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Extent and Determinants of Crop Diversification: Empirical Evidence from Kashmir Valley

Seerat Sajjad and Khursheed Hussain Dar[1]

ABSTRACT

Limited industrialization due to the lack of infrastructure has made agriculture and its allied activities vital to economic growth in Jammu and Kashmir. The study focuses on examining the extent and determinants of crop diversification in the fruit cultivated in the region. Primary data from 400 farming households producing horticulture crops was collected using a multi-stage sampling approach. The Simpson diversification index is used to measure the extent of crop diversification. Beta regression, an econometric technique, is used to analyze the determinants of crop diversification. The results of the study showed an average crop diversification index of .67. Additionally, results from beta regression show that education of the head, the main occupation of the head, irrigation availability, sources of irrigation, availability of credit, landholding, and household size had a significant and positive impact on crop diversification whereas earning members, credit intensity, market accessibility impacted crop diversification negatively. The results obtained have significant policy implications given the fact that the economy of the region has witnessed setbacks due to conflict and lack of industrial base. However, given its penetration, the horticulture section has sustained the region's economy. Besides, it is expected to help policymakers frame policies that will mitigate uncertainties, lead to nutritional enhancement, meet commercial needs, and promote sustainable farming systems.

Keywords: Crop diversification; Determinants, Simpson index; Beta regression; Kashmir

JEL codes: N95, O13, O53, Q19, R14

I

INTRODUCTION

Developing nations during the era of the Green Revolution emphasized the adoption of traditional methods of agricultural advancement. This involved promoting specialization in specific crops among farms, a strategy known as market-driven agricultural specialization. However, as income levels have risen and modernization and urbanization have advanced, consumer preferences have shifted from cereal grains to high-value crops (Singha *et al.,* 2014). This market-driven agricultural diversification entails shifting away from monocropping (Vyas, 1996) and includes practices like intercropping, crop rotation, mixed cropping, or cultivating cash crops (Hufnagel *et al.,* 2020). Engaging in complementary activities such as poultry farming, livestock rearing, and fish farming alongside crop production is also part of this strategy (Vyas, 1996). It comes with several benefits, such as maximizing returns by creating an optimal income portfolio and reducing the risk associated with price. Besides, it enables the farmers to overcome risks such as losses from pests, climate changes, and market fluctuations without significantly reducing their income (Mudasir, 2017). Diversification aims at maximum utilization of water, land, and various other resources, keeps a check on their efficient use by regulating and maintaining the

[1]Department of Economics, Central University of Kashmir, Ganderbal, Jammu and Kashmir-191 201.

ecosystem, and helps enhance biodiversity that leads to the country's overall growth of agriculture. (Hufnagel *et al.,* 2020). Additionally, it increases income, generates employment, promotes exports, and alleviates poverty (Ryan and Spencer, 2001), which has been the focus of international discussions and has recently been incorporated into Sustainable Development Goal 1 by the United Nations (UN, 2016). For the state of Jammu and Kashmir, agriculture is the mainstay of the economy, as lacking infrastructure impedes the development of industrialization in the state (Bazaz *et al.,* 2013). The conducive environment and the region's favorable location and climate allow the cultivation of various horticulture crops, such as fresh and dried fruits, including apples, pears, cherries, walnuts, almonds, and many more (Sharma *et al.,* 2023). The state's annual fruit production is worth Rs. 2000 crore, including the export of walnuts worth Rs. 300 crore (Dixit and Sharma, 2014). These crops are labour intensive (employing approximately seven lakh families dependent on horticulture for their livelihood)[1] and offer prospects for utilizing surplus labour, thereby augmenting their income. Preference is given to such crops as they can be cultivated on small plots of land (less than a hectare), even on uneven slopes, and yield more output. Additionally, once planted, these require minimal maintenance and continue to produce fruits for many years, making them a one-time investment with long-term benefits (Sharma *et al.*, 2023). However, increasing constraints related to limited land and input availability, diminishing potential for boosting agricultural output, and prevalence of small-scale farming among most farmers have raised significant concerns (Bazaz *et al.*, 2013). Decisions regarding which crops to produce and how to allocate resources are simultaneously influenced by both households (Hua *et al.,* 2005) and government policies (Di Falco and Perrings, 2005). Such choices significantly affect production levels, farm income, and household welfare (Gebiso *et al.,* 2023).

