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Research Article

SUBSISTENCE FARMER'S PRODUCTION DIVERSITY AND MARKET ACCESS: IMPACT ON RURAL WOMEN AND CHILDREN'S DIETARY DIVERSITY

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Abstract

Hunger and poverty are severe threats to developing nations like Pakistan. Rural people in developing countries are facing malnutrition and undernourishment due to low-income levels and limited access to nutritious food. Women's diets are the most crucial factor for their health and children. Increased dietary diversity is a significant approach to improving nutrition and health, and it can be enhanced by improving the production diversity among rural subsistence farming households. The study was conducted in four districts of the south Punjab region of Pakistan. Using the well-structured and pretested questionnaire, multistage stratified random sampling was employed to collect data from 600 rural households. The women's dietary diversity score, children's dietary diversity score, and production diversity score were calculated. The results indicate that women's dietary diversity is concerned with production diversity score; its interaction with market access, education, family size, and farming experience positively impacts dietary diversity. In contrast, the age of the respondent has a negative impact. The same association among factors was also observed for children's dietary diversity score. Based on the study results, it is recommended that there is a need to diversify the crops produced by small farmers, especially food crops so that they can get balanced food and not rely much on external purchases. Overall, the Government can play a crucial role by providing opportunities and facilities to grow non-conventional crops instead of conventional cash crops.

Keywords: Dietary Diversity, Production Diversity, Market Access, Rural, South Punjab.
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1. INTRODUCTION

Undernourishment and hunger are multidimensional concerns of the whole world. Over the last few decades, undernutrition has remained high even with enhanced food and diet security, specifically in African and Asian countries (Dubé et al., 2012; Godfray et al., 2020; IFPRI, 2014). According to the IFPRI report, about 800 million people worldwide are chronically hungry, and about 02 million suffer from micronutrient deficiency (IFPRI, 2014). The reason for this nutritional deficiency is not only the less food consumption but also the poor quality of diet and low dietary diversity cause the nutritional deficiency. The dietary diversity score is considered the most significant indicator of society's nutritional status for most scenarios. The decrease in overweight and obesity rates is also linked

to higher levels of dietary diversity (Popkin & Slining, 2013).

As higher dietary diversity is one of the significant approaches to enhancing nutrition and health, production diversity is considered the critical factor for higher dietary diversity among rural households (Pingali, 2015). The modern agricultural revolution has promoted narrow crop patterns worldwide, intending to enhance the productivity of major crops over the last 50 years (Khoury et al., 2014). In Africa and Asia, most of the rural population and small farmers are victims of hunger (Pinstrup-Andersen, 2007). For improved dietary diversity of subsistence farmers, the diversity in the production of crops at the farm level is considered one of the significant approaches (Jones et al., 2014; Pellegrini & Tasciotti, 2014; Powell et al., 2015).

According to the article, livestock-cum-agricultural farms are also among the best diversification methods for better dietary diversity among dietary diversity of farmers. When considering market access, the relationship between dietary and production diversity becomes more complex. If one has a better income, he will access the market to buy food instead of cultivating on a farm (Jones et al., 2014). This relation becomes more interesting when we also consider the off-farm income of farmers, as higher income leads to higher access to diversified food and market access, which results in more dietary diversity and vice versa (Haggblade et al., 2007). These arguments urge the need to study the impact of these parameters on rural women's dietary diversity, especially children's dietary diversity, to address the malnutrition and undernutrition challenge of rural subsistence communities of developing nations.

Malnutrition further becomes the cause of illness and stunt growth among children. During the last few decades, in Pakistan, like other developing countries, children's malnutrition has slightly increased (Asim & Nawaz, 2018). In Pakistan, the poverty level of an average family may or may not be a significant concern for lower children's dietary diversity for some reason. First, in the last 50 years, there has been no substantial reduction in the poverty rate, whereas, during the 1990s, the scarcity of goods significantly increased, causing a decrease in the skin-and-bone regularity rate. However, during the first decade of the ongoing century, the scarcity of goods is reduced, which significantly indicates the development in the country. Secondly, low purchasing power is considered an everyday miracle among rural people in Pakistan. Thirdly, the social care system is critically bound to the basis of Pakistani culture (Rana & Mumtaz, 2012).

A common question that arises in mind is, why is dietary diversity important? The consumption of different food groups provides various micronutrients and macronutrients to the body. The more food groups consume, the more dietary diversity and physical growth there is. A diverse diet is best to ensure nutrient adequacy. The diverse nutrient diets of children and rural women meet both kinds of needs, which we know and are likely yet unknown. Stunting children's growth is due to nutrition deficiency; low weight is a severe problem, and these parameters are essential in judging child malnutrition (Asim & Nawaz, 2018; Pretty et al., 2003). For financial and public development, childhood malnutrition and rural women remain the main communal problems in less advanced nations. According to the World Bank, more than half of the six million deaths of children aged below five each year in developing Asia are due to being underweight. The undernourishment and malnourishment of children are highest in Pakistan as compared to other developing nations (Muthini et al., 2018).

There is a need to diversify the agricultural production system so that poor people in the country can access nutritious and balanced food, especially subsistence farming communities (Pingali, 2015). Easy access of farmers from field to market facilitates

farmers' introduction of a cropping system, and farmers can increase their income (Qaim et al., 2014). It is observed that poor rural households find it difficult to manage diverse food with their low income.

