Agricultural Marketing Policies and Household Dietary Diversity and Nutrition in Tanzania

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Abstract

The consumption of nutrient-rich foods is sensitive to changes in income and price shocks, especially for low-income consumers. This study employs Tanzania National Panel Survey data to explore the linkage between agricultural marketing, dietary diversity and nutrition status in Tanzania. Findings reveal that market orientation significantly affect dietary diversity for lower income groups, while for the whole sample, the effect is indirect through overall income. Household dietary diversity significantly correlates with a lower probability of child stunting, which becomes insignificant when overall income is controlled; and female education and overall income have significant effects on dietary diversity and child nutrition. The findings suggest a judicious use of money obtained from the sales of agricultural products.

Key Words: *Agricultural marketing, Dietary diversity, Nutritional status, Panel data, Tanzania*

1. Introduction

The prevalence of malnutrition in sub-Saharan Africa (SSA) is consistently higher relative to other regions of the world. The proportion of undernourished people in SSA declined from 30% in 2000–02 to 23% in 2014–16. In spite of this decline, the number of undernourished people in SSA increased from 204 million to about 220 million people in the same period (UN, 2016). Even worse, the number of stunted children increased from an estimated 50.1 million in 2000 to 57.3 million in 2014. In 2013, the Food and Agriculture Organization of the United Nations (FAO) estimated the economic cost of undernutrition in developing countries to be as high as 3% of GDP (FAO, 2013).

This paper examines the relationship between agricultural marketing policies, household dietary diversity and nutrition status in Tanzania. Despite a significant reduction in the number of underweight children and those suffering from chronic malnourishment in Tanzania between 1992 and 2015, the rates of stunting among children and disparities in nutritional status are still high (UNICEF, 2020). The Tanzania Demographic and Health Survey reports that about 34% of children below five years of age in Tanzania are stunted, 14% are underweight, 5% suffer from acute and chronic malnutrition (wasting) and 4% are overweight (URT, 2016). Regional disparities are wide ranging, from a 56% prevalence of stunting in Rukwa to 15% in Dar es Salaam (URT, 2016).

Among the fundamental determinants of nutritional status are the availability of and access to a proper amount and combination of food (Hawkes and Ruel, 2006). Thus, a sustainable way of addressing malnutrition is to consume a high quality, diverse diet that provides adequate energy and the nutrients needed for good health (Arimond and Ruel, 2004; Arimond et al., 2010). The nutrition status of a household is linked to agriculture through various routes, which include the following: First, production for household self-consumption (Haddad, 2000; Jones et al., 2014; Kumar et al., 2015); second, income from agricultural marketing (The World Bank, 2007; Bhagowalia et al., 2012; Jones, 2017); third, low food prices due to increased food supply (The World Bank, 2007; Jensen and Miller, 2011; Bageant et al., 2016); fourth, women's empowerment (Sraboni et al., 2014; Malapit et al., 2015; Makate and Makate, 2018); and fifth, agriculture's contribution to national income and economic growth (The World Bank, 2007; Bageant et al., 2016).

Agricultural marketing policies that foster agricultural commercialization can be a useful means of promoting efficiency in agriculture, increasing agricultural household income and, consequently, improving household food and nutrition security (Von

Braun, 1988; Baylis et al., 2013). However, the consumption of a variety of nutrient-rich foods is very sensitive to changes in income levels and price shocks, especially for consumers with low incomes (FAO, 2013). One of the coping mechanisms for a majority of agricultural households is to practice a mix of subsistence and market-oriented production (Jones et al., 2014). Additionally, a household may choose to maximize its earnings and consumption by selling agricultural products that fetch relatively higher market prices and use the proceeds from marketing to purchase various nutritious foods. However, this approach carries a risk of jeopardizing the nutrition level if a higher market value is associated with higher nutrition content and the households consumes less nutritious foods from its own production while, at the same time, the proceeds from marketing are not used to purchase nutritious foods. Therefore, analyzing the relationship between agricultural marketing, dietary diversity and nutrition status of households has an intuitive appeal.

A number of studies have analyzed the effect of production for self-consumption on household food security and nutrition (Snapp and Fisher, 2015; Chinnadurai, 2016; Sibhatu and Qaim, 2018; Ecker, 2018; Lovo and Veronesi, 2019). A few studies have explored the role of marketing in promoting household food security and nutrition, with conflicting results. Baylis et al. (2013) analyzed the effect of agricultural market reforms on nutrition using household panel data from 1989 to 2000 in rural China and found that market liberalization improved nutrition. Koppmair et al. (2017) and Murendo et al. (2018) found that agricultural commercialization is positively associated with dietary diversity with respect to households, women, and children. Conversely, Carletto et al. (2017) found an insignificant effect of commercialization on nutritional status in three countries, namely, Malawi, Tanzania and Uganda.

In view of the diverse findings of the previous studies, this study is geared at shedding more light on the relationship between agricultural marketing, dietary diversity and nutrition status among agricultural households. Using three waves of nationally representative panel data (2008/2009, 2010/2011 and 2012/2013) in Tanzania, it measures market orientation and agricultural diversity, including crop, livestock and fish production, a combination which has not been used in previous studies. In addition, the study disaggregates the items to accommodate extensive analysis. Specifically, the objective of the study is three-pronged, to: examine the effect of market orientation on households' dietary diversity and nutrition status; analyze the effect of agricultural marketing infrastructure on households' dietary diversity and nutrition status; and investigate the effect household diet diversity has on nutrition status.

The paper is organized as follows: Section 2 describes the methodology and descriptive statistics, Section 3 delineates the empirical methodology used for estimation, Section 4 presents and discusses the results, and Section 5 provides the conclusion.

