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RESEARCH

Production and Dietary Diversities with Seasonality in Rural Agricultural Context in Sri Lanka: A Case of *Mahakanumulla* Village Tank Cascade System

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ABSTRACT

Dietary diversity is considered a characteristic of a healthy diet. Improving production diversity is a way to increase dietary diversity in subsistence farming contexts. However, with the agricultural transformation, this association must be revisited. The study aimed to investigate the association between production diversity and dietary diversity in rural agricultural households in Sri Lanka taking seasonality into account. The study site was the *Mahakanumulla* Village Tank Cascade System in the dry zone of Sri Lanka. Pooled Ordinary Least Squares regression was used in the estimation. The results indicated that production diversity and dietary diversity have a positive and statistically significant relationship. The education level of the household head, income and household size were also identified as factors affecting household dietary diversity. The households seem to smoothen dietary diversity levels across months; hence, there is no significant difference in dietary diversity between *Yala*/*Maha* seasons or pre- and post-harvesting periods. Cultivating some specific crop types such as cereals, involvement of livestock farming, and the season affected the frequency of consumption of some food groups such as dairy and meat. This study concludes that increasing production diversity could improve the nutrition of rural agricultural households in Sri Lanka. Hence, nutrition development programmes may benefit from encouraging production diversity in rural agricultural contexts.

INTRODUCTION

Inadequacy of nutrition constrains human welfare in developing countries significantly. Nutrition is vital for increasing productivity (Binns et al., 2017). Improving nutrition is explicitly incorporated in Sustainable Development Goal (SDG) 2: "Zero Hunger" and indirectly in SDG 1: "No Poverty". The estimated economic cost of undernutrition in Asia and Africa is around 5-11% of the GDP (Shekar, 2019). As a lower middle-income country in transition, Sri Lanka faces the challenge of combating the double burden of malnutrition where undernutrition coexists with obesity and diet-related non-communicable diseases, and micro-nutrient deficiencies (iron, zinc, calcium, folate, and vitamin A) (Abeywickrama et al., 2018).

Among the several other factors contributing to nutritional status, dietary diversity as a characteristic of food intake has received a recognition, and consuming a diverse diet reduces the likelihood of being nutrition deficient compared to consumption of a less diverse diet (Onyango et al., 1998; Mirmira et al., 2006; Arimond et al., 2010). Lack of diversity and low nutritional quality of the food resulting from household food insecurity and poverty are identified as the major causes of the prevalence of undernutrition in Sri Lanka (Rajapaksa et al., 2011). According to Jayawardena et al. (2013), the daily intake of fruits, vegetables and dairy portions is below national recommendations in Sri Lanka, while approximately seventy per cent of the population exceeds the upper limit of the recommendations for starch intake.

A wide array of strategies implemented to improve nutrition often target rural agriculture-based populations as they are prone to undernutrition compared to the urban sector (World Health Organization, 2019), and they are encouraged to increase their consumption and income from sales. A substantial amount of literature emphasises the role of production diversity in improving household dietary diversity in rural settings of developing countries (Dillon et al., 2015; Jones et al., 2014; Hirvonen and Hoddinott, 2017; Ecker, 2018; Zanello et al., 2019). On the contrary, numerous studies argue the importance of specialization compared to production diversity (Liu et al., 2014; Sibhatu et al., 2015; Sibhatu and Qaim, 2018).

Agriculture in developing countries is relatively subsistence oriented. In such a context, the non-separability of production and consumption decisions suggests a direct linkage between production diversity and dietary diversity (Dillon et al., 2015; Zanello et al., 2019). However, with the transition to market-oriented farming, production diversification incurs a higher cost. This happens because commercialisation is complemented by specialization in a few high-profitable crops or livestock. In such settings, market access aids in generating income by selling farm production, which increases the demand for a quality and diverse diet. Furthermore, it contributes to increasing the supply of diverse food in the market (Ayenew et al., 2018; Sibhatu and Qaim, 2018). However, high transaction costs of accessing markets and market failures in developing countries, especially in rural areas (Taylor and Adelman, 2003) may lead to avoiding separating production and consumption decisions, which rationalise diversifying farm production at a higher cost (Dillon and Barrett, 2017).

