Proceedings of the 2022 International Conference "ECONOMIC SCIENCE FOR RURAL DEVELOPMENT" *No 56*
Jelgava, LLU ESAF, 11-13 May 2022, pp. 555-562
DOI: 10.22616/ESRD.2022.56.055

EMPIRICAL ANALYSIS OF SMALLHOLDER PRODUCTION EFFECT TO DIETARY DIVERSITY

Fotima Saydullaeva[1], Ph.D. student; **Khusniddin Pardaev**[2], Ph.D. student;
Shukrullo Muratov[3], Ph.D. student; **Golibjon Tursunkulov**[4] Ph.D. student

[1, 2, 3, 4]Samarkand branch of Tashkent State Agrarian University

Abstract. Most of the vulnerable people live in rural areas. In that case, agricultural and rural development should be a crucial part of a food security and poverty reduction strategy. This article describes the results of a study on the example of smallholders in Samarkand region, which has a high share in agricultural production in Uzbekistan. In Uzbekistan, almost half of the population lives in rural areas and most of them are smallholders. This paper examines how agricultural production diversification (APD) impacts rural households' dietary diversity (HDD) using crop and livestock diversification separately at a household level. Data were analysed using a multivariate regression model, according to the results APD was positively correlated with HDD consumed their own production. Nevertheless, in terms of livestock diversification, there was a negative association with HDD which consumption comes from the market. Furthermore, it is identified that APD will increase productivity, especially livestock diversification is beneficial for nutrition. Along with, encouraging APD by the government can increase food availability and access by linking to agriculture in Uzbekistan. Besides that, dissemination of information on healthy eating by community self-government bodies, in the mass media, and at educational institutions will further increase their knowledge of dietary diversity as a food security indicator.

Keywords: dietary diversity, crop diversification, livestock diversification, multivariate regression model, nutrition.
JEL code: Q18, Q13

Introduction

Food and agriculture organization indicates that most of the food insecure and vulnerable people live in rural areas (Food and agriculture.., 2020). It has been widely reported that more than 80% of consumption food is produced by smallholders in the world (Food and agriculture.., 2014). Despite this, rural dwellers are still substantially food insecure (International fund for.., 2013). In that case, agricultural and rural development should be a crucial part of food security and poverty reduction strategy. This article analyses the factors influencing food access in rural areas of Uzbekistan, which is a low-middle-income country in Central Asia. In the first years of independence, Uzbekistan was considered an agrarian country because the main production of the economy was strongly related to agriculture. In recent years, due to the rapid growth of other sectors of the economy, the share of agriculture in the country's GDP has declined. At the same time, structural changes have taken place in agriculture, and the types of agricultural enterprises have also changed radically. State and collective farms have been replaced by private farmers and smallholders as the main producers of agricultural products. In Uzbekistan, 49 percent of the population lives in the countryside and the bulk of them are smallholders.

Private farms mainly produce state-ordered strategic products cotton and wheat on large areas of plots. From the point of view of smallholders, they especially use land plots as backyard kitchen gardens and are discretion to choose their crops to cultivate and trade to their demands (World Bank and.., 2018). Besides more than 90 percent of meat and milk and 60 percent of eggs were produced by smallholders in 2020. It means smallholders are highly engaged in animal husbandry. Still, smallholders have too small land sizes to generate profits at a scale that would negate the need to generate additional income via other means.

Recently, "The agricultural development strategy of the Republic of Uzbekistan for 2020 – 2030" has been adopted as a legal framework and roadmap for sustainable agricultural development in the country.

1Email: fsaydullayeva@yahoo.com; mobile phone: +998915290327
2Email:pardayev@yahoo.com; mobile phone: +998993895537
3Email: shukrullo.muratov@yahoo.com; mobile phone: +998938348383
4Email: golibtursunkulov@gmail.com; mobile, phone: +998995911995

The food security of the population is ensured as the priority of the strategy. Promote healthy consumption, intensifying and diversifying the agricultural production, increasing productivity in livestock, conducting research enhanced at the sustainable intensification of production of fish and poultry, as well as milk production was set as the main tasks of the priority direction of the strategy (Presidential decree of .., 2019). Accordingly, exploration and evaluation of the activities, and APD in smallholders accomplish a vital role in the performance of these tasks.