2. Methodology

The data

The study uses the three waves of Tanzania National Panel Survey (NPS) data (2008/09, 2010/11 and 2012/13), which is part of the Living Standard Measurement Studies collected by The World Bank and the Tanzania National Bureau of Statistics. The first wave was conducted over twelve months, from October 2008 to September 2009; the second wave ran from October 2010 to September 2011; and the fieldwork for the third wave of the NPS was from October 2012 to September 2013. During the second and third waves, specialized tracking teams remained in the field until November of the respective years.

The original sample size of the first wave was 3,265. This sample was designed in such a way that it was representative at the national, urban/rural, and major agro-ecological zones. The total sample size of households was clustered in 409 enumeration areas (within which 2,063 households were in rural areas and 1,202 in urban areas) across mainland Tanzania and Zanzibar (NBS, 2014). For the second wave of the NPS, the total sample size is 3,924 households. This represents 3,168 households in the first wave and 659 split-off households, which translates into an attrition rate of 3%. The third wave consists of a sample size of 5,015 households, representing the re-interviewed households, split-off households and those that were not located and interviewed during the second wave. A total of 3,786 households of the targeted 3,924 households were located again and re-interviewed, which translated into an attrition rate of roughly 3.5% between the second and third waves.[1]

Of the original sample of 3,265 households, 3,088 households were interviewed in all three waves. The attrition rate is 5.4%, which is fairly small for a period of four years. In the case of split-off households, the households that remained with the larger number of original members was used. For the main analysis, this study uses the 1,997 households that were engaged in at least one of the agricultural activities, namely, crop cultivation, livestock keeping, and fishing, in all three waves to form a balanced panel.

The NPS survey instruments comprise a household questionnaire, agriculture questionnaire, livestock and fishery questionnaire, and a community questionnaire. The data contain information on agricultural production at plot level and crop harvests at household level, household characteristics, assets, income, and consumption information for about 59 food items for the seven days preceding the interview. The data also contain individual information on age, education, anthropometric measures and health-related issues, for example, visiting a healthcare provider and hospitalization.

Outcome variables

In the literature, the most common measure of household dietary quality is dietary diversity, which proxies the extent to which nutritional requirements are satisfied (Hatløy et al., 1998; Jones et al., 2014; Parappurathu et al., 2015). Dietary diversity is defined as the variety of foods across and within food groups consumed over a given reference period to ensure the required intake of essential nutrients for good health status (Ruel, 2003; Parappurathu et al., 2015). A more diversified diet is associated with a higher calorie intake, intake of essential micronutrients and a positive nutritional status (Hatløy et al., 1998; Arimond and Ruel, 2004; Kant, 2004; Steyn et al., 2006; Bhagowalia et al., 2012; Azzarri et al., 2015; Kumar et al., 2015; M'Kaibi et al., 2017; Wagner and Tasciotti, 2018). Thus, dietary diversity qualifies as a good indicator of food and nutrition security (Ruel, 2003; Parappurathu et al., 2015).

The main outcome variables for the study are household dietary diversity and the nutrition status of children and adults. The first measure used is the household dietary diversity score (HDDS). HDDS is constructed based on a number of food groups consumed by a household in a given reference period. The food items are the 12 different food groups proposed by the FAO (FAO, 2011). The 12 food groups are: cereals; roots and tubers; vegetables; fruits; meats; eggs; fish and other seafood; pulses, nuts and seeds; milk and milk products; oils and fats; sweets; and spices, condiments and beverages. Each food group adds one point to the HDDS if at least one member of the household consumed the food item from the group in the seven days preceding the interview. Hence, the HDDS ranges from 0 to 12. The use of diversity scores is considered superior to the use of calories or diet richness, as it reflects the quality of food available to households (Ruel, 2003).

The second measure is food consumption score (FCS), which is calculated using the frequency of consumption of different food groups consumed by a household in the seven days preceding the survey. There are standard weights for each of the food groups that comprise the food consumption score: FCS = (starches*2) + (pulses*3) + vegetables +fruit + (meat*4) + (dairy*4) + (fats*0.5) + (sugar*0.5).

Anthropometric information is used to measure the nutritional status of children aged between 0 and 59 months. The physical growth of children under five is a generally accepted indicator of the nutritional status of the population they represent (WFP, 2005). Stunting is indicated by low height-for-age z-scores (HAZ). It indicates chronic malnutrition as it quantifies the failure to reach growth potential, which is a slow cumulative process (WFP, 2005). HAZ is expressed in terms of z-scores, which is the standard deviations relative to the standard median obtained from the World Health Organization's reference populations (WHO, 2006). Binary indicators were then computed to measure stunting (that is, HAZ < -2), and body mass index (BMI) for adults.

Independent variables

The key independent variables measure market orientation in two ways. First, by using the agricultural commercialization index (ACI), which is given by the following ratio:ACI= (Gross value of Agric.sales)⁄(Gross value of Agric.Production). Second, by using the per capita value of agricultural sales (PVAS), which is given by the following ratio: PVAS=(Gross value of Agric.sales)⁄(Household size)(adult equivalent . The second set of independent variables measure agricultural marketing infrastructure, for example, distance to the nearest market, distance to the nearest major road, and training and extension services with regard to marketing. The last of the independent variables is related to the third specific objective. It measures whether a woman in the household has the power to make decisions on marketing and the income from agricultural marketing.