Previous literature has empirically examined the links between production diversity and dietary diversity at the household/individual level. Jones et al. (2014); Sibhatu et al. (2015); Dillon et al. (2015); Hirvonen and Hoddinott (2017); Olabisi et al. (2021) and Kabir et al. (2022) found that increasing production diversity positively affects dietary diversity. Many of them used cross- sectional data, while some studies, such as Kabir et al. (2022), used panel data methods.

The association between household dietary diversity and socioeconomic factors were assessed in several studies. Liu et al. (2014) studied the importance of age, marital status, education level, gender of the household head and household size on the household dietary diversity in China. Their findings indicated significant relationships in gender, marital status, education level

and household size on dietary diversity. Similarly, in the case of Tanzania, years of education level and the household head being a female had a significant positive effect, and the head's age had a negative effect on household dietary diversity (Olabisi et al., 2021). In contrast, the household size was observed as insignificant. The same study found a significant positive association between the agricultural land owned and the involvement in vegetable cultivation and household dietary diversity. The role of home gardening on dietary diversity is widely discussed in the literature. Cabalda et al. (2011) provide evidence that the households engaged in home gardening are likely to have a higher dietary diversity than those not engaged in home gardening. A recent study on mid-country home gardens in Sri Lanka observed that households with organized home gardens have higher dietary diversity than those with non-organized home gardens (Thamilini et al., 2019).

In rural agriculture-based communities, it is essential to pay attention to the seasonal variation of dietary patterns (Kennedy et al., 2011). The associations may differ with different points in the agricultural cycle, where a surplus of the produce may be observed in the postharvest and the cultivation seasons depending upon the rainfall patterns. Hoddinott and Yohannes (2002) observed seasonal variation in dietary diversity in their multi-country analysis. The results suggested variability in food groups consumed in the hungry and postharvest seasons for India, the Philippines, Bangladesh and Kenya. Becquey et al. (2012) found diet quality worsens in the lean agricultural season compared to the regular season in Burkina Faso. Hirvonen et al. (2016) found that dietary diversity to be relatively high in the lean season in Ethiopia.

Seasonality in agricultural production and food availability is essential in understanding the interplay between production and consumption diversification (Becquey et al., 2012; Ayenew et al., 2018). This may decide the level of income and the households' food availability affecting consumption. Since the previous literature on the above linkages concerning the Sri Lankan context is available mainly in the form of regional studies, the present study was conducted to investigate, the relationship between production diversity and dietary diversity in the rural agricultural setting in Sri Lanka, and the association between dietary diversity and the seasonal variation (in terms of cultivation seasons (*Yala* and *Maha*) and pre-harvest and post-harvest seasons).

METHODOLOGY

The study was conducted in the *Mahakanumulla* Village Tank Cascade System (VTCS) located in the North Central Province, Anuradhapura District, in the rural Dry Zone of Sri Lanka, which belongs to the DL1b Agro-ecological region. The VTCSs provide Dry Zone farmers with a unique hydraulic system connecting a series of tanks. The VTCS is not just a hydraulic system, but it is intertwined with a food production system, a food landscape and the livelihood and lifestyle of the inhabitants. *Mahakanumulla* VTCS is the main cascade in the Dry Zone of Sri Lanka in the North Central Province. It is a branch-type cascade comprising of 26 small tanks and provides the essential characteristics of a VTCS (Panabokke et al., 2002). The total extent of paddy fields under this cascade is approximately 324 ha, and 1,359 families live under this cascade in 6 GN divisions (Department of Public Administration, 2018). Around 85% of the population of the Mahakanumulla VTCS are farmers, and almost all of them are engaged in paddy cultivation which is the starchy staple. Some farmers are engaged in *chena* cultivation, livestock and animal husbandry and inland fishery.

Notably, the most (78.2%) of the Sri Lankan population belongs to the rural sector (Department of Census and Statistics, 2019). According to the Household Income and Expenditure Survey conducted in 2019, 81% of the rural population is multi-dimensionally poor. Furthermore, 49.5% of the population is employed in agriculture in the North Central province in the rural dry zone

Figure 1: Location of the Mahakanumulla VTCS Source: Ratnayake et al. (2022)

(Department of Census and Statistics, 2021). All the above factors indicate the vulnerability of the residents in the area. Being a rural production and consumption system and most of the households being agriculture-based in the rural dry zone, Mahakanumulla VTCS represents the essential characteristics of the rural dry zone of Sri Lanka and, therefore, is a target for interventions to improve dietary diversity and nutrition.