Women's diets are the most critical factor for their health and their child. Proper diets can have a significant impact on children under five years old. Moreover, in recent years, due to an increased focus on nutrition-related programming, women's diets have been considerably acceptable but must be of better quality to meet the nutritional requirements (Food and Nutrition Technical Assistance Project (FANTA), 2015). It is observed that women's dietary diversity score is measured by measuring the individual women's dietary diversity score between the ages of 15 and 49. The dietary diversity scores were estimated using the 24-hour nutritional consumption of women. There are 11 food groups, namely pulses; starchy staples; vitamin A-rich fruits; dark green leafy vegetables and vegetables; roots and tubers; other fruits and vegetables; milk and milk products; egg; fish; meat; sugar and condiments, children's dietary diversity is defined as ideal if children (aged 6–59 months) consumed at least four food groups out of seven foods groups (Conrad et al., 2018). Minimum Dietary Diversity for Women (MDD-W) is a good indicator for women 15-49 years of age to evaluate their nutritive status by consuming at least five food groups out of ten food groups (FAO & FHI, 2016).

In most developing nations, markets for various food items are absent or imperfect; market information is also imperfect and irregular in most developing countries and production of the agriculture sector rather than subsistence in nature (Dillon & Barrett, 2014; Hoddinott et al., 2015). Globally, hunger is a burning issue even in the modern world. It has been observed that 170 million children (5-59) months age in the globe are facing strictly undersized growth, and 110 million (19%) are moderately or inhospitably low weight, according to overall estimation, almost more than partially all shocked growth children exist in the Asia region, nearly 51 million (8%) babies (5-59) months of age are only wasted in Asia (Asim & Nawaz, 2018).

Famine and hunger are also complex and worldwide problems in food security. Undernutrition and undernourishment are significant problems of primary concern in many developing countries. Dietary imbalance is accountable for a considerable number of women's and children's health loss production, diminishing physical health and human mental adjustment, exposure to numerous kinds of infections, and overdue deaths. In Asia and Africa, many hungry people live in rural areas (Sibhatu et al., 2015). Malnutrition problems are primarily present in rural areas of Asia and Africa, and it has been observed that they are subsistence farmers with low incomes. Even with the upgraded nutrients and food preservation over the previous few decades, the rate of malnutrition among low-weight children and women remains considerably prominent, particularly in African and Asian rural areas (Dubé et al., 2012; Godfray et al., 2020; IFPRI, 2014).

It has been estimated that 800 million people are hungry worldwide, and approximately 2 billion people cannot uptake essential nutrients for their whole lives (IFPRI, 2014). The income of households plays a significant role in nutritive variety, as inferior-income households lead to fewer dietary conditions, which causes different kinds of health problems. Sometimes, the production and consumption variety relationship might run undesirable in some circumstances; most small land-holding growers in under-developing states also have non-farm earning bases like private shops and some kinds of investment (Haggblade et al., 2009). Therefore, the function of natural market access is vital to food diversity.

In Pakistan, almost two-thirds of the total population spend their lives in backward rural areas, mostly where scarcity and malnutrition are common and burning issues nowadays. Mostly, rural people are directly connected with the agriculture sector, concerned with raring livestock and easygoing personal shops, and even have the highest existence of malnutrition among their children due to low income. Increased agriculture sector growth can improve food security with modern methods and technology, reducing poverty. The primary purpose of this study is to explore and explain the relationship between agriculture production variety and the dietary range of rural women and children under five years old (Asim & Nawaz, 2018). The agricultural production sector directly contributes to expanding the dietary consumption of the rural poor people with diversified food groups. So, it is necessary to focus on agricultural productivity. These productivity increases result in income increases, which are guaranteed to improve the nutritive condition of women and children in rural areas. Good food produced at farms can also boost the alimentary quality of the diet.

Productivity diversity and dietary diversity are associated with each other. Rural women's dietary diversity and children under five years of age's dietary diversity are highly affected by farm production. It was observed that a problem is arising in South Punjab. There needs to be more production diversity and low nutrient diversity in rural areas because they have traditional farming systems. On the other hand, nutritional diversity is essential for good health and proper growth of the human body. The study's objectives are 1) To assess the impact of production diversity on the dietary diversity of rural women and children under five years of age; 2) To identify the role of market access in dietary diversity; 3) To give policy recommendations based on study results.

2. Methodology

2.1. Study Area & Data Collection

The study was conducted in the South Punjab part of Punjab province, Pakistan. This study was mainly conducted in Multan and Dera Ghazi (DG) Khan Division. The reasons behind the selection of south Punjab are low income of households, low farm productivity, less access to food markets, low dietary diversity, and small land holdings. South Punjab's area is especially vulnerable because of its landlocked position, adverse soil quality, and severe climatic conditions, including inadequate and irregular precipitation. A multistage stratified random sampling technique drew the sample from the population. Firstly, we select two districts from each division and two tehsils from each district. Secondly, three villages from each tehsil were chosen randomly. From each village, 25 households were interviewed through face-to-face interviews. At last, the total sample size was 600.

The data was collected through a cross-section survey of subsistence farmers in the study area. A well-structured and pretested questionnaire about the socio-economic factors, production diversity, women's dietary diversity, and child dietary diversity was employed for the data collection.

2.2. Empirical and Statistical Framework

Kennedy et al. (2010) stated that the dietary diversity score and food variety score can be used to measure the dietary diversity among individuals. Generally, the dietary diversity score is adequate for cross-country comparison because it measures the number of food groups consumed during a recall period (07 days). On the other hand, the food variety score counts the number of food items consumed during the recall period, and it is generally employed when we need to calculate the dietary pattern in a specific study area. Therefore, we have used the dietary diversity score to meet the study objectives.