A number of households' socioeconomic variables were used as control variables in the multiple regressions. These variables include: age, sex, education and household size. The variables purported to influence dietary and nutritional-related decisions include distance (in km) to the nearest drinking water source, and time taken and distance (in km) to the nearest market. The control measures for household affluence include ownership of residential house, walling material of the dwelling, real expenditure by the household (per adult equivalent) in the preceding 12 months, and total land cultivated by the household. Other control measures are household location, whether rural or urban; as well as control measures for agro-ecological zone, region, and month of interview and survey year, to take into account geographical, time and seasonal variations.

Descriptive statistics

Table 1 presents the summary statistics for the variables used in the analysis.

On average, about 41% of children under five were stunted. The FCS was 9.6, on average, indicating a fair diversity in diets among households when compared to a perfect score of 16 where all food groups are consumed. The mean HDDS indicated that in a period of seven days before the survey, a household consumed, on average, 8 different food groups out of the possible 12 in all three waves. The variation in food consumption score and dietary diversity across households was small. The value of marketed agricultural production was only about 36% of the total value of harvests, which indicates that market orientation is fairly low and agricultural households are practicing predominantly subsistence farming. Reflecting this, the annual per capita value of agricultural sales was found to be low, that is, about TShs70,000 (approximately USD34). Annual per capita expenditure was also low, about TShs540,000 (approximately USD262). The expenditure per adult equivalent and distance to nearest market and nearest major road showed a wide variation among households, hence, a logarithmic transformation was applied. Only about 5% of farming households received training or extension services related to marketing their products.

Table 1: Summary statistics

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		All waves		Wave 1		Wave 2		Wave 3	
	N	Mean	Sd	Mean	Sd	mean	sd	mean	Sd
Outcome variables									
Stunted	6,490	0.408	0.492	0.477	0.500	0.377	0.485	0.388	0.487
Food consumption score	5,991	9.649	3.754	9.496	3.742	9.907	3.661	9.544	3.846
Hh. dietary diversity score	5,991	8.026	2.084	7.870	2.046	8.226	1.984	7.980	2.202
Main explanatory variables									
ACI	5,554	0.364	0.335	0.327	0.313	0.389	0.355	0.375	0.333
PVA ('000)	5,984	70.01	326.8	46.68	121.4	60.07	155.2	103.3	529.3
Extension services (received=1)	5,927	0.0521	0.222	0.0808	0.273	0.0443	0.206	0.0308	0.173
Log of distance to nearest major road	5,701	2.691	1.646	2.210	1.742	2.246	1.714	3.552	1.028
Log of distance to nearest market	5,782	4.358	0.953	4.124	0.945	4.108	0.957	4.820	0.769
Control variables									
Sex (male =1)	5,991	0.768	0.422	0.773	0.419	0.774	0.418	0.756	0.430
Age	5,991	49.52	15.38	47.80	15.43	49.66	15.35	51.09	15.20
Years of schooling	5,941	4.736	3.530	4.747	3.519	4.693	3.553	4.770	3.518
Household size	5,984	5.696	3.041	5.409	2.858	5.841	3.120	5.839	3.119
Female highest education	5,991	5.562	3.413	5.238	3.350	5.582	3.402	5.864	3.458
Walling (brick or concrete=1)	5,991	0.334	0.472	0.299	0.458	0.335	0.472	0.369	0.483
Residence (own house=1)	5,991	0.917	0.276	0.917	0.276	0.915	0.278	0.918	0.274
Log of time to nearest water	5,915	3.327	1.286	3.625	1.143	3.242	1.270	3.126	1.378
Log per capita expenditure	5,984	13.19	0.605	13.04	0.578	13.14	0.575	13.39	0.606
Cultivated area (acres)	5,991	10.97	20.63	9.199	16.93	11.82	22.89	11.90	21.49
Location (rural=1)	5,991	0.862	0.345	0.875	0.330	0.861	0.346	0.849	0.358
Under-5 children's age (months)	7,355	29.15	17.32	29.74	17.20	28.92	17.32	28.93	17.39

The socioeconomic characteristics of the households indicate that three quarters of the households are male headed, the average years of schooling of the heads of households is about five years, and the household size is 5.7 people, on average. A well-educated female member of the household may have a big influence on the dietary decisions made within the households, which may also signify women's intra-household bargaining power. Furthermore, the study found that the years of schooling of the most highly educated female member of the household is 5.6 years, on average, and that the majority of households (92%) live in their own houses, but fewer than 34% dwell in houses with strong walling material. In addition, most of these agricultural households are in rural areas (86%) and cultivate, on average, a total of 11 acres in both the long and short rain seasons.

3. Empirical model

The main estimation involved exploring the household agricultural production diversity and household dietary diversity, whereby the outcome variables were different measures of dietary diversity as described above, ranging from zero to the maximum finite value a measure can take. Second, we estimated equations that sought to analyze diet diversification in child nutrition, which was quantified using anthropometric measures and expressed as binary indicators. In all cases, we estimated a panel data model with the following generic form:

$$DD_{it} = \alpha M_{it} + \beta X_{it} + T_t + \mu_i + \varepsilon_{it} \quad (1)$$

where subscript i is an index for household and t is the time index. DD_{it} is a measure of household dietary diversity of household *i* at time *t*; M_{it} is the measure of market orientation and other key independent variables of household *i* at time t; X_{it} is a set of characteristics of the head of the household and other household-level control variables; T_t is time fixed effects; μ_i is (unobserved) household fixed effects; ε_{it} is the idiosyncratic error term; and α is the parameter of interest.