Theoretical model and statistical analysis

The underlying theoretical model is a non-separable household model that directly connects agricultural production aspects to household consumption. The specification by Dillon et al. (2015) in which agricultural households maximise expected utility arising from the consumption of own-produced food (c_{own}), goods purchased from the market (c_{market}) and leisure (l) is adapted in this study. Households choose consumption vectors, farm inputs and leisure to maximise $\sum_{t=0}^{\infty} \beta^t U(c_{own,t}, c_{market,t}, l_t)$ subject to an agricultural production function that specifies output as a function of inputs including household labour; a labour equation specifying that total labour endowment is spent on on-farm and off-farm labour and leisure; and a budget constraint.

Consumption choices, c_t is the total consumption generated from the own-produced food (c_{own}), and goods purchased from the market (c_{market}). Here, dietary diversity is used as a proxy for the consumption choice, c_t. Under non-separability, consumption choices such as dietary diversity are directly influenced by production factors. Therefore, in a reduced form, it can be written as $c_t = f(P, Y, I, H)$, where P is a vector of prices, including market prices (and transaction costs), food prices, input prices and interest rates. Y denotes agricultural production factors, I captures exogenous income and H represents household characteristics influencing preferences.

$$c = \beta_0 + \beta_1 Y + \beta_2 I + \beta_3 H + \varepsilon \quad \text{...Equation (1)}$$

The dependent variable c is the indicator of dietary diversity. Y captures the variables associated with agricultural production, which include production diversity (the simple count of the crops cultivated), involvement in animal husbandry (yes=1, no=0), a measure of market access (distance

Table 1: Description of the variables

Vector	Variable	Indicator	Measure
Consumption choice (c)	Dietary diversity	Household Dietary Diversity Score (HDDS)	Sum of the food groups consumed out of the 12 food groups[1] (score of 1 is given if a food group is consumed and 0 if a food group is not consumed) Range: 0-12
		Food Variety Score (FVS)	The simple count of food items consumed
Agricultural production characteristics (P)	Production diversity	Crop diversity	The simple count of the crops cultivated
	Involvement in animal husbandry		If involved (yes)=1, If not involved (no)=0
	Market characteristics	Distance to the nearest retail shop	Distance from household to the nearest retail shop in metres
	Season	Cultivation season (Yala/Maha)	Maha season=1 Yala season=2
		Pre-harvest or post-harvest season	Pre-harvest season=1 Post-harvest season=2
Income (I)	Income of the household		Income of the household in thousand LKR
Household characteristics (H)	Age of the household head		Age of the household head (Years)
	Education of the household head		Number of years of education of the household head (years)
	Household size		Number of household members

to the nearest retail shop (m),) and season as a binary variable (Maha/Yala and pre-harvest/ post-harvest). *I* captures the household income (Rs. thousand), *H* includes the control variables such as household characteristics, including the size of the household and age (years) and education of the household head (years). ε captures the error component. The description of the variables is given in the Table 1.

Dietary diversity is commonly measured by summing the number of foods or food groups consumed over a reference period. The dietary Diversity Score (DDS) and the Food Variety Score (FVS) are the widely used indicators to measure dietary diversity. (Jones et al., 2014; Mahmudiono et al., 2017; Cordero-Ahiman et al., 2021; Kundu et al., 2021; Vogliano et al., 2021; Jang et al., 2021, Zhang et al., 2021).