Dynamic changes in production by economic forms increased by 7.1% on smallholders and decreased by 7.3% on private farms. In the livestock sector, meat production has doubled, milk production has tripled and egg production has increased tenfold. In Samarkand region, compared to the real production per capita by recommended norms, the produced products were higher than the level of demand per capita. Statistical observations show the highest rate among the production of vegetables and grapes, the amount of which was three times higher than in previous periods (Saydullaeva, 2021). Several studies found that socio-demographic factors of agricultural producers' statistically significant impact the household income changes (Muratov, 2021). Smallholders would prefer mixed crop production and consumption, and sell the rest of production by contract through the agri-food supply chain. They want to produce products on a contract basis with partners in the sector for an entity to minimize risks and guarantee returns (Pardaev, 2021). Additionally, scientists have carried out an investigation on crop diversification in the case of Uzbekistan (Bobojonov et al., 2013). Although the available literature on APD has been disclosed, only crop diversification has been identified at the level of private farms (Primov, 2021; Hasanov, 2016). The novelty of the work is that this paper examines how APD impacts smallholders' food security using crop and livestock diversification separately at the household level.

The purpose of this article is to analyse the smallholders` production diversity influences HDD and recommend a healthy diet for rural households. The main objectives of our paper are the follows: (1) to measure APD indices in Samarkand region case; (2) to investigate the impact of APD on the HDDS of rural households and (3) to analyse the factor effecting to the HDDS.

The paper is structured as follows. In the next parts, we provided the material and methods, presented research results, and discussed the tasks; finally, provide a conclusion and suggestions for policy implications.

Materials and methods

The study was conducted in Samarkand region, which is a major agricultural area in Uzbekistan. Agricultural production was the highest (12.9 percent) share in this region in 2021. Data collection started at the beginning of January to the end of March 2021 through in-person interviews. Total of 328 respondents were randomly selected in nine districts (Akdarya, Bulungur, Ishtixan, Jomboy, Kushrabad, Payarik, Pasdargom, Taylak, Urgut) of Samarkand region.

In this paper, one of the attractive household dietary diversity score (HDDS) is used to indicate household food access. Swindale and Bilinsky proposed using 24-hour recall data on food intakes categorized into 12 different food groups (Swindale and Bilinsky, 2006). The HDDS is a count variable that includes 12 food groups from 0 to 12. The food groups took in cereals, roots and tubers, vegetables, greens, fruits, nuts and pulses, meat, eggs, milk and dairy products, sugar, beverages, oil and fat. In this study, HDDS was divided into two variables to allow assess more accurately the impact of APD.

APD is measured at a given time and, place by a sole quantitative indicator. Pal and Kar argue that there are several indices available to measure APD (Pal and Kar, 2012). Among them, Simpson Index, Shannon Index, Entropy Index, Ogive Index, Composite, and Herfindahl-Hirschman Index are the most

applicable to measure the degree of diversification (Kumar, Kumar and Sharma, 2012). Each of these indices has its pros and cons in terms of data essential, level of sophistication, and ease of computation and interpretation.

Herfindahl-Hirschman Index (HHI), is the most popular method in economics to measure the market concentration (Ferreira, 2012). Previous studies have been used to measure crop diversification (Pellegrini and Tasciotti, 2014a; Adjimoti et al., 2017; Auffhammer and Carleton, 2018), only a few studies applied to measure livestock diversification (Sussy, Shadrack and Oluoch-Kosura, 2019; Mulwa and Visser, 2020). In this paper, HHI was applied to measure the extent of APD. Using the equation below, the index (Ht) was calculated such as:

$$H_t = 1 - \Sigma(S_{it})^2 \quad (1)$$

S_{it} has denoted the share of *i* crop in total planted area in the year 't'. From the point of view livestock diversification index S_{it} represents the share of *i* livestock type in total number of livestock then applied to calculate the diversification index (Chalmers K. Mulwa and Visser, 2020).This index bounds between zero and one value. Higher is the value of the index, the larger is the degree of diversification. The index provides only the magnitude of diversification, and not its nature or direction.