Estimating the above equation using ordinary least squares (OLS) is a challenge when the explanatory variables (referred herein as(XV_{it}) are correlated with μ_i, that is, if $E(XV_{it}\ \mu_i)\neq 0$. Thus, OLS will yield biased and inconsistent estimators. To eliminate the unobserved heterogeneity, a fixed effects (FE) model is applied. The FE model transforms the variables by time demeaning[2] the process, which leads to the elimination of time-invariant variables, including unobserved heterogeneity. This process is referred to as fixed effects transformation, or within transformation. Next, a pooled OLS estimation is applied to the transformed variables. However, this estimator sweeps away the coefficients of time-invariant observable variables, as they disappear through the within transformation. If the time-varying variables are of more interest in the analysis of the model, the FE estimator yields more robust parameter estimates (Wooldridge, 2010).

If μ_i is uncorrelated with XV_{it}, then transforming the variables to eliminate μ_i results in inefficient estimators. In that case, more efficient parameters would be obtained from the random effects (RE) model, which exploits the serial correlation ε_{it} in a generalized least squares (GLS) framework. In contrast to the OLS method, which ignores the serial correlation in the composite error term(μ_i+ε_{it}), a GLS framework will solve the serial correlation problem.

In most empirical cases, the assumption that XV_{it} is uncorrelated with μ_i is violated. There are scenarios under which some of the explanatory variables, including the key explanatory variables, may be correlated with the unobserved heterogeneity term μ_i. For example, for the above dietary diversity equation (Equation 1), household agricultural diversity is most likely to be correlated with unobserved household characteristics, for example, the nutritional knowledge of some members of the household. Unobserved heterogeneity could also be correlated with other explanatory variables. For example, per capita income may be higher for those with who invest aggressively. Because FE takes into account the correlation between XV_{it} and μ_i, it tends to be widely used, more than RE that does not take this into account. In most cases, both models are estimated and then the Hausman test is carried out to test whether the coefficients of time-varying explanatory variables in FE and RE estimations are statistically equal. Ideally, RE estimates are used, unless the Hausman test rejects the hypothesis. Rejection of the Hausman test is considered to mean that the key assumption of the RE that $E(XV_{it}\,\mu_i)=0$ is false (Wooldridge, 2010). To analyze the effect of marketing and dietary diversity on children's nutritional status, random effects probit and pooled cross-sectional data models are estimated with the generic form:

$$N_{iht} = \alpha + \beta D_{iht} + \gamma X_{iht} + \varepsilon_{it} \tag{2}$$

where subscript i is an index for child, h is an index for household; and t is the time index. The variable N_{iht} is a binary measure of child nutritional status (stunted, wasted or underweight), in household h at time t; D_{iht} is the measure of degree of marketing or dietary diversity of household h at time t; X_{iht} is a set of characteristics of the child, head of the household and other household-level control variables; ε_{iht} is the error term; and β is our parameter of interest.

4. Results

Effect of market orientation and infrastructure on household dietary diversity

This section presents the results of the effect of market orientation and infrastructure on households' dietary diversity. We have two outcome variables that measure dietary diversity: HDDS and FCS. Each of the two outcome variables is regressed on two different measures of market orientation, ACI and PVAS, in separate regression models. Control variables are included in each regression.

Table 2: Effect of market orientation and infrastructure on HDDS and FCS (fixed effects model)

Variables	(1)	(2)	(3)	(4)
	HDDS	HDDS	FCS	FCS
ACI	0.120		0.00639	
	(0.106)		(0.192)	
PVAS		0.000094		0.000335*
		(0.000096)		(0.000172)
Extension services (received=1)	0.0316	0.0266	0.153	0.148
	(0.126)	(0.124)	(0.227)	(0.223)
Log of distance to nearest major road	0.0393	0.0371	0.0222	0.0228
	(0.0299)	(0.0283)	(0.0540)	(0.0509)
Log of distance to nearest market	0.0169	0.00678	-0.0198	-0.0565
	(0.0456)	(0.0434)	(0.0826)	(0.0780)
Sex (male =1)	-0.0589	-0.0114	-0.379	-0.228
	(0.170)	(0.164)	(0.307)	(0.296)
Age (years)	-0.0138**	-0.0136**	-0.00558	-0.00525
	(0.00654)	(0.00622)	(0.0118)	(0.0112)
Years of schooling	0.0643***	0.0503**	0.0827**	0.0623
	(0.0226)	(0.0218)	(0.0409)	(0.0392)
Female highest education	0.0781***	0.0806***	0.0707**	0.0730**
	(0.0167)	(0.0160)	(0.0302)	(0.0288)

continued next page

Table 2 Continued

Variables	(1) HDDS	(2) HDDS	(3) FCS	(4) FCS
Residence (own house=1)	0.0657	0.0319	-0.0778	-0.174
	(0.144)	(0.135)	(0.260)	(0.244)
Walling (brick or concrete=1)	0.109	0.170	0.104	0.148
	(0.113)	(0.110)	(0.204)	(0.197)
Log. time to nearest water source	0.00123	-0.0147	-0.00218	-0.0247
	(0.0317)	(0.0302)	(0.0573)	(0.0544)
Cultivated area (acres)	0.00621***	0.00644***	0.00806**	0.00775**
	(0.00184)	(0.00182)	(0.00333)	(0.00328)
Location (rural=1)	-0.266	-0.311*	-0.234	-0.368
	(0.191)	(0.176)	(0.346)	(0.317)
Constant	7.440***	7.736***	8.402***	9.154***
	(0.574)	(0.540)	(1.038)	(0.971)
Observations	5,197	5,524	5,197	5,524
R-squared	0.062	0.056	0.036	0.034
Number of households	1,951	1,992	1,951	1,992
Month of interview FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 2 presents the marginal effects of market orientation and infrastructure on households' dietary diversity as measured by HDDS and CS using a panel data fixed effects model. Columns 1 and 2 of Table 2 present the marginal effects of market orientation as measured by ACI and PVAS on HDDS, respectively. Conversely, columns 3 and 4 of Table 2 present the marginal effects of market orientation as measured by ACI and PVAS on FCS, respectively. For both HDDS and FCS, it was found that market orientation, using both measures, ACI and PVAS, does not have a statistically significant effect (p>0.05) on dietary diversity. This means that higher values and larger proportions of marketed agricultural production do not translate into higher dietary diversity. The likely implication from these results is that farmers diversify their diets from self-consumption of diversified agricultural production (Chegere and Stage, 2020) rather than by purchasing diversified food products. This implication aligns with the observation that the examined agrarian society predominantly practices subsistence farming. Conversely, it could be that market orientation has no direct effect on household dietary diversity, but an indirect effect through income, which will be tested later.