The household dietary diversity score is a simple, low-cost assessment tool that aims to accurately reflect a family's economic access to various foods (Vogliano et al., 2021). This study used the household dietary diversity score (HDDS) to assess dietary diversity according to Food and Agriculture Organization guidelines- 2010 (Kennedy et al., 2011). The Household Dietary Diversity Score (HDDS) proposed by Swindale and Bilinsky (2006) consists of 12 food groups which are cereals; white tubers and roots; vegetables; fruits; meat; eggs; fish and other seafood; legumes; nuts and seeds; milk and milk products; oils and fats; sweets; and spices, condiments, and beverages. To calculate the HDDS, the food items consumed by a person within the day are categorised into the above 12 food groups following the guidelines of the FAO, and a score of 1 is given if a food group is consumed and 0 if that food group is not consumed. The HDDS was calculated by summing the number of categories reported, and therefore, the possible score range is 0-12 for HDDS (Kennedy et al., 2011). The FVS is the simple count of food items consumed within the reference period (For example, if a person consumed 12 food items for the day, the FVS will be 12). To obtain the HDDS and FVS, food consumed by one of the household members within a day was counted. Since the results of

Table 2: Description of the variables for the secondary regression models

Category	Variable	Indicator	Measure
Consumption choice (c)	Frequency of consumption of the food group[2]		Number of days a given food group was consumed out of the total days of the study period (e.g.: consumption frequency of meat = number of days in which meat is consumed/ number of total days)
Agricultural production characteristics (P)	Cultivation of the specific crop group/ ownership of livestock		Cultivation of the specific crop group/ ownership of livestock (0=no, 1=yes); (crop groups/livestock: Cereals, Vegetables, Fruits, Legumes, Cash crops, Livestock)
	Involvement in home gardening		Number of hours spent for home gardening (hrs)
	Area cultivated		Total area cultivated by the household in acres
	Season	Cultivation season (Yala/Maha)	Maha season=1 Yala season=2
		Pre-harvest or post-harvest season	Pre-harvest season=1 Post-harvest season=2

the regression analysis showed a positive and statistically significant association between production diversity and dietary diversity. Subsequently, a separate set of OLS regressions was estimated following Ecker (2018) further to understand the effects of agricultural production on consumption. The OLS regression models contained the agricultural production activities (i.e. cultivation of different crops such as cereals and legumes, involvement in livestock farming/ home gardening, which are binary variables) and area cultivated as independent variables and the consumption frequency of specific food groups, which are vegetables, fruits, dairy and meat, as dependent variables. The food group consumption frequency was calculated as the number of days a given food group was consumed out of the total days of the study period (Table 2).

Collection of data

Ethical approval for this study was obtained from the Ethical Clearance Committee (Ref: ECC/2021/E/002) of the Faculty of Agriculture, University of Peradeniya, Sri Lanka.

Demographic data of the households, agricultural production data of the previous year (2020), and involvement in home gardening were collected through a primary household survey using a pretested questionnaire. Cluster random sampling was done within the GN divisions for a sample size of 100, which accounts for around 10% of the total number of households. The sample selection was done proportionately based on the total number of households in the 6 GN divisions. The list of households available at the GN office was used as the sampling framework, and households with a member who is willing to provide diet data were selected randomly. Diet data were collected from the same households by maintaining a self-administered diet diary that records daily diet data for four months in2021. Therefore, diet data were collected from the same household at four time points. The respondents were trained to fill out the diet diary before data collection. The breakdown of the four months is as follows: four weeks from February to March, which corresponds to the pre-harvest season, four weeks from April to May, which corresponds to the post-harvest season of *Maha* (2020/2021) cultivation season, four weeks from July to August, which corresponds to the pre-harvest season and four weeks from September to October, which corresponds to the post-harvest season of *Yala* (2021) cultivation season.

RESULTS AND DISCUSSION

Descriptive statistics

Table 3 and 4 provides the summary statistics of the variables. The HDDS of the sample varied from 3 to 9 food groups and indicated a mean of 6.61. The FVS score varied between 3-15 food items, and the mean FVS was 9.46. Table 4 indicates the minimum and the maximum of the FVSs within the food groups. The minimum of food items consumed in the food groups of cereals and oils and fats, being one, indicates the constant intake of at least one cereal and oils and fats every day. The highest FVS within the food groups is recorded for vegetables. The estimated scores are close to the previous estimations of dietary diversity levels of Sri Lanka by Rathnayake et al. (2015), which recorded a DDS of 7.3 and FVS of 8.7, which also indicates that the dietary diversity levels are low. Dietary diversity is a tool to identify the risk of food insecurity prevalence; low dietary levels may suggest the risk of food insecurity (Oldewage-Theron and Kruger, 2008).

