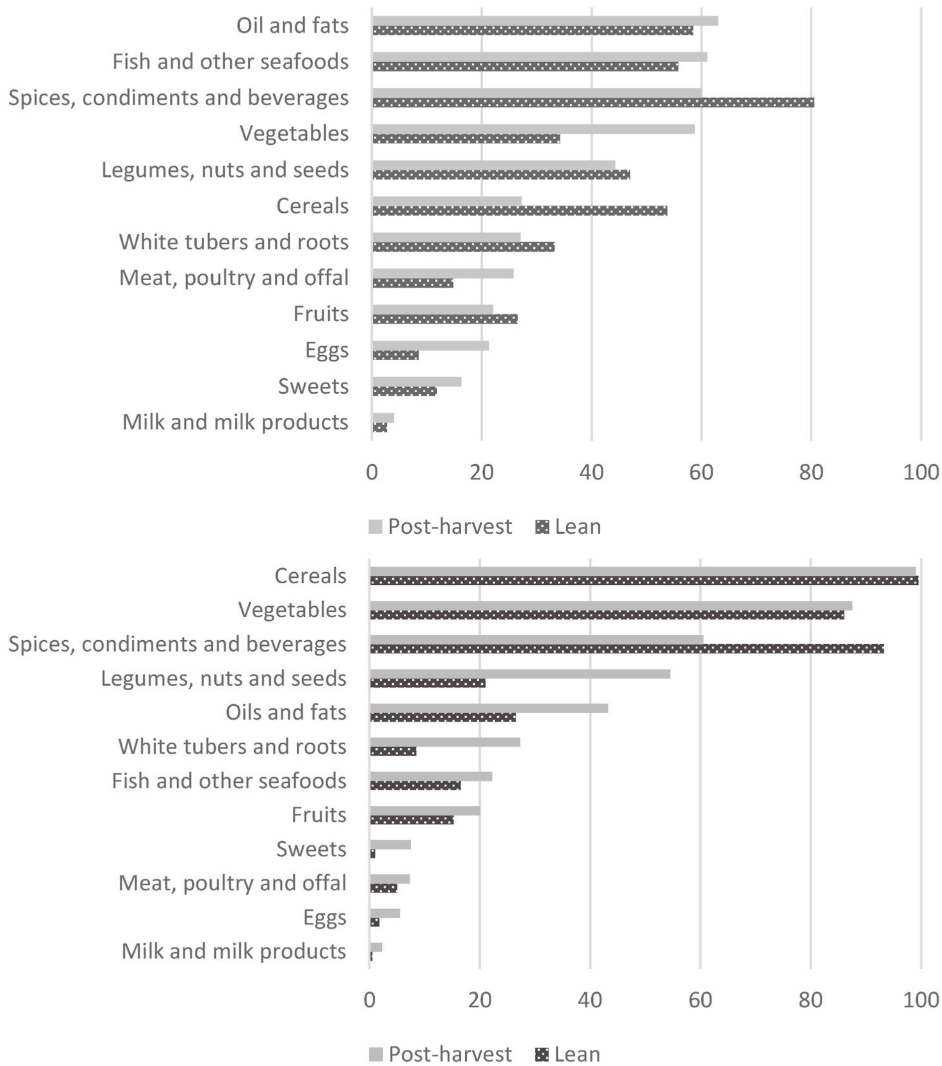

Figure 2. Comparison of food groups purchased over past 7 days and food groups consumed over past 24 h, by season (%).
A: Food purchased by households over past 7 days, by season (%).
b. Foods consumed by households over past 24 h, by season (%).