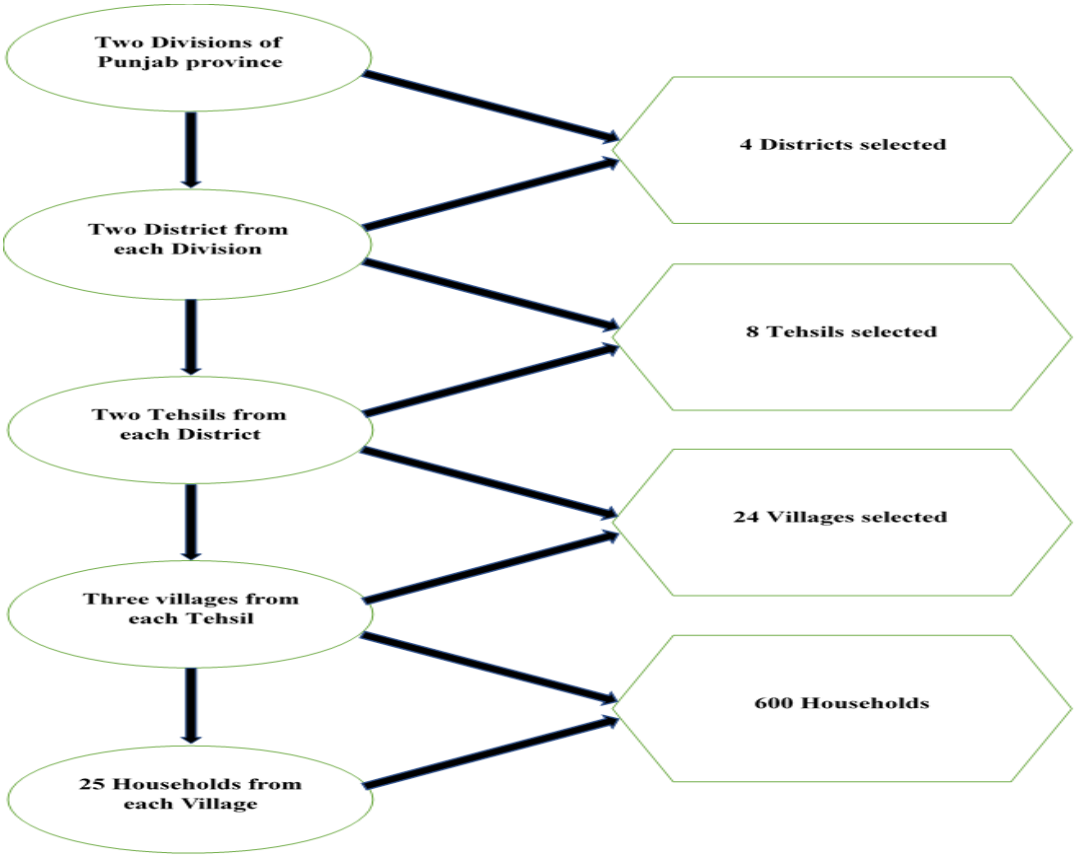

Figure 1: Flow diagram of sampling framework

2.3. Women's Dietary Diversity Score (WDDS)

The women's dietary diversity score (WDDS) measures food groups consumed during the previous 07 days recall period by women in the study area (Kennedy et al., 2010). We used the FAO recommended guidelines, "Guidelines for measuring household and individual dietary diversity," to calculate the WDDS. According to these guidelines, the data was collected from about 09 different food consumption statuses during the previous 07 days recall period. Table 1 briefly describes the food groups used to calculate the WDDS.

The WDDS was calculated based on how many food groups were consumed by women during the recent 07-day recall period. The number of food groups consumed by women was summed up to the total food groups consumed by women, which is termed WDDS.

2.4. Children's Dietary Diversity Score (CDDS)

As per FAO guidelines about dietary diversity, the children's dietary diversity score (CDDS) measured the number of food groups consumed by individual children of age between 06 to 23 months during the recent 07-day recall period (Muthini et al., 2018). The data was collected about 07 food groups consumed by children during the recall period at the time of the interview. Table 2 describes these 07 food groups used to measure the CDDS in this study.

In most rural families, one person supports the whole family and has a subsistence farming system. The low income of the household head directly impacts the child's diet because the household head cannot buy diversified food for the family members. We observed that most households in the study area have monthly incomes less than 20,000/- PKR (meager income). So, they cannot buy diversified food for their family members, especially for children, and they cannot diversify their farms because of low-income generations. They even need help to adopt modern agricultural practices.