All the households consumed cereals, nearly all consumed oils and fats (98 %), and 88 % of the households consumed vegetables in the study period. The lowest consumptions were recorded for eggs, meat and fruits, which indicated 14 %, 21 % and 23 % of respondents, respectively. These results support Jayawardena et al. (2013), who pointed out that the majority of the population in Sri Lanka exceeds the recommended starch intake, while the dairy and fruit intakes are below the required levels. Figure 2 shows the seasonal breakdown of the consumption by food category, where nearly all the households consumed cereals, vegetables and oils and fats and the lowest consumption was indicated for eggs, meat and fruits irrespective of the seasonality.

The mean age of the household head in the sample is 48 years, and the average household size is four. Households in the sample cultivate an average area of 2.5 acres, and the mean number of hours spent on home gardening is around 6 hours per week. The household head's mean number of years of education is 11 years, indicating the GCE Ordinary level, and the mean household income is Rs. 55,330. Only 20 per cent of households are involved in animal husbandry. The mean crop diversity is 1.68.

Seasonal variation of dietary diversity

Table 5 shows the results of mean comparison tests of HDDS and FVS in cultivation season *Maha* and *Yala* and pre-harvest and post-harvest seasons. According to the results, the HDDS does not vary across seasons. On the other hand, FVS shows a significant difference between *Maha* and *Yala*, indicating that more food items are consumed in the *Yala* season than *in Maha.* However, the FVS does not indicate a significant difference between pre-harvest and post-harvest seasons. Therefore, the household dietary diversity does not show significant differences between seasons, which suggests that the households try to smoothen their consumption across months (Wik, 1999; Sirisankanan, 2013). They may use their savings, borrow, or engage in off-farm income-earning activities (Senanayake and Premaratne, 2014; Wickramasinghe and Fernando, 2017).

Production diversity and the other factors affecting the dietary diversity

As the available data may not capture some of the factors affecting household dietary diversity, biased estimates can result. Some of the previous studies have disregarded this issue (Jones et al., 2014; Sibhatu et al., 2015), while some of the studies, such as Dillon et al. (2015) and Hirvonen and Hoddinott (2017) have addressed the issue using Instrumental Variables (IV) strategies. Since this study was conducted with limited resources, the construction of IVs was difficult, and weak or invalid instruments would lead to even more biased estimates than OLS, so the use of IVs was avoided (Murray, 2006).

The results of the OLS model are provided in Table 6. They indicate a positive statistically significant relationship between crop diversity and the dietary diversity indicators of HDDS and FVS. This relationship is in line with the findings by Jones et al. (2014),

Table 3: Summary statistics of the variables

Variable	Mean	Std. Dev.	Min	Max
HDDS	6.61	1.33	3	9
FVS	9.46	2.23	3	15
Age of household head	48.59	9.02	28	90
Education level of household head (Number of years)	11.11	2.05	5	17
Income (LKR. Thousand)	55.33	21.88	10	125
Household size	4.00	0.92	2	7
Area cultivated (ac)	2.58	2.21	0	10
Number of hours spent for home gardening per week	5.81	9.13	0	55
Distance to the nearest retail shop (m)	238.75	296.63	0	1500
Crop diversity	1.68	1.38	0	6
	Frequency	**Percentage**		
Involvement in animal husbandry				
Yes=1	76	20.65		
No=0	292	79.35		

Table 4: The range of dietary diversity indicators in the sample.

	Minimum	Maximum
HDDS	3	9
FVS	3	15
FVS within the food groups:		
Cereals	1	2
Tubers and roots	0	1
Vegetables	0	5
Fruits	0	2
Meat	0	1
Eggs	0	1
Fish and other sea food	0	2
Legumes, nuts and seeds	0	2
Milk and Milk products	0	1
Oils and fat	1	2
Sweets	0	2
Spices/condiments/beverages	0	3

Dillon et al. (2015), and Hirvonen and Hoddinott (2017). It confirms that households make joint decisions regarding production and consumption. It may be that higher crop diversity brings higher income for households to afford a more diversified diet. Furthermore, it could suggest that even with the efforts of being commercialised, rural Sri Lankan agricultural households are still more subsistence-oriented.