We also find that the marketing infrastructure variables are not statistically significant (p>0.05). They are: distance to the nearest market, distance to the nearest major road, and training in and extension services on marketing. The likely reason behind such results is that a majority of farmers sell their crops to intermediaries who collect them from their farms or their homes during the harvest season. In this case, the marketing infrastructure may have minimal direct effects on farmers, but that will most probably be at the expense of lower farm-gate prices.

The statistically significant ($p<0.05$) effects of some of the control variables are of particular interest for the results presented in Table 2. One such observation is the effect of the education of the most educated female member of the household, which is consistently positive, significant and relatively greater in magnitude than the effect of the education of the household head on household dietary diversity. This suggests that a woman's level of education has an effect on household decision-making, which positively affects nutrition. The size of the cultivated area that may capture a household's wealth or total value of agricultural production also has a positive and significant effect on dietary diversity.

Next, we test whether market orientation affects dietary diversity indirectly through income. We asses this mechanism by first regressing per capita expenditure on the two measures of market orientation, ACI and PVAS; then we regress dietary diversity on per capita expenditure as a proxy for income. The marginal effects from these estimations are presented in Table 3. We find that PVAS has a statistically significant ($p<0.01$) effect on per capita expenditure, while ACI has no significant effect.

Table 3: Marginal effect of market orientation on income and effect of income on dietary diversity (fixed effects model)

	(1)	(2)	(3)	(4)
Variables	**Log per capita expenditure**	**Log per capita expenditure**	**HDDS**	**FCS**
ACI	0.00678			
	(0.0279)			
PVAS		0.000068***		
		(0.000025)		
Log per capita expenditure			1.158***	2.073***
			(0.0616)	(0.111)
Constant	12.98***	13.04***	-7.369***	-17.86***
	(0.151)	(0.141)	(0.955)	(1.719)
Observations	5,197	5,524	5,524	5,524
R-squared	0.198	0.194	0.143	0.121
Number of households	1,951	1,992	1,992	1,992
Month of interview controls	YES	YES	YES	YES
Household controls	YES	YES	YES	YES
Year controls	YES	YES	YES	YES

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

This could imply that those selling higher proportions of their produce are not necessarily farmers with larger sales or higher income. PVAS links directly with income because it is actually a subset of total household income. We also find that per capita expenditure, which is a proxy for income, has a positive and significant effect on dietary diversity as measured by HDDS and FCS. Therefore, we can deduce that market orientation has an indirect effect of dietary diversity through the overall income effect.

It could also be conjectured that the reason for not observing significant effects of market orientation is due to aggregating farmers of all income groups and/or bunching the commercialization of all food groups. To explore this in more detail, separate estimations are run that disaggregate the sample by income terciles, and disaggregate the measures of the agricultural commercialization index to individual food product components. Table 4 reports the marginal effects that market orientation have on HDDS and FCS for different income terciles, and Table 5 shows the marginal effects of the commercialization of individual agricultural product groups on HDDS and FCS.

Table 4 shows that ACI, which measures the proportion that is commercialized, has a positive and significant ($p<0.05$) effect on dietary diversity for the lower income groups, while its effect is insignificant for the higher income group. This implies that relatively poor farmers will benefit more in terms of improved dietary diversity if they become more market oriented. However, we find no statistically significant effect for PVAS; this could be because the effect of income is absorbed after the creation of income quintiles, which group together those with similar incomes. The results in Table 5 indicate that the commercialization of production of some of the individual agricultural product groups –pulses, nuts and seeds; fruits; and fats and oils – was statistically significant in increasing household dietary diversity, thereby enriching the household diet. The commercialization of the other remaining agricultural product groups (cereals; roots and tubers; vegetables; fish and other seafood; eggs; milk and milk products; sweets; and spices, condiments and beverages) had either a negative or insignificant effect on HDDS. There was no statistically significant effect for any single individual agricultural product group on FCS at a 5-per-cent level of significance.