Table 1: Food Groups to Calculate WDDS

Question Number (s)	Food Group	Examples
1, 2	Starchy Staples	Wheat, Rice, Maize/corn, Millet, or Any Other Grains or Foods Made from These (e.g., Vermicelli, Noodles, Porridge, or Other Grain Products) + Barley. White Potatoes, White Yam, or Other Foods Made from Roots
4	Dark green leafy vegetables	Dark Green/Leafy Vegetables, Including Spinach, Cabbage, Watercress, Lettuce + Locally Available Vitamin-A Rich Leaves
3, 6	Other Vitamin-A rich Fruits & Vegetables	Pumpkin, Carrot, Squash, Sweet Potato. That Are Orange Inside + Other Locally Available Vitamin-A Rich Vegetables (E.G., Red Sweet Pepper. Ripe Mango, Muskmelon, Apricot. Ripe Papaya, Dried Peach, and 100% Fruit Juice Made from These + Other Locally Available Vitamin-A Rich Fruits.
5, 7	Other Fruits & Vegetables	Other Vegetables (E.G., Tomato, Onion, Brinjal) + Other Locally Available Vegetables. Mango, Apple, Banana, Cherry, Dates, Guava, Lemon, Litchi, Olive, Mulberry, Plums, Pomegranate, Kiwi, Blackberry, Fig, Peach and Dry Fruits Including Almonds, Pistachios, Cashewnut and Walnuts.
8	Organ Meat	Liver, Kidney, Heart, or Other Organ Meats.
9, 11	Meat & Fish	Beef, Lamb, Goat, Chicken, Duck, Other Birds. Fresh or Dried Fish
10	Eggs	Eggs from Chicken, Duck, Ostrich, or Any Other Egg
12	Legumes, nuts & seeds	Dried Beans, Dried Peas, Lentils (Masoor), Nuts, Seeds, or Foods Made from These (E.g., Peanut)
13	Milk & Milk products	Milk, Cheese, Yogurt, Butter or Other Milk Products

Source: (Kennedy et al., 2010

Table 2: Food Groups for Children Dietary Diversity Score

Question Number	Food groups	Examples
1	**Fruits**	Mango, Pumpkin, Apricot (Fresh or Dried), Papaya, Dried Peach, and 100% Fruit Juice Made from These Other Fruits, Including Wild Fruits And 100% Fruit Juice Made from These.
2	**Vegetables**	Leafy Vegetables + Locally Available Vitamin A Rich Leaves Such as Spinach, Pumpkin, Or Sweet Potato. Vitamin A Rich Vegetable Like Potato Etc.
3	**Grains**	Bread, Pasta, Noodles, Breakfast, Cereal, Couscous (Salad), Rice, Corn, Barley.
4	**Dairy**	Milk & Milk Products.
5	**Protein**	Meat, Fish, Chicken, Eggs, Bean, Lentils, Chickpeas and Nuts
6	**Other foods**	Drinks, Junk Food, and Foods Having Caffeine (Tea, Coffee, Energy Drinks).

Source: (Muthini et al., 2018)

2.5. Production Diversity Score (PDS)

The production diversity score (PDS) is a simple and unweighted count measure used to estimate the number of crops, fruits, vegetables, or livestock raised on the farm by an individual during the last year (Kennedy et al., 2010). To calculate the PDS for this study, the individual farmer collected data from about 06 different crops and livestock production. Table 3 describes the crops and livestock production groups used to measure the PDS.

Table 3: Groups for Production Diversity Questionnaire

Q. No.	Crop food groups	Examples
1	**Cereals**	Wheat, barley, maize, sorghum, millet, rice
2	**Legumes, nuts and seeds**	Field pea, linseed, bean, lentil, groundnut, castor, sunflower, mustered oil crops such as canola, rapeseed.
3	**Vegetables**	Onion, cabbage, tomato, garlic, gourd, cucumber, okra, brinjal, cauliflower, lettuce, spinach, turnip, coriander, peas
4	**Fruits**	Mango, oranges, guava, dates, pomegranate, strawberry, papaya, apple, apricot, cherry, peach, lemon, litchi, olive, mulberry, plums, pear, sweet lime and dry fruits (almond, walnut)
5	**Spices**	Pepper, turmeric, bay leaf
6	**Livestock**	Cow, buffalo, sheep, goat, poultry

The association between the agriculture sector and nutrition runs both ways, as a good diet and health influence the ability to carry out agricultural-based labor (Mughal & Fontan Sers, 2020). Time spent by a woman laborer hurts nutrition as it decreases time for childcare (one of the underlying determinants of a child's nutritional status) and affects the dietary necessities of a woman. It is theoretically thought that growth in grain production as cereal crops is positively linked with dietary enhancement (Mughal & Fontan Sers, 2020). Many of the farmer's households operated their farm at a subsistence level; however, farmers with diverse sources of income (agricultural and non-agricultural) existed better protected against adverse shocks in food availability.

2.6. Econometric Model

The following multiple linear regression models adopted (Sibhatu et al., 2015) with square and interaction terms were employed to analyze the women's and children's on-farm production diversity and dietary diversity.

For Women:

$$WDDS_i = \alpha_0 + \alpha_1 PDS_i + \alpha_2 PDS_i^2 + \varepsilon_i \text{---} \text{(Model-01)}$$

In the extended model, we also used additional variables like market access, education, age, farming experience, and family size to measure the effects of socio-economic factors.

$$WDDS_{Si} = \alpha_0 + \alpha_1 PDS_i + \alpha_2 PDS_i^2 + \alpha_3 MA_i + \alpha_4 (PDS_i \times MA_i) + \alpha_5 Edu + \alpha_6 Age + \alpha_7 Exp + \alpha_8 F.Size + \varepsilon_i \text{ --- (Model-02)}$$

For Children:

$$CDDS_i = \alpha_0 + \alpha_1 PDS_i + \alpha_2 PDS_i^2 + \varepsilon_i \text{ --- (Model-03)}$$

In the extended model, we used additional variables like market access, education, age, farming experience, and family size as follows;

$$CDDS_{Si} = \alpha_0 + \alpha_1 PDS_i + \alpha_2 PDS_i^2 + \alpha_3 MA_i + \alpha_4 (PDS_i \times MA_i) + \alpha_5 Edu + \alpha_6 Age + \alpha_7 Exp + \alpha_8 F.Size + \varepsilon_i \text{ -- (Model-04)}$$

Several other factors influence dietary diversity. Farm production diversity may be correlated with some of the omitted factors, which had potentially biased the estimated results. For the robustness check, we used an extended model that included household socio-economic and demographic characteristics as explanatory variables.