In addition to crop diversity, the household head's education level and the household's income level have a statistically significant positive relationship with HDDS and FVS. This observation is inconsistent with the findings by Olabisi et al. (2021), Liu et al. (2014) and Ochieng et al. (2017). The positive effect of education on dietary diversity may be because education level may increase the awareness and significance of diet towards nutrition. On the other hand, with the increment of income of the households, the

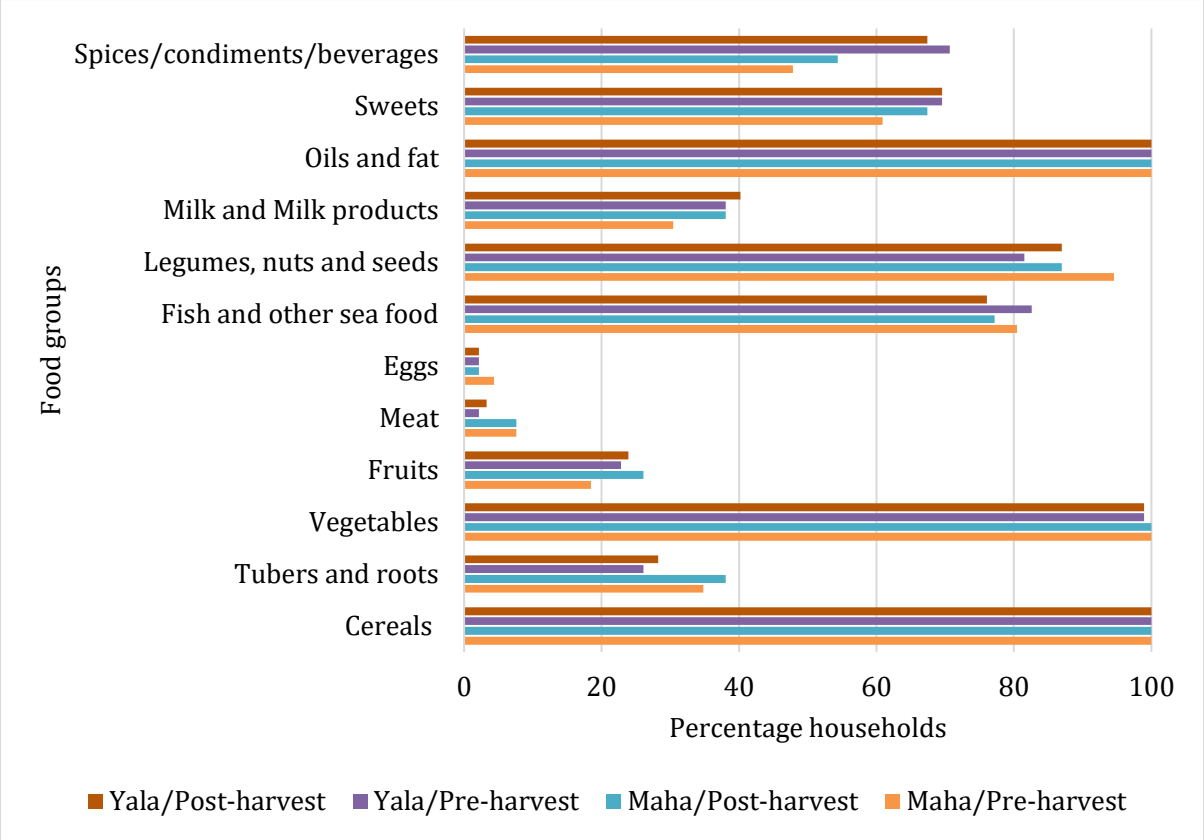

Figure 2: Consumption of at least one item in a food group

Table 5: Mean comparison test statistics of dietary diversity indicators between the seasons

Variable	Mean ± Standard Error		t- statistic	Probability
	Maha (n= 184)	*Yala* (n= 184)		
HDDS	6.10±0.10	6.2±0.10	-0.6922	Pr(|T| > |t|) = 0.4893
FVS	8.77±0.16	9.23±0.17	-1.9621**	Pr(|T| < |t|) = 0.0253
	Pre-harvest (n= 184)	Post-harvest (n= 184)		
HDDS	6.09±0.10	6.21±0.10	-0.8463	Pr(|T| > |t|) = 0.3980
FVS	8.92+0.16	9.08±0.17	-0.6976	Pr(|T| > |t|) = 0.4859

affordability increases and the demand for a diverse diet may increase. The household size indicated a significant negative relationship with dietary diversity, which may suggest that a higher number of members leads to a high cost per meal in a household, which in turn cuts down the diversity of the diet.