Previous studies in India and J&K have focused on agriculture diversification and the factors that affect such diversification. The study adds to the literature a) by focusing on fruit diversity within the horticulture sector. Additionally, determinants affecting such diversification in the entire Kashmir valley of Jammu and Kashmir are studied to provide a comprehensive micro-level analysis for all districts of Kashmir valley b) Incorporating the Simpson index for diversification helps to understand both the species richness and evenness c) study uses fractional response model. Such models do not require assumptions of conditional distribution, accommodate variation in variance patterns, and can be used for non-linear combinations.

II

LITERATURE REVIEW

Various empirical studies have been conducted on crop diversification in developed and developing countries.Windle and Rolfe (2005), using a multinomial logit model, found that education, size of the farm, age, family size, net income, and other related factors affected diversification in agriculture in Australia's Central Queensland Valera *et al.*(1989) in Zambia revealed that crop diversification was

affected by factors such as inadequacy insufficiency of rainfall in the dry season and inadequacy of irrigation facilities and drainage facilities. Several studies have analyzed the extent and status of diversification at international (although scarce), micro, and macro levels. A study by Bansal *et al.* 2020 concluded that crop diversification was significantly and positively impacted by landholding size, age, and education, whereas income impacted crop diversification negatively. Another study by Dembele *et al.* (2018) showed that education level, age of the head of the family, size of the family, ownership of assets, and income from the farm significantly influenced farm diversification strategies. Belay *et al.* (2017) argued that the size of the family, age, ownership of livestock, landholding size, and accessibility to market. Information on climate and income from farms have a significant impact on determining farmers' choices. Ashfaq *et al.* (2008) in Pakistan found that determinants such as machinery on the farm, education, landholding size, experience in farming, and machinery used on the farm significantly impact diversification decisions. In a study by Fetien *et al.* (2009) using Tobit regression, factors such as temperature, amount of rainfall, size of the farm/landholding, age, livestock, and extension significantly impacted crop diversification. Additionally, Ibrahim *et al.* (2009), using a multiple linear regression model, found that age, heads of family education level, accessibility to the road, availability of tractor rental, and income from crop income significantly determined crop diversification in Nigeria. A study by Aneani *et al.* (2011) using the multinomial logistic regression model (MLRM) found accessibility to credit, age, and regional location affected crop diversification. Singh *et al.* (1997) in India analyzed the influence of infrastructural factors such as institutions, irrigation, market, and technology that affected diversification. Ashok and Balsubramania (2006) revealed that factors such as marketability, irrigation, and road accessibility have a significant relationship with diversification, whereas the farm size was insignificant. Joshi *et al.* (2004) reported that small farmers have the advantage of having cheap family labour instead of being hired, but lack of proper irrigation and accessibility to the market constrains the diversification opportunities. A study by Weiss and Briglauer (2000) in Australia using instrumental variable regression reported that education, size of the family, size of landholding, and location of district significantly determine diversification. Additionally, Malik *et al.* (2002) in India found districts that showed that market accessibility led to diversification. However, districts could not diversify due to inadequate markets and irrigation facilities, and there was more risk. Bhattacharyya (2008), in the state of West Bengal, found that factors such as technology, roads, and proper rainfall were key determinants for diversification. In contrast, a lack of proper irrigation and proper institutional support affected crop diversification.

III

DATA COLLECTION

Sampling Procedure

The study uses Cochran (1977) sample formula that makes the sample size sufficiently and statistically representative.

$$n_s = Z^2 * pq/e^2 = 385$$

n_s represents the sample size,
Z = the value on the Z table at 95 per cent confidence level =1.96
p = 0.50 representing the participation of different households in crop diversification;
q = 1-p i.e., 0.50 that do not participate in different households in crop diversification
e = Sampling error at 5 per cent

Primary data was collected using an interview schedule about farming households regarding determinants impacting diversification, which were framed in English, and the same was explained in the local language for the respondents. The study used the multi-stage sampling technique. In the first stage, all ten districts of Kashmir Valley, divided into three zones, North, Central, and South, were selected. These include Baramulla, Bandipora, Kupwara from the North Zone, Budgam, Ganderbal, Srinagar from the Central Zone, and Anantnag, Pulwama, Shopian, and Kulgam from the Southern Zone. Two blocks from each district that showed a good amount of diversification were selected using the block information from the directorate of Horticulture during the second stage. In the final stage, information on the extent and determinants of crop diversification from 400 farming households was collected using snowball sampling.