3. Results and Discussion

3.1. Descriptive Statistics

The finding of the study indicates that the most frequently consumed food groups by women were starchy staples (99.17%), followed by other fruits & vegetables (95.19%), milk (89.89%), meat & fish (81.86%) and vitamin-A rich fruits & vegetables (66.78%). In comparison, the groups of eggs (62.30%), legumes (61.31%), green leafy vegetables (56.42%), and organ meat (14.08%) were less likely to be consumed (Figure 2). We have data from about 1207 women. We calculated the Average Women Dietary Diversity Score (WDDS) among these women, which is 6.257 from the nine food groups.

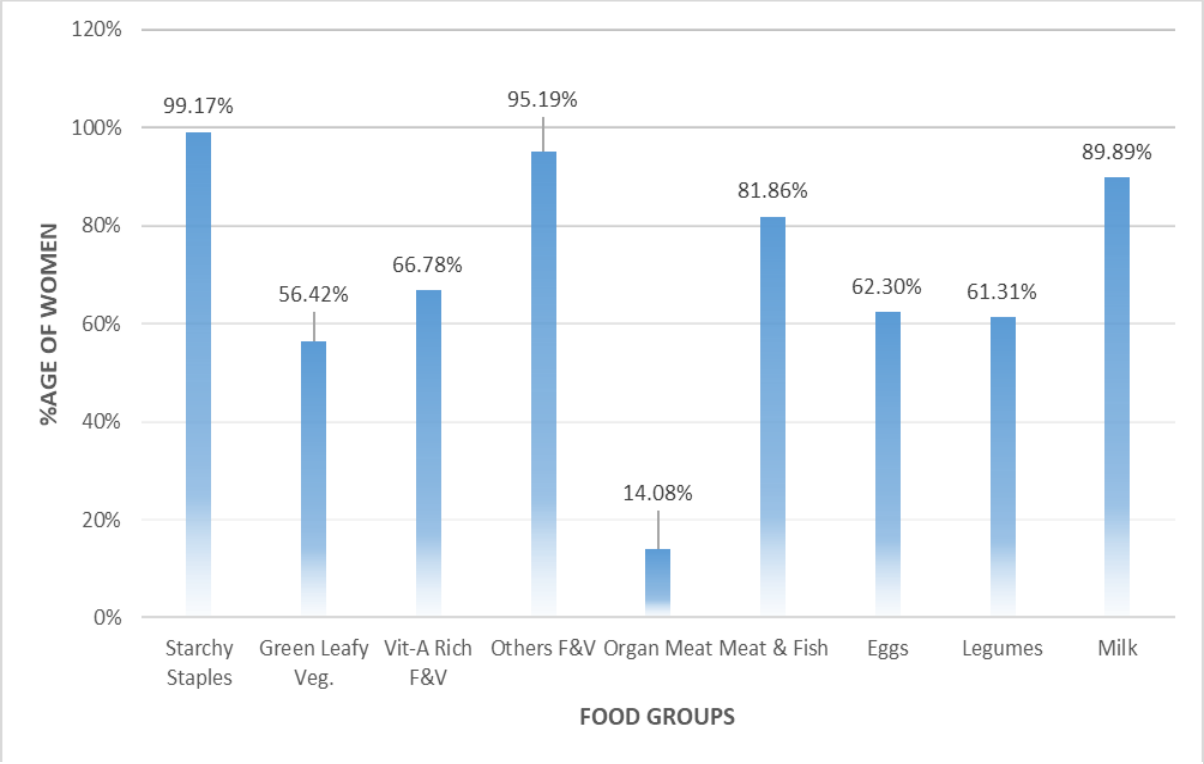

Figure 2: Food Groups Consumed by Women

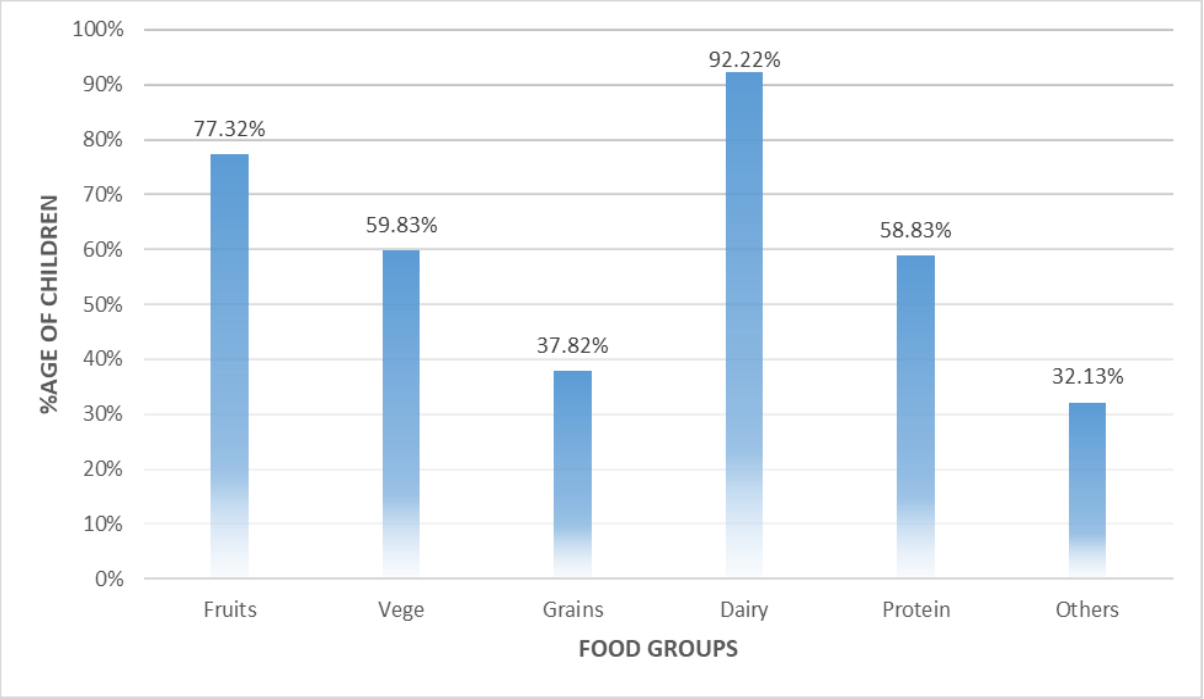

Figure 3: Food Groups Consumed by Children.

On the other hand, the most frequently consumed food groups by children were dairy products (i.e., milk) (99.17%), followed by fruits (77.32%), vegetables (59.83%), and protein (i.e. meat) (81.86%). In comparison, the groups of grains (37.82%) and others (32.13%) were less likely to be consumed (Figure 3). We have data on about 1195 numbers of children. We calculated the Average Children Dietary Diversity Score (CDDS) among these children, which is 3.22 from the six food groups.

From the production side, the most frequently grown crop groups by the small farmers were cereals (97.89%), followed by livestock (73.56%) and vegetables