Table 4: Effect of market orientation and infrastructure on HDDS and FCS by income terciles

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	First tercile (low income)				Second tercile				Third tercile (high income)			
	HDDS	FCS	HDDS	FCS	HDDS	FCS	HDDS	FCS	HDDS	FCS	HDDS	FCS
ACI	0.351**	0.645**			-0.175	-0.831**			0.168	0.268		
	(0.178)	(0.328)			(0.172)	(0.323)			(0.204)	(0.354)		
PVAS			0.000258	0.00113*			1.65e-05	0.000184			0.000377	0.000796*
			(0.000341)	(0.000622)			(0.000105)	(0.000196)			(0.000262)	(0.000455)
Constant	6.512***	7.046***	6.738***	7.240***	8.846***	11.80***	9.021***	11.84***	7.058***	6.850***	7.465***	8.873***
	(0.911)	(1.682)	(0.881)	(1.606)	(0.949)	(1.782)	(0.911)	(1.707)	(1.193)	(2.071)	(1.052)	(1.825)
Observations	1,789	1,789	1,879	1,879	1,768	1,768	1,851	1,851	1,640	1,640	1,794	1,794
R-squared	0.167	0.119	0.153	0.113	0.081	0.065	0.081	0.060	0.112	0.081	0.104	0.077
Number of households	658	658	664	664	658	658	666	666	635	635	662	662
Month of interview controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Household controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Disaggregated effects of ACI components on HDDS and FCS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	**Cereals**	**Roots and tubers**	**Pulses, nuts and seeds**	**Vege-tables**	**Fruits**	**Spices, condiments and beverages**	**Meats**	**Fish and other seafood**	**Milk and milk products**	**Eggs**	**Oils and fats**	**Sweets**
Marginal effects on HDDS												
ACI components	0.0581	0.213*	0.282***	0.284	0.296**	0.0613	-0.313	-0.176	0.353	0.0695	0.310**	0.415*
	(0.123)	(0.127)	(0.0971)	(0.196)	(0.117)	(0.186)	(0.207)	(0.275)	(0.225)	(0.208)	(0.125)	(0.226)
Observations	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524
R-squared	0.056	0.057	0.058	0.056	0.057	0.056	0.056	0.056	0.056	0.056	0.057	0.057
Number of households	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992
Marginal effects on FCS												
ACI components	0.0772	0.0249	0.227	0.403	0.391*	-0.278	-0.0118	-0.870*	0.705*	-0.389	0.256	0.0702
	(0.222)	(0.228)	(0.175)	(0.352)	(0.211)	(0.334)	(0.372)	(0.494)	(0.405)	(0.375)	(0.225)	(0.406)
Observations	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524	5,524
R-squared	0.033	0.033	0.033	0.033	0.033	0.033	0.032	0.033	0.033	0.033	0.033	0.033
Number of households	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992	1,992
Month of interview controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Household controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The effect of dietary diversity on children's nutritional status

We explore the effect of dietary diversity on stunting, which is used as an indicator for child nutritional status. First we use pooled cross-sectional data of all children who were under five years old in at least one of the three waves. Second, we use balanced panel data of all children who were under five in all three waves using a panel random effects probit model. Table 6 presents the marginal effects of estimates of the effect of household dietary diversity (HDDS and FCS) on stunting using pooled cross-sectional data of all children who were under five in at least one of the three waves.

Table 6: Effects of dietary diversity on children's nutritional status (pooled probit)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Without controls		With controls except income		With all controls	
	Stunting	Stunting	Stunting	Stunting	Stunting	Stunting
HDDS	-0.0257***		-0.0180***		-0.00660*	
	(0.00310)		(0.00338)		(0.00390)	
FCS		-0.0118***		-0.00803***		-0.00214
		(0.00163)		(0.00172)		(0.00196)
Log per capita expenditure					-0.0807***	-0.0851***
					(0.0137)	(0.0135)
Observations	6,490	6,490	6,390	6,390	6,390	6,390
Month of interview controls	NO	NO	YES	YES	YES	YES
Household controls	NO	NO				
Year controls	NO	NO	YES	YES	YES	YES

Table 6 specifically shows a statistically significant ($p<0.05$) simple correlation between dietary diversity (measured by HDDS and FCS) and children stunting in columns 1 and 2. Stunting reflects long-term undernourishment. Dietary diversity is associated with a lower probability of children being stunted. When other factors that affect nutrition, excluding income, were controlled for, the correlation between FCS and child nutrition remained significant. However, when overall household expenditure is added to the control variables, the effect of dietary diversity measures on stunting become statistically insignificant ($p>0.05$).[3]

Conversely, we find that some other factors have statistically significant effects on stunting with the expected signs: belonging to a female-headed household, young age of the child, education of the highest educated female in the household, large household sizes and overall household expenditure, which are positively associated with a lower probability of being stunted. For checking the robustness of our results, we estimated the effect of household dietary diversity (HDDS and FCS) on stunting using balanced panel data of all children who were below five in all three waves using a panel random effects probit model. We used dietary diversity measure as a contemporaneous variable, with results reported in Table A2 of the Annex; and as lagged variables, with results reported in Table A3 of the Annex. In both cases, the results are similar to those from the pooled probit model, where the simple correlation between dietary diversity and stunting is significant, but when other factors are controlled for the effects become insignificant.

5. Discussion and conclusion

Production for market sales opens up the possibility of using revenue from crop sales to buy important foodstuffs in markets, rather than relying solely on own production. In addition, diversifying diets with sufficient quantities of food is a sustainable way of containing malnutrition. However, the challenge lies in changes in income and variability of prices over time, which tend to affect the consumption of high value foods more, especially for households with low incomes. This paper examined the relationship between agricultural marketing, dietary diversity and nutrition status in Tanzania, using data from the Tanzania National Panel Survey.

The study had a three-pronged objective. The first item of the objective involved examining the effect of market orientation on households' dietary diversity. Using a commercialization index and per capita value of agricultural sales to measure market orientation, the study's finding is that the effect of market orientation on dietary diversity (measured by a household dietary diversity score and a food consumption score) is not significant. However, when the analysis is disaggregated by income, it is observed that market orientation has a positive significant effect on dietary diversity among those in the lower income group, but an insignificant effect on the higher income group. It is also found that the per capita value of agricultural sales positively affects dietary diversity indirectly through an improvement in overall household income. When the level of the commercialization index is disaggregated into different agricultural product components, the results are mixed and not conclusive.