IV

METHODOLOGY

Model Specification

The index and fractional response models were used to analyze data descriptive statistics.

Simpson Diversification Index

Simpson Index of Diversity (SID) is the most appropriate index to measure diversification (Basavaraj *et al.*, 2016) since it provides a dispersion of various crops in a geographical area (Joshi *et al.*, 2004). The Simpson diversification index has a value between 0 and 1. A value of 0 shows complete specialization, whereas 1 indicates complete diversification. Simpson's diversification index is preferred to other indices since it considers the number and the quantities of crops produced. The Simpson diversification index in a study is given in equation (1)

$$SDI = 1-\sum \frac{N_i(N_i-1)}{N(N_i-1)} \quad \ldots. \ (1)$$

$Ni =$ number of crops of the given species
$N =$ total number of crops

Fractional Response Models

Beta regression models (a type of fractional response model) are effective for modelling continuous variables y that take values within the open unit interval (0, 1), particularly because Ordinary Least Squares (OLS) estimators can lead to biased and inconsistent coefficients for the independent variables. These models operate under the assumption that the dependent variable follows a beta distribution, which addresses the issue of heteroscedasticity (Ferrari and Cribari-Neto, 2004) and accommodates nonlinearity (SN *et al.*, 2024). The beta regression model is based on an alternative parameterization of the beta density in terms of the variate mean and a precision parameter. The beta density is usually expressed as given in the equation

$$f(y;p,q) = \frac{\Gamma(p+q)}{\Gamma(p)\Gamma(q)}\, y^{p-1}(1-y)^{q-1},\ 0<y<1, \quad \ldots. (2)$$

Where $p, q > 0$, and $\Gamma(.)$ is the gamma function. Ferrari and Cribari-Neto (2004) proposed a different parameterization by setting $\mu = \frac{p}{(p+q)}$and $\varphi = p + q$:

$$f(y;\ \mu,\varphi) = \frac{\Gamma(\varphi)}{\Gamma(\mu\varphi)\Gamma((1-\mu)\varphi)}\, y^{\mu\varphi-1}\ (1-y^{(1-\mu)\varphi-1},\ \ 0<y<1,$$

With $0 < \mu < 1$ and $\varphi > 0$. We write $y_i \sim \beta(\mu,\varphi)$.Here,$E(y) = \mu$ and $VAR(y) = \frac{\mu(1-\mu)}{(1+\varphi)}$. The parameter φ is known as the precision parameter since, for fixed μ, the larger the φ smaller the variance of y ; φ^{-1} is a dispersion parameter. Let y_1,……, y_n be a random sample such that $y_i \sim \beta(\mu,\varphi)$, $i = 1$,….,n.The beta regression model is defined in equation (3)

$$g(u_i) = x_i\beta = \eta_k, \quad \ldots.(3)$$

Where $\beta = (\beta_1, \ldots, \beta_k)^\top$is a $k \times 1$ vector of unknown regression parameters ($k < n$), $x_i = (x_{i1}, \ldots, x_{ik})^\top$ is the vector of k regressors or independent variables or covariates) and $\eta_k$is a linear predictor (i.e., $\eta_i = \beta_1 x_{i1} + \ldots. + \beta_k x_{ik}$; usually $x_{i1} = 1$ for all i so that the model has an intercept). In particular

$$\text{VAR}(y_i) = \frac{\mu_i(1-\mu_i)}{1+\varphi} = \frac{g^{-1}(x_i^\top\beta)[1-g^{-1}(x_i^\top\beta)}{1+\varphi}$$

The log-likelihood function is $\ell(\beta,\varphi)\ \sum_{i=1}^{n}\ \ell_i\ (\mu_i\ ,\varphi)$, where

$\ell_i(\mu_i,\varphi) = \log\Gamma(\varphi) - \log\Gamma(\mu_i\varphi) - \log\Gamma((1-\mu_i)\ \varphi) + (\ \mu_i\varphi - 1)\log y_i + \{(1-\mu_i)\ \varphi - 1\}\log\ (1-y_i)$

Data and Variables

The description of variables used in beta regression is given in Table 1.