(47.70%). In comparison, the groups of legumes, nuts & seeds (21.26%), fruits (21.26%), and spices (15.33%) were less likely to be produced (Figure 4). We have data from about 522 small farmers. We calculated the Average Production Diversity Score (PDS) among these households, which is 2.8 from the six crop groups.

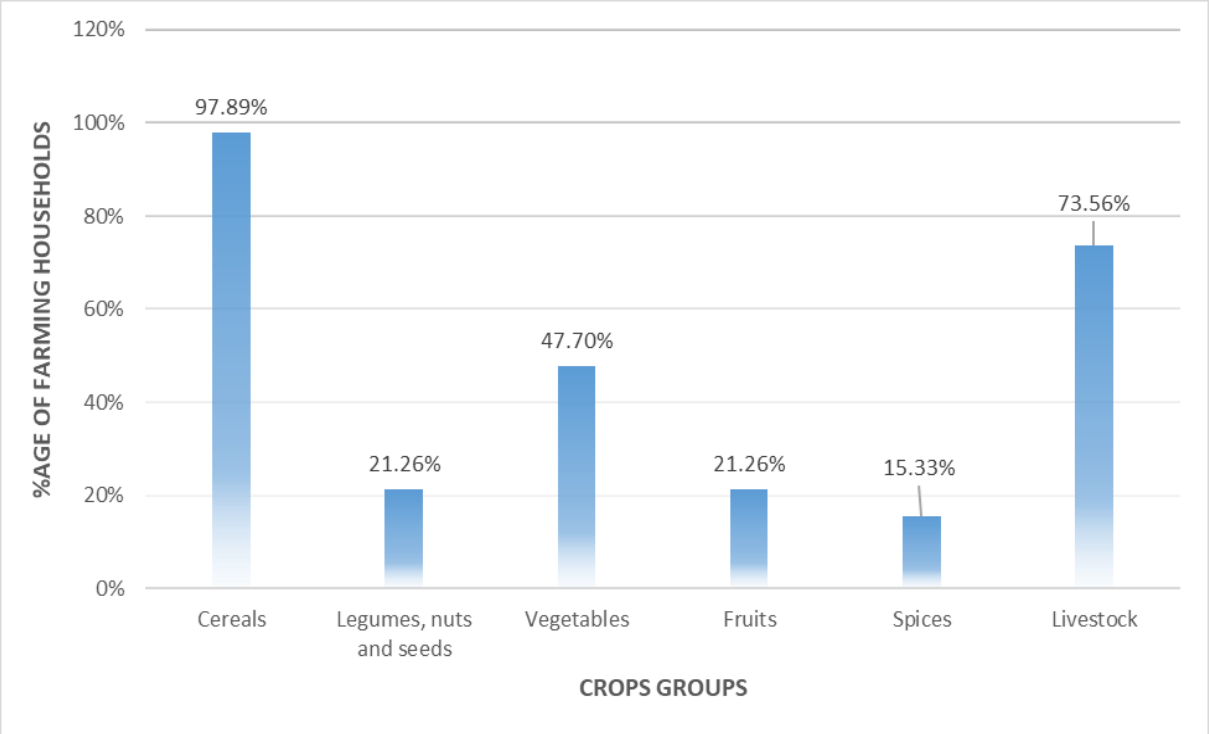

Figure 4: %age of Households growing the Crops Groups

3.2. Regression Results

We employed a regression model to study the impact of production diversity on women's dietary diversity. Table 4 shows that WDDS significantly depends upon the PDS of rural households. The household with higher PDS will enjoy higher WDDS and vice versa. Results show that if any household increases the PDS by 1 unit, then the WDDS will resultantly increase by 1.118 units with supporting highly significant t-statistics, which is 5.08***. This signifies a robust positive association between PDS and WDDS. Different studies during the literature review also emphasize that if someone has more diversity in production (i.e., raising more crops or raising livestock), it means having more PDS. The individuals (women) in his house will enjoy more dietary diversity (more WDDS) because of higher sources to consume more food (Muthini et al., 2018; Sibhatu et al., 2015; Sibhatu & Qaim, 2018).