Identifying the nutrition knowledge level of the household head is important. Nevertheless, it is a complicated task to measure its scale. We have to define a tool for expressing information and knowledge about the quality, quantity, and timing of food consumption. In determining households' nutrition knowledge, the survey included a nutrition knowledge index in which 12 questions were formulated on the framework of a literature review (Mancino and Kinsey, 2008) that impressed knowledge of daily fruit and vegetable consumption norms and knowledge of diseases caused by excessive consumption of fat.

Several empirical research has underlined the parallel importance of market access for HDD (Bonuedi, Kornher and Gerber, 2021). Measuring market access is also different considering the research aim and scope. In this paper, distance to the closest market is applied to determine market access. Credit access, land size household assets, access to pure water and natural gas, and household socio-demographic characteristics are used to control independent variables.

To explore the association between livestock diversification, and crop diversification nutrition knowledge with households' dietary diversity, we estimated multivariate regression analysis. Multivariate regression is a model that evaluates a single regression analysis consisting of several dependent variables and provides a concise mathematical statement of the model (Richard A. Johson, 2007). Briefly, in the fixed effects regression model, each dependent variable in a sample of n observations may be expressed as a linear function of a set of independent variables plus a random error, ε. The number of independent variables (x) is denoted by q, and the βs are the regression coefficients as follows: (Cleff T., 2019)

$$y_n = \beta_0 + \beta_1 x_{n1} + \beta_2 x_{n2} + \cdots + \beta_q x_{nq} + \varepsilon_n \quad (2)$$

The general structure of the model can be demonstrated as follows:

$$Y_{1,2} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \varepsilon_{1,2}$$

X_1 - Crop diversification
X_2 - Livestock diversification
X_3 - Nutrition knowledge
X_4 - Household monthly income, logarithmic
X_5 - Market access
X_6 - Household facilities
X_7 - Access pure drinking water
X_8 - Access natural gas
X_9 - Credit access
X_{10} - Land size
X_{11} - Household head age
X_{12} - Household head education
X_{13} - Household head experience

Research results and discussion

Table 1 describes households' characteristics. As dependent variables mean household dietary diversity from own production and bought from the market were respectively 3.6 and 5.024.

Household assets more than 50 percent of respondents have their own car, and 57 percent of households use a refrigerator. Only 7 percent of respondents in the sample size have a stove for cooking and contemporarily, more than 68 percent of households use an electric oven. 25 percent of household heads acquired high education. Average head age and experience are respectively 53 and 23 years.

Table 1

Descriptive statistics for analysing HDDS

Descriptive statistics for analysing HDDS

Variables	Obs	Mean	Std. Dev.	Min	Max
HDDS own	328	3.622	1.645	0	8
HDDS bought	328	5.024	1.663	1	10
Crop diversification (HHI)	328	.767	.125	.282	.903
Livestock diversification (HHI)	256	.204	.237	0	.663
Nutrition knowledge	328	9.293	1.717	4	12
Log Household monthly income	328	15.12099	.6501497	13.21767	16.70588
Market access, km Household facilities	328	4.232	2.432	.5	12
Car	328	.524	.5	0	1
Refrigerator	328	.573	.495	0	1
Stove	328	.72	.45	0	1
Electric oven	328	.683	.466	0	1
Credit access	328	.305	.461	0	1
Access pure drinking water	328	.878	.328	0	1
Access to natural gas	328	.28	.45	0	1
Household high education	328	.256	.437	0	1
Land size, ha	328	0.22	16.574	7	130
Head age	328	53.329	13.194	30	82
Head experience	328	23.146	14.732	0	60

Source: authors' own calculations based on questionnaire data

Table 2 shows estimates of APD between HDD. Livestock diversification was calculated using 256 observations cause 72 respondents indicated that they didn't engage in livestock rearing. The multivariate regression analysis results indicated that crop diversification was significantly and positively impacted to change the HDDS which consumption food from its own production. Namely, diversification of households own planted crops is upgrading the HDDS by 60%. However, if a family purchases the consumption food

from the market it minimizes the HDDS by 3%, but its statistical significance level is very low. Several previous research also found positive relationship between APD and dietary diversity case of developing countries (Murendo *et al.*, 2018; Romeo *et al.*, 2016). From the point of view, a scale of livestock diversification score increases HDDS by 20%, but there was a significant and negative impact on HDDS by 43% if consumption food bought from the market. The meaning is that less diversified households in livestock tend to buy more diversified livestock products from the market.