Consumption frequency of food groups

Table 7 provides the results of mean comparison tests of the frequency of consumption of food groups between the seasons. The results indicate that vegetables and meat are more frequently consumed in the *Maha* season compared to *the Yala* season. When pre-harvest and post-harvest seasons are considered, a significant difference in consumption is observed only for meat, where meat is consumed more frequently in the post-harvest season.

Effects of agricultural production activities on household dietary diversity and food group consumption frequency

The models' estimates, which examine the effect of agricultural production factors on

Table 6: Model estimation results for factors affecting dietary diversity

	Pooled OLS			
	HDDS		**FVS**	
Crop diversity	0.126**	0.050	0.228***	0.083
Age of household head	-0.002	0.007	-0.116	0.011
Education level of household head (Number of years)	0.121***	0.033	0.181***	0.056
Income (LKR. Thousand)	0.006*	0.003	0.009*	0.005
Household size	-0.163**	0.076	-0.294**	0.126
Involvement in animal husbandry (yes=1)	0.162	0.171	0.189	0.284
Distance to the nearest retail shop (m)	-0.0002	0.0002	0.0002	0.0004
Season	0.120	0.135	0.147	0.225
Pre-harvest/ Post-harvest	0.092	0.135	0.488**	0.225
Constant	5.203***	0.650	7.281***	1.083
R^2	0.0729		0.0813	
F statistic	3.13		3.52	
Prob >F	0.0012		0.0003	

Table 7: Summary results of the mean comparison tests for frequency of food group consumption

Variable	**Mean**		**t-statistic**	**Probability**
	Maha	***Yala***		
Percentage (%) of days consumed				
Vegetables	33.08±1.12	27.05±1.06	3.9135	Pr(|T| > |t|) = 0.0001
Fruits	18.41±1.53	19.51±1.73	-0.4777	Pr(|T| > |t|) = 0.6331
Dairy	33.26±2.42	33.89±2.52	-0.1776	Pr(|T| > |t|) = 0.8591
Fish	48.54±1.22	50.93±1.16	-1.4143	Pr(|T| > |t|) = 0.1581
Meat	23.68±1.18	18.58±0.98	3.3262	Pr(|T| > |t|) = 0.0005
	Pre-harvest	**Post-harvest**		
Percentage (%) of days consumed				
Vegetables	30.09±1.17	30.05±1.06	0.0238	Pr(|T| > |t|) = 0.9810
Fruits	18.42±1.59	19.50±1.67	-0.4674	Pr(|T| > |t|) = 0.6405
Dairy	33.02±2.46	34.13±2.47	-0.3186	Pr(|T| > |t|) = 0.7502
Fish	50.09±1.15	49.38±1.24	0.4223	Pr(|T| > |t|) = 0.6731
Meat	19.77±1.07	22.50±1.18	-1.7576	Pr(|T| > |t|) = 0.0398

the HDDS, FVS and the frequency of consumption of vegetables, fruits, dairy and meat, are shown in table 8. The involvement in home gardening and the area cultivated showed a significant positive effect on dietary diversity. The frequency of vegetable consumption was affected only by the season where, compared to the *Maha* season, the frequency of vegetable consumption in *Yala* is significantly less. On the other hand, the frequency of fruit consumption is affected by both the cultivation season and pre-harvest and post-harvest season, where consumption frequency is higher in the *Yala* season and post-harvest. As most fruit crops are perennial, the seasonal effect (*Maha/Yala*) on fruit consumption can be interpreted as an effect of the fruiting season in Sri Lanka. Most fruit crops are harvested from May to August,

Table 8: Effects of agricultural production activities on household dietary diversity and food group consumption frequency