TABLE 1: DESCRIPTION OF VARIABLES

Variables (1)	Description (2)	Measurement (3)
SDI	Simpson Diversification Index	Continuous
LLH	Log Landholding	Continuous
ASIZ	The average size of the family	Continuous
EM	Earning members	Continuous
EDH	Education of the head	Dummy (1= literate / 0= not literate)
MO	Main occupation	Dummy (1= farming / 0= other than farming)
IRR	Whether the area is irrigated or not	Dummy (1= yes / 0= no)
SOIRR	Sources of Irrigation	Dummy (1= artificial / 0= rainfed)
AOC	Availability of credit	Dummy (1= yes / 0= no)
AMC	The average amount of credit	Continuous
MAC	Market accessibility	Dummy (1= yes / 0= no)

IV

RESULTS

Descriptive statistics are shown in Table 2. It is essential to consider the farmer's characteristics and environment to support the results derived from the FRM model. The mean for the SDI is 0.6750024, with a standard deviation of 0.118587. The variables SDI, landholding size, average size of family, earning members, availability of credit, and average amount of credit show a mean of 0.6750, 2.1375, 6.7846, 1.4832, 0.3621, 70405.28 and standard deviation of 0.1185, 0.8700, 3.0340, 0.9373 and 1084.5 respectively.

TABLE 2: DESCRIPTIVE STATISTICS

Variable (1)	Simpson diversification index (2)	Landholding (3)	The average size of the family (4)	Earning members (5)	The average amount of credit (6)
mean	0.6750	2.1375	6.7846	1.4832	70405.3
Std. dev.	0.1185	0.8700	3.0340	0.9373	108439
Min	0.231	0.4054	1	1	0
Max	0.917	5.5012	30	10	300000

Source: Authors self-calculation using Stata

The impact of earning members on the SDI is negative and significant at a 5 per cent significance level, implying an increase in the number of earning members leads to a decrease in crop diversification by 6.85 per cent. The study's results align with those of Nasir and Hundie (2014). The impact of credit intensity on the SDI is negative and significant at a 10 per cent significance level, implying increased credit intensity leads to a decrease in crop diversification by 9.43E-0 (Table 3). The study's results align with the study of Neogi and Ghosh (2022) and Chhatre *et al.* (2016). The impact of the size of the land holdings expressed in Kanals on the SDI is positive and significant at a 1 per cent level of significance, implying an increase in the land holdings leads to an increase in crop diversification by 9.7 per cent. The study's results align with previous studies (Amine and Fatima, 2016; Benin *et al.*, 2004; Ibrahim *et al.,* 2009; Sichoongwe *et al.,* 2014). The impact of the household head practicing

farming on the SDI is positive and significant at a 1 per cent significance, implying an increase in the number of household heads practicing farming

TABLE 3: BETA REGRESSION FOR DETERMINANTS AFFECTING CROP DIVERSIFICATION

SDI	Coefficient	Std. err.	Z	P>|z|	[95% conf. interval]	
(1)	(2)	(3)	(4)	(5)	(6)	(7)\
LLH	0.0971	0.0328	2.96	0.003*	0.0327113	0.1615581
ASIZ	0.0360	0.0096	3.74	0.000*	0.0171317	0.0549608
EM	-0.0685	0.0340	-2.01	0.044**	-0.1353259	-0.0018158
EDH	0.0905	0.0599	1.51	0.131	-0.0269554	0.2079964
MO	0.1798	0.0665	2.7	0.007*	0.0494597	0.3102591
IRR	0.2370	0.0756	3.13	0.002*	0.0887676	0.3853383
SOIRR	0.1649	0.0725	2.27	0.023**	0.0227922	0.3070663
AOC	0.2063	0.1136	1.82	0.069***	-0.0164275	0.4291007
AMC	-9.43E-0	5.05E-0	-1.87	0.062***	-1.93E-06	4.71E-08
MAC	-0.2341	0.060	-3.84	0.000*	-0.3536966	-0.1146705