But it holds to a certain level; if we move towards achieving higher PDS, then it would have a diminished effect on the WDDS (we have a positive impact of PDS and a negative effect of PDS-squared, which means that as people get higher PDS the impact of PDS is lessoned on WDDS). It is cleared here by our model's second variable (PDS_SQ). Sibhatu and Qaim stated in their study that higher production diversity may have a positive effect, no effect, and even a negative effect on the dietary diversity of rural subsistence farmers in different situations (Sibhatu et al., 2015; Sibhatu & Qaim, 2018). The coefficient of Intercept indicates that we have 4.9 WDDS with zero PDS. This suggests that the people of rural communities who are not growing crops or raising animals (i.e., laborers or working other than agriculture) and the individuals (women) of their families enjoy the average dietary diversity.

Table 5 describes the effects of socio-economic factors on WDDS. As we

Table 4: Regression Results of Model-01

	Coefficients	*Standard Error*	*t Stat*
Intercept	4.972351	0.333076	14.92858***
PDS	1.118222	0.220249	5.077073***
PDS_SQ	-0.18736	0.030795	-6.08416***
F-statistics	27.3434	p-value	0.00000

*** Statistically significant at the 1% level.

Table 5: Regression Results of Model-02

	Coefficients	*Standard Error*	*t Stat*
Intercept	5.946585	0.486025	12.23515***
PDS	0.86942	0.246911	3.521193***
PDS_SQ	-0.16816	0.031491	-5.33986***
MACESS	-0.01853	0.020816	-0.8901*
PDS_MACESS	0.010903	0.007467	1.460068*
Education	0.026247	0.013352	1.965761**
Age	-0.03292	0.00764	-4.30878***
Farming Exp	0.032597	0.008778	3.71371***
Family Size	0.010175	0.025981	0.391638*
F-statistics	10.1404	p-value	0.00000

*, **, *** Statistically significant at the 10%, 5%, and 1% level, respectively.

thoroughly discussed the relationship between WDDS and PDS in the first model, this model showed the same relationship (Sibhatu & Qaim, 2018). Here, access to markets for buying food and for selling farm produce was shown to be more critical for WDDS. It can be observed by interpreting the relationship between MACESS and WDDS. As the distance towards the market is reduced by 1 km, the WDDS will increase by 0.018 units and vice versa. It is not highly significant, but it is substantial enough to make some association between market access and women's dietary diversity score here. Hence, improving access to markets through better infrastructure and institutions seems to be a more promising approach for better WDDS (Koppmair & Qaim, 2017).

Now, we move toward the interaction term of PDS_MACCS. What does it tell us? In the literature, the interaction term of market access and PDS remains insignificant in most cases. The result of our estimated model shows a positive and significant interaction coefficient of market access and PDS, which interprets that production diversity is more important for remote areas, and most of the farms in these areas are at subsistence levels (Sibhatu et al., 2015). Higher Women's education significantly increases dietary diversity, especially in low agricultural productive regions. Our result indicates that educated women were likelier to experience a higher dietary diversity than women with lower education. One of the reasons for this phenomenon of higher dietary diversity with higher education is that educated women allocate a significant share of expenditure for their food (Mbwana et al., 2016; Morseth et al., 2017), and also there is a reason behind this allocation of budget, which is greater awareness and knowledge about the advantages of nutritionally diversified food (Taruvinga et al., 2013). In our model, the effect of household

Table 6: Regression Results of Model-03

	Coefficients	*Standard Error*	*t Stat*
Intercept	2.047612	0.333023	6.148567***
PDS	0.824931	0.220214	3.746041***
PDS_SQ	-0.11557	0.030791	-3.75333***
F-statistics	7.1084	p-value	0.00090

*** Statistically significant at the 1% level.

education on WDDS is significant, and if a household gets one year more education, then WDDS will increase by 0.03 units. The magnitude is less but substantial, with a t-stat value of 1.97**.

The result depicts that the age of the household head is negatively associated with WDDS. The higher the age of the household head, the lower the WDDS. The coefficient describes that an increase in the age of the household head by 01 year decreases the WDDS by 0.03 unit with highly significant t-statistics. There are some explanations to support our result. One may be that the aged household head may not be involved in work for a longer time during the day, and the second may be that the aged household head does not have a significant amount of income to purchase the appropriate quantity of food for the consumption of their families (Huluka & Wondimagegnhu, 2019). On the other hand, the farming experience of household heads has a positive and significant effect on WDDS, although the effect is negligible. The result indicates that an increase of one year in the farming experience of household heads increases the WDDS by 0.03 units. This may be due to the higher the experience of the household head, the higher the likelihood of him allocating a significant amount of his time to farm activities (Huluka & Wondimagegnhu, 2019).