The second item of the objective involved analysing the effect of agricultural marketing infrastructure on households' dietary diversity. Marketing infrastructure, when measured by distance to the nearest market, distance to the nearest major road and training and extension services on marketing, is found to have an insignificant effect on dietary diversity. However, the study finds that female education levels and size of land cultivated have positive and significant effects on diet diversity.

The last item of the objective entailed investigating the effect of household dietary diversity on nutrition status. The study finds that household dietary diversity (measured by HDDS and FCS) have statistically significant simple correlations with a lower probability of child stunting, which is a variable used to capture nutrition status. However, dietary diversity is found to have no significant impact on stunting of children when overall household expenditure is controlled for. The study finds the following factors to have positive and significant effects on dietary diversity: being in a female-headed household, age of the child, education of the highest educated female in the household, household size and overall household expenditure.

Several implications emanate from these findings. First, improving some factors, for example, female education levels and overall income levels, may enhance dietary diversity. Second, some results seem to indicate that farmers could have a tendency to market crops with relatively higher nutritional content if they are associated with higher market values, while consuming relatively less nutritious foods from their own production without using the proceeds from crop sales to purchase nutritious foods, thereby affecting children's nutritional status in particular. Third, factors that favour dietary diversification may not be part of the policy agenda that is geared at improving dietary diversity and the nutritional status of children. This anomaly needs to be seriously addressed.

In general, the study emphasizes that market participation is important. By enhancing market infrastructure farmers will be enabled to improve and transform agricultural commercialization, thereby improving their incomes. However, it may not deliver on improving diet and nutrition status if the proceeds from sales of agricultural products do not translate into the purchase of diversified and more nutritious foods. Moreover, factors such as the education of female members of the household and overall income of the household also matter. Therefore, policies for improving dietary diversity and the nutritional status of children, as well as the overall dietary diversity of farm households, should also incorporate these factors.

Notes

1. See NBS (2012) and NBS (2014) for more details.

2. See NBS (2012) and NBS (2014) for more details.

3. Time demeaning means obtaining the new variable by subtracting the value of the variable for a cross-sectional observation from the mean of that variable across all time periods for that observation, that is, $\ddot{X}_{it} = X_{it} - \bar{X}_i$

4. Full results with all controls are presented in Table A1 in the Annex.

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Annex

Table A1: Effects of dietary diversity on children's nutritional status (pooled probit with full controls)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting	**Stunting**	**Stunting**	**Stunting**	**Stunting**	**Stunting**
HDDS	-0.0257***		-0.0180***		-0.00660*	
	(0.00310)		(0.00338)		(0.00390)	
FCS		-0.0118***		-0.00803***		-0.00214
		(0.00163)		(0.00172)		(0.00196)
Sex (male =1)			0.0512***	0.0505***	0.0517***	0.0515***
			(0.0121)	(0.0121)	(0.0121)	(0.0121)
Age of child (months)			0.000920***	0.000925***	0.000891**	0.000891**
			(0.000348)	(0.000348)	(0.000347)	(0.000347)
Age of household head (years)			-0.000337	-0.000230	-0.000518	-0.000487
			(0.000468)	(0.000467)	(0.000468)	(0.000468)
Female highest education			-0.00766***	-0.00835***	-0.00723***	-0.00748***
			(0.00214)	(0.00213)	(0.00214)	(0.00213)
Household size			-0.00315**	-0.00277**	-0.00397***	-0.00395***
			(0.00137)	(0.00138)	(0.00141)	(0.00143)
Residence (own house=1)			0.00738	0.00899	0.00483	0.00518
			(0.0207)	(0.0207)	(0.0206)	(0.0206)
Walling (brick or concrete=1)			0.00870	0.00480	0.00710	0.00550
			(0.0146)	(0.0146)	(0.0146)	(0.0145)
Log. time to nearest water source			-0.00407	-0.000770	-0.00293	-0.00180
			(0.00531)	(0.00528)	(0.00531)	(0.00528)
Unimproved pit latrine (base=no toilet)			0.0543***	0.0491***	0.0544***	0.0528***
			(0.0182)	(0.0183)	(0.0181)	(0.0181)

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Table A1 Continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting	Stunting	Stunting	Stunting	Stunting	Stunting
Improved pit latrine (base= no toilet)			-0.0530*	-0.0608**	-0.0380	-0.0399
			(0.0303)	(0.0303)	(0.0306)	(0.0306)
Flush toilet (base=no toilet)			0.00962	0.00335	0.0275	0.0258
			(0.0362)	(0.0361)	(0.0364)	(0.0364)
Cooking fuel (clean=1)			-0.198***	-0.192***	-0.179**	-0.177**
			(0.0681)	(0.0689)	(0.0739)	(0.0743)
Lighting fuel (clean=1)			-0.0435	-0.0445*	-0.0249	-0.0251
			(0.0268)	(0.0267)	(0.0272)	(0.0272)
Log per capita expenditure					-0.0807***	-0.0851***
					(0.0137)	(0.0135)
Location (rural=1)			0.0397*	0.0432**	0.0303	0.0314
			(0.0218)	(0.0217)	(0.0219)	(0.0219)
Observations	6,490	6,490	6,390	6,390	6,390	6,390
Month of interview controls	NO	NO	YES	YES	YES	YES
Year controls	NO	NO	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A2: Effects of dietary diversity on children's nutritional status (panel random effects probit)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting	Stunting	Stunting	Stunting	Stunting	Stunting
HDDS	-0.0315***		-0.0307***		-0.0211**	
	(0.00886)		(0.00953)		(0.0102)	
FCS		-0.0113**		-0.00949*		-0.00385
		(0.00457)		(0.00490)		(0.00518)
Sex (male =1)			0.0910**	0.0897*	0.0941**	0.0937**
			(0.0459)	(0.0462)	(0.0456)	(0.0458)
Age of child (months)			0.00514	0.00588	0.00492	0.00533
			(0.00527)	(0.00527)	(0.00524)	(0.00524)
Age of household head (years)			-0.000253	8.89e-05	-0.000285	-8.92e-05
			(0.00172)	(0.00172)	(0.00171)	(0.00172)
Female highest education			-0.00318	-0.00523	-0.00307	-0.00435
			(0.00695)	(0.00692)	(0.00699)	(0.00696)