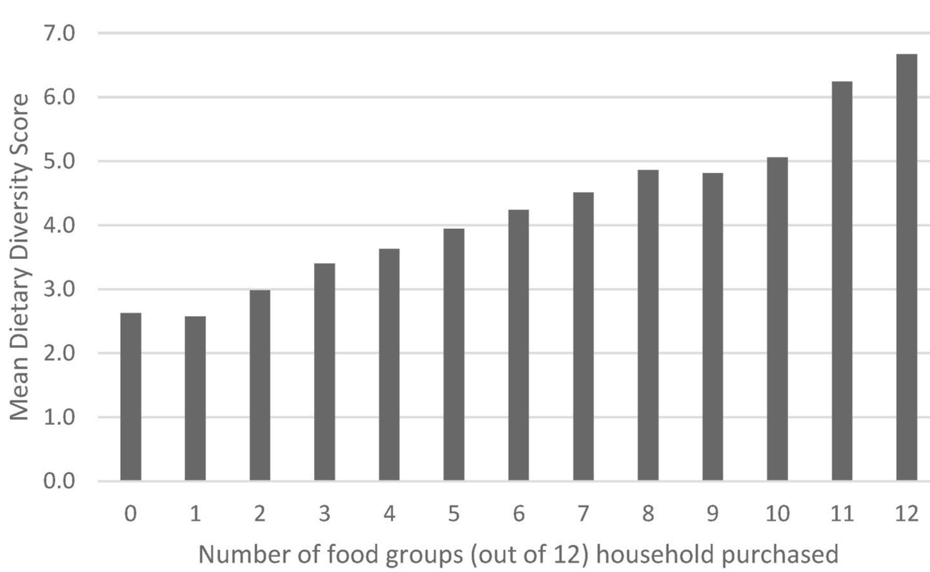

Figure 3. Household dietary diversity by number of food categories purchased (%).

Table 2
Panel Poisson regression results of factors associated with household dietary diversity.

	Model 1			Model 2		
	Coef.	SE	IRR	Coef.	SE	IRR
Food purchases diversity score (past 7 days)	0.019*	(0.012)	1.020	0.018	(0.012)	1.019
Lean season (0/1)	−0.156***	(0.038)	0.856	−0.149***	(0.037)	0.861
FISP beneficiary in 2016/17 (0/1)	−0.015	(0.052)	0.985	−0.012	(0.052)	0.988
Age of household head (years)	−0.001	(0.002)	0.999	−0.001	(0.002)	0.999
Female headed household (0/1)	−0.085	(0.063)	0.918	−0.077	(0.063)	0.926
Household size	−0.008	(0.017)	0.992	−0.005	(0.017)	0.995
Respondent ever attended school (0/1)	0.099	(0.069)	1.104	0.093	(0.069)	1.098
Household asset index	0.091	(0.073)	1.095	0.096	(0.073)	1.100
Cultivated local maize (0/1)	0.003	(0.063)	1.003	–	–	–
Cultivated hybrid maize (0/1)	0.021	(0.068)	1.021	–	–	–
Cultivated groundnuts (0/1)	0.094	(0.063)	1.099	–	–	–
Cultivated beans (0/1)	0.039	(0.072)	1.040	–	–	–
Cultivated other pulses (0/1)	−0.038	(0.073)	0.963	–	–	–
Cultivated any maize (0/1)	–	–	–	0.098	(0.168)	1.102
Cultivated at least a legume (0/1)	–	–	–	0.068	(0.080)	1.070
Wald Chi2	33.856			31.872		
Prob > Chi2	0.001			0.000		
N	754			754		

Notes: The table presents results of the fixed effects Poisson regression, using panel data, of factors associated with household dietary diversity (the dependent variable). We use food purchases over the period - past 7 days. Model 1 and 2 includes receipt of FISP coupons in the period of study, i.e. 2016/17 farming season. Details about specific legume crops cultivated are included in Model 1 while in Model 2 we aggregate the variable to represent cultivation of any legume and maize. (0/1) indicates dichotomous variable equal to 1 for the included category, otherwise equal to 0 for the base category. IRR is incidence rate ratio. Standard errors (SE) are indicated in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. Similar models were conducted with alternative definition of FISP – i.e. 'ever' participation in the past years since it started in the 2005/6 agricultural season and the variable was also not significant.

Table 3
Poisson regression results explaining factors influencing dietary diversity by period of data collection.