Source: Authors self-calculation using Stata. P-values sig at 1%*,5%**,10%***

leads to an increase in crop diversification by 17.9 per cent. The results of the study align with the study of Kumar *et al.* (2012). The impact of household size on the SDI, i.e., the number of the members of the household (a proxy for the given labour) (Gebru *et al.*,2018), is positive and significant at a 1 per cent level of significance, implying an increase in household size leads to increase in crop diversification by 3.6 per cent. The results of the study align with the study of Baba and Abdulai (2021) and Rahman and Kazal (2015). The impact of credit availability on the SID is positive and significant at a 10 per cent significance level, implying that credit availability leads to an increase in crop diversification by 20.6 per cent. The study's results align with Ullah *et al.* (2015). The impact of distance from the market on the diversification index is positive and significant at a 1 per cent significance level, implying that distance away from the market decreases crop diversification by 23.41 per cent. The results of the study align with the study of Ibrahim *et al.* (2009). The impact of the availability of irrigation on the SDI is positive and significant at a 1 per cent level of significance, implying that the availability of irrigation led to an increase in crop diversification by 23.7 per cent. The impact of the sources of irrigation on the SDI is positive and significant at a 5 per cent level, implying that the availability of irrigation led to an increase in crop diversification by 16.4 per cent. The results are in line with those of Sahu (2021).

V

DISCUSSION

The negative effect of earning members on crop diversification arises from reduced productivity and declining income as family labour decreases due to participation in off-farm activities (Reardon, 1997). The significant and negative impact of credit intensity on crop diversification is that farmers require high and continuous investment for crop diversification. The credit helps in increasing such investment and enables farmers to take risks. However, this is associated with credit

risks since there is a need for more working capital than cereal crops, and the credit instruments are not systematized for alternate crops. Additionally, price volatility leads to a high cost of capital that impacts crop diversification (Chhatre *et al.,* 2016). The significant and positive impact of the size of landholdings on crop diversification indicates that larger land areas can accommodate more crops, which are crucial for meeting food security requirements (Gebiso *et al.,* 2023). The strong positive effect of heads of households who practice farming as their primary occupation stems from dedicating most of their time and skills to cultivating commercial crops, unlike farmers who treat farming as a secondary activity (Kumar and Sharma, 2012). The significant and positive impact of household size on crop diversification reveals that large families have no labor shortage and tend to prioritize food security (Gebiso *et al.,* 2023). The substantial positive effect of credit availability on crop diversification indicates that access to credit enables farmers to increase their income from agricultural activities, enhancing their consumption. Moreover, having more capital to invest in fruit production further boosts their potential earnings (Birthal *et al.,*2006). The significant and negative impact of distance from the market shows accessibility, favouring diversification due to the ease of selling their produce (Monika *et al.,* 2017). The positive effect of irrigation availability on crop diversification suggests that access to irrigation enables farmers to cultivate various crops on the same land with increased cropping intensity (Pavithra & Gaddi, 2022).

VI

CONCLUSION

The decisions of households and the intensity of crop diversification depend on various socio-economic, institutional, and technological determinants that increase farmers' income, reduce risk, and help improve their livelihoods. Cultivating various crops increases farm profitability and ensures the sustainment of land productivity. The study analyzed the extent of diversification of major horticulture and its impact on determinants for all districts in the Kashmir valley of the state of Jammu and Kashmir. Primary data from 400 farmers was collected using an interview schedule to assess crop diversification. The extent of diversification was measured using the Simpson diversification index, whereas the impact of determinants of the crop diversification index was measured using the beta regression model. The results of the study indicate that the average diversification of farming households is .67, as measured by the Simpson diversification index. The results from beta regression indicate that factors Results of the study show that factors such as landholding, the average size of family, education, farming, irrigation, sources of irrigation, and credit availability affect crop diversification positively. In contrast, lack of market accessibility, earning members, and credit intensity have a negative impact on crop diversification. The role of small farmers is important since they help to provide food to the country’s citizens. Such policies should be implemented by government and non-governmental institutions to

help farmers grow various crops through access and control over land, which will, in turn, help improve food security (SDG 2) and reduce poverty (SDG 1). Improvement in the market should be made so crops are diversified for commercial purposes apart from their sustenance. Efforts should be made to make credit available easily to farming households so they can continue to engage in crop diversification that helps them increase income and improve employment opportunities. Research and development should be done, and new technologies should be made available to ensure the sustainability of farming systems that further lead to environmental conservation. Further investigation can be done to determine the livelihood impacts of diversification on household income, and a study can be conducted to assess the impact on crop diversification for the whole state.

NOTE

1. https://horticulture.jk.gov.in/aboutus.html

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