Table 6 shows that CDDS significantly depends upon the household's PDS. The result describes that the association between production diversity and dietary diversity is positive, but the effect is relatively small (Sibhatu et al., 2015). The household with higher PDS will provide higher dietary diversity to its children and vice versa. The result shows that if any household increases the PDS by 1 unit, the CDDS will increase by 0.825 units, supporting highly significant t-statistics of

Table 7: Regression Results of Model-04

	Coefficients	*Standard Error*	*t Stat*
Intercept	1.990103	0.488344	4.075209***
PDS	0.603521	0.248089	2.432684**
PDS_SQ	-0.1072	0.031641	-3.38803***
MACESS	-0.04736	0.020915	-2.26442**
PDS_MACESS	0.014948	0.007503	1.99221**
Education	0.010559	0.013416	0.787027*
Age	-0.00233	0.007676	-0.3034*
Farming Exp	0.005695	0.008819	0.645755*
Family Size	0.094875	0.026105	3.634325***
F-statistics	4.2258	p-value	0.00006

*, **, *** Statistically significant at the 10%, 5%, and 1% level, respectively.

3.75. This signifies a robust positive association between CDDS and PDS. Different studies during the literature review also emphasize that if a household has more diversity in production (i.e., raising more crops or raising livestock), it means having more PDS. The individuals (children) in his house will enjoy more dietary diversity (more CDDS) because of the higher sources of food to consume (Sibhatu & Qaim, 2018). But it holds to a certain level. If we move towards achieving higher PDS, then it would have a diminishing effect on the CDDS (we have a positive impact of PDS and a negative effect of PDS-squared, which means that as people get higher PDS, the impact of PDS is lessoned on CDDS).

Table 7 represents the result of model-04, which describes the effects of socio-economic factors, including PDS, on CDDS. The relationship between PDS and CDDS is the same as observed in the previous model, indicating a positive association between PDS and CDDS (Sibhatu & Qaim, 2018). However, market access to buy food and sell farm produce was shown to be more critical for CDDS. It can be observed by interpreting the MACESS and CDDS relationship. As the distance towards the market is reduced by 1 km, the CDDS will increase by 0.05 units and vice versa. It is not highly significant, but it is substantial enough to make some association between market access and children's dietary diversity score here. Therefore, improved market access through infrastructural and institutional development could significantly improve CDDS (Koppmair et al., 2017).

The relationship between PDS_MACCS and CDDS is identical to the one we observed in the case of WDDS in the earlier model. The result of our model highlights the positive and significant relationship among these variables, supported by the same results Sibhatu et al., (2015). Moreover, the education of the household head also plays a vital role in better CDDS (Bi et al., 2019), especially the education of women members of the family, which may increase the CDDS (Mbwana et al., 2016; Morseth et al., 2017). This is mainly because educated women tend to have greater awareness and understanding of nutritional health benefits (Taruvinga et al., 2013). In our model, the effect of household education on CDDS is significant, and if a household gets one year more education, then CDDS will increase by 0.01 unit. The magnitude is less but substantial, with a t-stat of 0.87*.

The result shows that one more year increase in household age will decrease the CDDS by 0.03 units. There are some explanations to support our result. One may be that the aged household head may not be involved in work for a longer time during the day, and the second may be that the aged household head does not have a significant amount of income to purchase the appropriate quantity of food for the consumption of their families (Huluka & Wondimagegnhu, 2019). The farming experience also plays a vital role in achieving better CDDS, but the effect is considerably small. The result indicates that one more year of farming experience would result in 0.006 units more CDDS. This could be because the more experienced households are more likely to devote their time to agricultural activities (Huluka & Wondimagegnhu, 2019).

The determining factors of dietary diversity are complex and depend upon many distinct and interconnected factors. The conceptual framework to determine malnutrition proposed by the United Nations International Children's Emergency Fund (UNICEF) provides a detailed impression of factors affecting dietary diversity. Therefore, this study has highlighted some of the determining factors of dietary diversity, that is, the sub-component of dietary intake.

4. Conclusion and Recommendations

The study results conclude that farm diversification positively impacts the dietary diversity of women and children under five years of age. Production

diversity and market access have a more significant impact on dietary diversity. Regarding women's dietary diversity, the production diversity score and its interaction with market access, education, family size, and farming experience positively impact dietary diversity. In contrast, the age of the respondent has a negative effect. The same factors also affect children's dietary diversity scores.

The results show a positive and significant impact of production diversity of dietary diversity of women and children under five years of age. Market access coupled with production diversity score also positively and significantly impacts the dietary diversity of women and children under five years of age. It is recommended that small farmers diversify their crops, especially food crops so that they can get balanced food and not rely too much on external purchases. Farming households should also engage themselves in off-farm earning activities. The Government can play a crucial role by providing opportunities and facilities to grow non-conventional crops instead of conventional cash crops.

5. Recommendations

Based on study results, it is recommended that small farmers diversify their crops, especially food crops so that they can get their balanced food and only a little relied on external purchases. Farming households should also engage themselves in off-farm earning activities. Overall, the Government can play a crucial role by providing opportunities and facilities to grow non-conventional crops instead of conventional cash crops. The specific recommendations are as follows.

1. There should be an increase in the area under their cultivation. With the rise in the number of households in the cultivated area, as well as women and children, dietary diversity will also increase.
2. Production diversity is directly associated with household dietary diversity. So, I strongly recommend enhancing their production diversity at the farm level. Because of their production diversity, household dietary diversity will increase, and a variety of food will be available for household consumption.
3. The standard of education should be increased because education level is positively associated with dietary diversity.
4. Family size should be under control through local meetings and face-to-face individual talks because the population decreases natural resources and causes hunger.
5. Farm experience of farmers directly associated with household dietary diversity. The dietary diversity of households increases as a result of farm experience increases.
6. The extension wing of the Agriculture Department should work to create awareness about crop diversification and its impact on dietary diversity and income.

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