	Lean Season				Post-harvest Season			
	Model 1		Model 2		Model 1		Model 2	
	Coef.	IRR	Coef.	IRR	Coef.	IRR	Coef.	IRR
Food purchases diversity score (past 7 days)	0.040*** (0.012)	1.040	0.040*** (0.011)	1.041	0.051*** (0.011)	1.052	0.049*** (0.011)	1.050
FISP beneficiary in 2016/17 (0/1)	0.008 (0.054)	1.008	0.020 (0.053)	1.020	−0.025 (0.050)	0.975	−0.016 (0.050)	0.984
Age of household head (years)	−0.002 (0.002)	0.998	−0.002 (0.002)	0.998	−0.001 (0.002)	0.999	−0.001 (0.002)	0.999
Female headed household (0/1)	−0.021 (0.059)	0.979	−0.027 (0.059)	0.973	0.005 (0.056)	1.005	0.007 (0.056)	1.007
Household size	−0.015 (0.014)	0.985	−0.012 (0.014)	0.988	0.010 (0.014)	1.011	0.010 (0.014)	1.010
Respondent ever attended school (0/1)	0.021 (0.065)	1.022	0.022 (0.065)	1.023	0.063 (0.061)	1.065	0.063 (0.061)	1.065
Household asset index	0.188** (0.078)	1.207	0.184** (0.077)	1.202	0.231*** (0.076)	1.259	0.246*** (0.074)	1.279
Cultivated local maize (0/1)	−0.024 (0.070)	0.977	–	–	0.121** (0.059)	1.128	–	–
Cultivated hybrid maize (0/1)	0.028 (0.071)	1.028	–	–	0.101 (0.063)	1.107	–	–
Cultivated groundnuts (0/1)	0.027 (0.058)	1.028	–	–	0.080 (0.056)	1.083	–	–
Cultivated beans (0/1)	0.082 (0.059)	1.086	–	–	0.081 (0.055)	1.084	–	–
Cultivated other pulses (0/1)	0.067 (0.057)	1.070	–	–	0.122** (0.057)	1.130	–	–
Cultivated any maize (0/1)	–	–	−0.006 (0.176)	0.994	–	–	0.209 (0.177)	1.232
Cultivated at least a legume (0/1)	–	–	0.123* (0.071)	1.131	–	–	0.223*** (0.066)	1.250
constant	1.168*** (0.143)	3.217	1.127*** (0.213)	3.086	0.871*** (0.135)	2.389	0.757*** (0.193)	2.132
Wald Chi2	45.440		43.493		92.639		88.648	
Prob > Chi2	0.000		0.000		0.000		0.000	
N	400		400		400		400	

Notes: The table presents results of the Poisson regression of factors associated with household dietary diversity (dependent variable) disaggregated by period of data collection. We use food purchases over the period - past 7 days. Models includes receipt of FISP Coupon in period of study i.e. 2016/17 farming season. Details about specific legume crops cultivated are included in Model 1 while in Model 2 we aggregate the variable to represent cultivation of any legume and maize. (0/1) indicates dichotomous variable equal to 1 for the included category, otherwise equal to 0 for the base category. IRR is incidence rate ratio. Standard errors (SE) are indicated in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

global comparison. For example, studies have reported average dietary diversity scores of 5 or above in contexts as varied as Cambodia, Ethiopia, Nigeria and Sri Lanka (Ajani 2010; Jayawardena et al., 2013; McDonald et al., 2015; Workicho et al., 2016), and between 7 and 10 in communities of Colombia and Ecuador (Vellemaet al., 2016). It is almost half of the average of 8.4 reported from a national sample in Malawi (Jones et al., 2014), but similar to an average of 4.2 reported in another survey of smallholder farmers in central and southern Malawi (Koppmair et al., 2017).