					Frequency of food group consumption (percentage of days consumed)							
	HDDS		**FVS**		Vegetables		Fruits		Dairy		Meat	
Cultivation of crops / ownership of livestock (0=no, 1=yes);												
Cereals	0.08	0.15	0.34	0.25	-2.17	1.69	5.71**	2.48	-2.93	3.78	-4.80***	1.64
Vegetables	0.26	0.19	0.58	0.31	0.16	2.12	-1.58	3.11	14.93	4.74	1.16	2.06
Fruits	0.12	0.26	-0.08	0.42	-4.11	2.87	3.30	4.21	3.86	6.42	0.02	2.79
Legumes	-0.22	0.25	-0.40	0.40	0.91	2.71	-1.56	3.98	-6.19	6.06	2.81	2.63
Cash crops	-0.45	0.32	-0.80	0.53	-0.61	3.57	8.32	5.24	-1.97	7.98	-4.93	3.46
Livestock	0.18	0.18	0.22	0.29	0.53	1.97	0.47	2.89	8.61*	4.40	-0.76	1.91
Involvement in home gardening	0.02**	0.01	0.04***	0.01	-0.21	0.09	0.39	0.13	0.36*	0.20	0.21***	0.09
Area cultivated	0.08**	0.04	0.13***	0.06	-0.05	0.39	1.50	0.57	-0.05	0.87	0.81**	0.38
Season	0.10	0.14	0.46**	0.23	-6.03***	1.54	1.10***	2.26	0.62	3.44	-5.10***	1.49
Pre-harvest/ Post-harvest	0.12	0.14	0.16	0.23	-0.04	1.54	1.08***	2.26	1.11	3.44	2.72*	1.49
Constant	5.42***	0.33	7.20***	0.54	41.99***	3.69	5.73	5.41	26.11***	8.24	24.19***	3.58
R^2	0.0512		0.0810		0.0666		0.0665		0.0539		0.1005	
F statistic	1.93		3.15		2.55		2.54		2.03		3.99	
Prob >F	0.0404		0.0007		0.0056		0.0057		0.0292		0.0000	

Note: Season (1= Maha, 2= Yala); Pre-harvest=1 and Post-harvest=2)
Note: The table presents the results of OLS regression models

which coincides with the *Yala* season. The frequency of dairy product consumption increased significantly when the household is engaged in livestock farming and home gardening. The frequency of meat consumption shows significant relationships with several production factors. The frequency of meat production and being involved in the cultivation of cereals shows a negative association. It may be that income from cereals is low compared to other crops and hence may lower a household's ability to afford meat.

Further, most households cultivate rice, which is the staple food as the cereal crop. Therefore, for most households, it is for subsistence rather than generating income, unlike other crops. Area cultivated and involvement in home gardening increased the frequency of meat consumption, which may suggest the effect of affordability. Furthermore, compared to *Maha*, the frequency of meat consumed decreased in *Yala* and the same increased in the post-harvest season compared to the pre-harvest season.

Overall study results suggest the possibility of improving the nutritional status of rural households in Sri Lanka via production diversity-induced dietary diversity. Therefore, efforts to improve dietary diversity may benefit from encouraging production diversity. Encouraging and facilitating home gardening will aid in improving the dietary diversity levels. The government programs already in place, such as subsidized seed distribution to develop home gardens will be beneficial. Furthermore, the results show the positive association between the education level and the dietary diversity, which highlights the importance of improving education. Future research is recommended to establish the effect of production diversity on income to isolate the subsistence and income effects of production diversity on dietary diversity.

CONCLUSIONS

This study examined the relationship between production diversity, seasonality of production and dietary diversity in the Mahakanumulla Village tank cascade system, which is in the rural dry zone of Sri Lanka and identified that production diversity affects dietary diversity. The households maintain dietary diversity levels across months and are not significantly affected by the cultivation season and the affordability differences between pre-harvest and post-harvest periods. Agricultural production factors such as cultivating specific crops and involvement of livestock farming and seasons affect the frequency of consumption of food groups such as dairy and meat. Considering the above, the strategies to improve the nutrition of rural agricultural households in Sri Lanka by increasing dietary diversity may benefit from programmes encouraging production diversity.

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