Table 2

Multivariate regression Crop and livestock diversification on dietary diversity

Equation	Obs	Farms	RMSE	R-sq	F	P
HDDS_own	256	17	1.269198	0.3313	7.401066	0.0000
HDDS_bought	256	17	1.255928	0.2775	5.735947	0.0000
			HDDS_own		HDDS_bought	
Crop diversification (HHI)			1.600* (0.948)		-1.036 (0.938)	
Livestock diversification (HHI)			1.196*** (0.423)		-1.430*** (0.418)	
Nutrition knowledge			0.124* (0.051)		-0.039 (0.050)	
Log household monthly income			0.010 (0.141)		-0.101 (0.140)	
Distance market			0.017 (0.052)		-0.039 (0.051)	
Car			0.089 (0.183)		-0.112 (0.181)	
Refrigerator			-0.126 (0.210)		0.227 (0.208)	
Stove			-0.120 (0.222)		0.287 (0.219)	
Electric oven			-0.484** (0.212)		0.540** (0.210)	
Credit access			-0.775*** (0.197)		-0.101 (0.195)	
Access pure drinking water			0.435 (0.295)		0.727** (0.292)	
Natural gas			0.201 (0.262)		-0.943*** (0.259)	
Head high education			0.402* (0.221)		0.552** (0.219)	
Land size			0.034*** (0.006)		-0.007 (0.005)	
Head age			0.017* (0.010)		-0.023** (0.010)	
Head experience			0.003 (0.009)		-0.013 (0.009)	
_cons			-0.575 (2.343)		8.359 (2.319)	

Source: authors' own calculations based on questionnaire data

Interestingly, the nutrition knowledge of the household head has a positive association with HDDS with own production. The educated household head's own production is increasing HDDS by 12%, in other ways 4% decrease the HDDS.

The presence of an electric oven in households revealed a negatively impacted on the HDDS from own production, but a positive impact bought from the market.

Credit access has a weak negative linkage with HDDS from its own production. It expresses that households sell most of their own production on the market to pay money back the credit (Cele and Mudhara, 2022).

Results from access to pure drinking water have a positive association and access to natural gas has a negative association with HDDS bought from the market at 5 and 1 percent statistical significantly respectively.

Household head education level is statistically significant at 1 percent with a positive association with HDDS. It means having high education of the household head has the opportunity consume more diversity. We know that land availability plays an important role in own agricultural production. In our learning case, the land size has a strong and positive impact to increase the HDDS for own producers. Having more land for consumption food purchased by families it is a slight negative change the HDDS.

In Uzbekistan, commonly, the aged household head prefers to produce their own and organic. Therefore, in our analyses, increasing per age of household head is upgrading the HDDS of own produces by almost 2% and 2% degraded HDDS for food purchased by families.

Conclusions

1) The study outcomes exhibited that APD had a positive, strong impact on HDD with their own production but in terms, of livestock diversification there has a negative association with household dietary diversity which consumption comes from the market. The results recommend that involving APD will increase the consumption of production; especially livestock diversification is beneficial for rural household nutrition.

2) APD is considered as an effective strategy that can help contribute to improved yield for the smallholders which will transform into more and a variety of food for consumption, accumulate stocks of products with reduced seasonality, and minimize the risks of selling surplus.

3) Along with, encouraging APD by the government can increase food availability and access by linking to agriculture in Uzbekistan.

4) Besides that, dissemination of information on healthy eating by community self-government bodies, in the mass media, and at educational institutions will further increase their knowledge on dietary diversity being a food security indicator