Household diets were dominated by consumption of cereals and vegetables, with the consumption of these being insensitive to seasonal variations in prices. Hence, despite high prices of cereals, mainly maize, in the lean season, the increased purchases of this food category in the lean season show the importance of maize in diets in Malawi. There was also a marked reduction in purchase of vegetables from 59% of households in the post-harvest season to 34% of households in the lean season – yet the proportion consuming vegetables remained the same. This suggests that reduction in purchases may be compensated by availability of own vegetables in the lean season, although the measurement of vegetable consumption as a broad group may mask reductions in the lean season in quantity and type of vegetables. As the patterns between purchase of cereals and of vegetables in the post-harvest and lean seasons suggest, increased purchase of maize in the lean season is likely at the expense of other food groups – a finding supported by our forthcoming work (Drivers of Food Choice, 2021). Similarly, several other food groups including 'meat, poultry and offal', 'eggs' and 'sweets', albeit not commonly purchased or consumed, were considerably less likely to be purchased in the lean season. The markedly higher purchase of the group 'spices, condiments and beverages' in the lean season likely reflects the greater use of products to mask a narrow diet consisting largely of maize. We also found that a greater range of food groups were commonly purchased than consumed, which may be due to some food products being purchased for re-sale – possibly sold to brokers that take the produce to markets outside of our study regions. However, the data do also point to the importance of market-sourced foods. The top foods consumed are, except for 'spices, condiments and beverages', not the ones sources from the market. Thus, where households do source foods from the market, this (when not purchased to sell-on), this is mainly to supplement foods sources from other means (largely own-production), resulting in greater dietary diversity than could be achieved otherwise.

The study captured food purchase diversity in the same food groups used to capture dietary diversity. This allowed us to progress beyond standard approaches for measuring market participation and diversity, and thus extends the debate in the existing literature regarding the impact of market participation on dietary diversity. This is also important in the context of need for improved methods and metrics in food systems research more broadly (Turner et al., 2013; Waage et al., 2018). However, an important limitation of this study is that the measurement of market participation in food purchases did not differentiate between purchases for home consumption and purchases for resale. This is a critical area for further improvement in measurement and data collection. Given the role of income in the relationship between market participation and dietary diversity, further investigation is also needed of income, rather than simply assets as measured by our asset index – which we included in the multivariate analyses.

Furthermore, we have explored the association between purchase and consumption of broad food groups, which likely masks changes across time and differences in quantity and food type purchased within food groups. Our analysis of food purchases over past 7-days and past 30-days whilst providing consistent results in their effect on dietary diversity over past 24-hour may suffer from issues of recall bias and comparability of the recall periods used. There is, therefore, much scope for more fine-scale measurement and exploration of these associations, which also assesses changes in purchase in consumption within food groups. Furthermore, this study falls short in its ability to measure changing diets in the context of a nutrition transition (Walls et al., 2018) since household dietary diversity measures, and also our new food purchases diversity measure which is based on these standard dietary diversity measures, do not currently adequately account for consumption of processed foods that have low nutritional value, and such processed foods are also more likely to be consumed outside of the home. The food purchases diversity score here presented needs further testing and validation in different settings to assure its reliability.

The association between higher food purchase diversity and greater dietary diversity suggests that raising cash incomes of smallholder farmers through cash transfers and other means would likely be important to allow for wider food choices and higher dietary diversity. In this setting of low dietary diversity and with local markets that sell largely nutritionally important foods such as fruits, vegetables, grains and animal-source foods with limited availability of processed foods, greater market participation would likely be very beneficial for household dietary diversity. However, it is also worth noting that nutritional outcomes do not necessarily improve with higher incomes (Jayawardena et al., 2013; Herforth and Ahmed 2015), raising the need for investigation of this relationship, including in regard to market characteristics. Markets are diverse, and it is likely that the importance of markets for diets is contingent on the structure and characteristics of the foods sold in the market, and how well the market is functioning.

In sum, this study found that increased food market participation likely increases dietary diversity in rural Malawi populations with very low dietary diversity and poor nutritional status, as well as supporting overall food security particularly during the lean season. This suggests that for poor households, social support in terms of cash transfers and other interventions to raise household incomes has great potential to improve the dietary diversity of households, and again particularly during the lean season. We have highlighted areas for future investigation, including the need for improved metrics for measuring market participation. Given the variability in market types between different country and other settings, context specific work in this area will be important. The specific ways that local contextual variation affects the relationship between production, market participation and dietary diversity is not yet well understood.

Declaration of competing interest

Authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gfs.2020.100486.

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