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Table A2 Continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)
	Stunting	Stunting	Stunting	Stunting	Stunting	Stunting
Household size			-0.00136	-0.00156	-0.00215	-0.00273
			(0.00372)	(0.00379)	(0.00365)	(0.00373)
Residence (own house=1)			-0.0317	-0.0388	-0.0404	-0.0479
			(0.0664)	(0.0681)	(0.0662)	(0.0674)
Walling (brick or concrete=1)			0.0127	0.0106	0.00971	0.00680
			(0.0448)	(0.0452)	(0.0439)	(0.0440)
Log. time to nearest water source			-0.0122	-0.00626	-0.0114	-0.00754
			(0.0155)	(0.0156)	(0.0156)	(0.0157)
Unimproved pit latrine (base=no toilet)			0.0396	0.0264	0.0483	0.0416
			(0.0556)	(0.0573)	(0.0543)	(0.0553)
Improved pit latrine (base=no toilet)			-0.0837	-0.0994	-0.0626	-0.0661
			(0.0955)	(0.0944)	(0.0961)	(0.0955)
Flush toilet (base=no toilet)			-0.0988	-0.122	-0.0763	-0.0861
			(0.0873)	(0.0879)	(0.0876)	(0.0884)
Lighting fuel (clean=1)			-0.0548	-0.0663	-0.0326	-0.0361
			(0.0904)	(0.0899)	(0.0927)	(0.0931)
Log per capita expenditure					-0.0753**	-0.0977***
					(0.0369)	(0.0370)
Location (rural=1)			0.0433	0.0478	0.0306	0.0314
			(0.102)	(0.103)	(0.105)	(0.106)
Observations	764	764	752	752	752	752
Household controls	NO	NO				
Month of interview controls	NO	NO	YES	YES	YES	YES
Year controls	NO	NO	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table A3: Effects of lagged dietary diversity variables on children's nutritional status (panel random effects probit)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Stunting**	**Stunting**	**Stunting**	**Stunting**	**Stunting**	**Stunting**
Lagged HDDS	-0.0324***		-0.0157		-0.0125	
	(0.0100)		(0.00998)		(0.00953)	
Lagged FCS		-0.0114**		-0.00927*		-0.00788
		(0.00505)		(0.00496)		(0.00487)
Sex (male =1)			0.0543	0.0533	0.0576	0.0559
			(0.0596)	(0.0675)	(0.0539)	(0.0569)
Age of child (months)			-0.00591	-0.00569	-0.00688	-0.00663
			(0.00627)	(0.00678)	(0.00576)	(0.00601)
Age of household head (years)			-0.00192	-0.00185	-0.00219	-0.00213
			(0.00205)	(0.00216)	(0.00193)	(0.00198)
Female highest education			-0.0134*	-0.0145*	-0.0132*	-0.0141*
			(0.00764)	(0.00815)	(0.00763)	(0.00794)
Household size			0.000285	0.000718	-0.000986	-0.000626
			(0.00440)	(0.00461)	(0.00431)	(0.00440)
Residence (own house=1)			-0.0343	-0.0342	-0.0507	-0.0493
			(0.0683)	(0.0697)	(0.0637)	(0.0637)
Walling (brick or concrete=1)			0.00975	0.00965	0.0120	0.0124
			(0.0518)	(0.0550)	(0.0485)	(0.0501)
Log. time to nearest water source			-0.0316*	-0.0291*	-0.0325**	-0.0306*
			(0.0166)	(0.0172)	(0.0156)	(0.0157)
Unimproved pit latrine (base=no toilet)			-0.0279	-0.0316	0.0141	0.0119
			(0.0563)	(0.0572)	(0.0533)	(0.0532)
Improved pit latrine (base=no toilet)			-0.168**	-0.177**	-0.0983	-0.108
			(0.0820)	(0.0821)	(0.0794)	(0.0788)
Flush toilet (base=no toilet)			-0.161	-0.170*	-0.0824	-0.0919
			(0.102)	(0.102)	(0.109)	(0.108)
Lighting fuel (clean=1)			-0.129	-0.125	-0.0814	-0.0775
			(0.0879)	(0.0889)	(0.0927)	(0.0912)
Log per capita expenditure					-0.158***	-0.155***
					(0.0383)	(0.0392)

continued next page

Table A3 Continued

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Stunting**	**Stunting**	**Stunting**	**Stunting**	**Stunting**	**Stunting**
Location (rural=1)			0.0639	0.0619	0.0287	0.0274
			(0.104)	(0.112)	(0.103)	(0.107)
Observations	553	553	551	551	551	551
Month of interview controls	NO	NO	YES	YES	YES	YES
Year controls	NO	NO	YES	YES	YES	YES

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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