Bibliography

1. Abdulla, P. (2021) 'Status of Crop Diversification in Uzbekistan and its Empirical Analysis, *Journal of Marketing and Emerging Economics*, 1(5), pp. 7–12.
2. Adjimoti, G. O. et al. (2017) 'Input Policies and Crop Diversification: Evidence from the Collines Region in Benin', *African Development Review*, 29(3), pp. 512–523.
3. Auffhammer, M. and Carleton, T. A. (2018) 'Regional Crop Diversity and Weather Shocks in India', *Asian Development Review*, 35(2), pp. 113–130.
4. Bobojonov, I. et al. (2013) 'Options and Constraints for Crop Diversification: a Case Study in Sustainable Agriculture in Uzbekistan', *Agroecology and Sustainable Food Systems*, 37(7), pp. 788–811.
5. Bonuedi, I., Kornher, L. and Gerber, N. (2021) 'Agricultural Seasonality, Market Access, and Food Security in Sierra Leone', *Food Security*, (November). DOI: 10.1007/s12571-021-01242-z.
6. Cele, T. and Mudhara, M. (2022) 'Impact of Market Participation on Household Food Security among Smallholder Irrigators in KwaZulu-Natal, South Africa', *Agriculture*, 12(2), p. 261.
7. Economic, F. A. O. (2014) 'The State of Food and Agriculture (SOFA) 2014'.
8. FAO (2020) 'and Rural Poverty: Supporting and Protecting the Rural Poor in Times of Pandemic', in *FAO: Rome, Italy*.
9. Ferreira, C. (2012) 'Bank Efficiency, Market Concentration and Economic Growth in the European Union'.
10. Hasanov, S. (2016) 'Agricultural Policies to Enhance the Development of Fruit and Vegetable Subsectors in Uzbekistan', *European Scientific Journal*, 12(13).

11. IFAD, U. (2013) 'Smallholders, Food Security and the Environment', *Rome: International Fund for Agricultural Development*, 29.
12. Kumar, A., Kumar, P., and Sharma, A. N. (2012) 'Crop Diversification in Eastern India: Status and Determinants', *Indian Journal of Agricultural Economics*, 67(902-2016–66732).
13. Mancino, L. and Kinsey, J. D. (2008) *Is Dietary Knowledge Enough? Hunger, Stress, and Other Roadblocks to Healthy Eating*.
14. Mulwa, Chalmers K and Visser, M. (2020) 'Farm Diversification as an Adaptation Strategy to Climatic Shocks and Implications for Food Security in Northern Namibia', *World Development*, 129, p. 104906.
15. Mulwa, Chalmers K. and Visser, M. (2020) 'Farm Diversification as an Adaptation Strategy to Climatic Shocks and Implications for Food Security in Northern Namibia', *World Development*, 129, p. 104906. DOI: 10.1016/j.worlddev.2020.104906.
16. Muratov, S. A. (2021) 'The Economic Assessment of Factors Affecting Small Household (tomorka) in Rural Areas and Their Income', *Irrigation and Melioration*, 2021(3), pp. 45–51.
17. Murendo, C. et al. (2018) 'Nutrition Education, Farm Production Diversity, and Commercialization on Household and Individual Dietary Diversity in Zimbabwe', *Food & Nutrition Research*, 62.
18. Pal, S. and Kar, S. (2012) 'Implications of the Methods of Agricultural Diversification in Reference with Malda District: Drawback and Rationale', *International Journal of Food, Agriculture and Veterinary Sciences*, 2(2), pp. 97–105.
19. Pardaev, Kh. (2021) 'Smallholders Preferences for Contract Design Attributes, a Case of Samarkand Province', *Economics and education*, (5), pp. 59–66.
20. Pellegrini, L. and Tasciotti, L. (2014) 'Crop Diversification, Dietary Diversity and Agricultural Income: Empirical Evidence from Eight Developing Countries', *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, 35(2), pp. 211–227.
21. Presidential decree No. UP-5853 "About Approval of the Strategy of Development of Agricultural Industry of the Republic of Uzbekistan for 2020 – 2030" October 23, 2019
22. Richard A. Johson, D. W. W. (2007) *Applied Multivariate Statistical Analysis*, Pearson Education.
23. Romeo, A. et al. (2016) 'Linking Farm Diversification to Household Diet Diversification: Evidence from a Sample of Kenyan Ultra-poor Farmers', *Food security*, 8(6), pp. 1069–1085.
24. Saydullaeva, F. J. (2021) 'Main Directions of Food Security in Uzbekistan (the case of Samarkand province)', *Irrigation and Melioration*, 2021(3), pp. 39–44.
25. Sussy, M., Shadrack, N. and Oluoch-Kosura, W. (2019) 'Determinants of Maize Yield Variability on Smallholder Farms in Western Kenya'.
26. Swindale, A. and Bilinsky, P. (2006) 'Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide', *Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development*.
27. World Bank and The Eurasian Centre for Food Security (2018) 'Agricultural and Food Systems Transformation for Better Food Security and Nutrition in Eurasia: Country Study Tajikistan'.