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An exploration to agricultural diversification in India: A study of Bundelkhand region

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ABSTRACT

The study examines an exploration of agricultural diversification in India. Economic Survey 2022 calls for agriculture diversification in view of acute water stress in cultivated areas where wheat, paddy, and sugarcane are grown in India. Agriculture diversification has a direct association with farm income. Thus, it can substantially contribute to the income creation capacity of marginal and small farmers and stabilize their livelihoods. Thus, approaching this notion, a study aimed at an empirical analysis of agricultural diversification in the Bundelkhand region with the help of a primary survey. For this, a logit regression model has been used. With the implication of the logit model, it has been found that agriculture diversification is potentially and significantly more likely to be affected by the farm size, literacy, and agricultural training on technology demonstration. The study suggests restructuring education in rural areas and incorporating the aspect of regional agriculture literacy into the school curriculum. Special training or literacy programmes must be conducted specifically by targeting the small and marginal farmers, as the study found them more enthusiastic to adopt diversified agricultural practices. Further, there is an acute need to prevent ongoing land diminution, as excessively marginal land holdings are not effective and productive for diversified agricultural practices.

Contribution/ Originality: This study is based upon a primary survey of the Bundelkhand region, India, to identify the factors of agricultural diversification. As the agricultural practices in the Bundelkhand region of India, are relatively poor, this study is expected to have a positive influence from a policy perspective.

1. INTRODUCTION

Economic Survey, 2022, is compelling foragriculture diversification in view of acute water tension in cultivated areas where wheat, paddy, and sugarcane are grown. Apart from that, the emphasis is on increasing oil seed production to lessen the dependency on imports of cooking oil. But in general, agriculture diversification has immense potential to ameliorate farmers' income. The staple crops (cereals, pulses, and oilseeds) occupied 77% of the total gross cropped area but only 41% of the total production of the crop sector. Similarly, the value-added by High-Yield Crops (HYC)for fruits, vegetables, fibers, and condiments occupy 19% of the total cropped area (Das et al., 2016). Thus, the scope for the wider expansion of diversification in agriculture sector to generate farmers' income capacity is probably inevitable.

Not only this, the diversification of high-value commodities, such as the production of horticultural commodities such as milk, meat, fish, and eggs, has revealed a remarkable surge during the past two decades (Anwer, Sahoo, & Mohapatra, 2019; Joshi, Gulati, Birthal, & Tewari, 2004). The main goals of diversification are to sustain natural resources and create for a sustainable development. As stated by Pacheco, Ochoa-Moreno, Ordoñez, and Izquierdo-Montoya (2018), diversification aims to preserve natural resources, provide employment, and boost agricultural revenue in the long run. According to Barghouti, Kane, Sorby, and Ali (2004) crop heterogeneity or diversification is a significant stress-relieving option for the economic growth of the farming communityvarieties can be among the most significant technological advancements in raising farmers' incomes by up to double or more. Increasing the crop portfolio is the aim of crop diversification, which aims to free farmers from reliance on a single crop for revenue (Bezabih & Sarr, 2012; Parihar et al., 2018).

The diversification is more than just figuring out what other crops can be cultivated or how to produce them economically. It goes beyond agro-economics. It has to do with giving farmers, both on and off the farm, more chances to employ their resources—such as family labor and managerial expertise—in a more effective manner. Diversification is considered a strategy to minimize farm risk (Barrett, Reardon, & Webb, 2001; Ellis, 2000). Diversification is considered a shift from one crop to another crop or from one enterprise to another enterprise (Gupta & Tewari, 1985; Vyas, 1996) which concluded that larger farms were relatively less diversified. They also added that tenancy (cash renting) discourages diversification. There was a positive relationship between farms with higher irrigation intensity and those located nearer to the market and diversification. It was also observed that there was a direct and positive association between greater business risk and crop diversification. They also mentioned how diversification raises the level at which farm income is stabilized in the presence of risk and capital constraints. They suggested that effective implementation of land ceiling policy may encourage crop diversification, which in turn leads to a higher level of farm income. Malik and Singh (2002) and Sharma (2007) observed that at large level, agricultural heterogeneity was negatively affected by fertilizer consumption, intercrop value net yield, variability, tractor density, skewness in the dispersal of farms, and percent cropped area irrigated. However, market substances have a favorable impact on it. Micro-level: diversity is directly correlated with dairy income and family size and negatively correlated with farm size, market distance, and assets per hectare. According to Rajendran et al. (2017) and Sharma (2007) there is a favorable correlation between horticultural production and infrastructure, which finally becomes the main factor influencing how much money farmers may make. Joshi et al. (2004) and Shiyani and Pandya (1998) examined the influence of skilled and unskilled agricultural manpower on agriculture diversification, and the study exhibited that better-educated, skilled manpower had clear adaptability towards diversification and was aware enough to diversify the risks that arise due to seasonality in agriculture.

In India, Bundelkhand is abundant in land, forest, and mineral resources in Bundelkhand and the surrounding regions. But despite several development initiatives, it still lags far behind others in terms of industry, agriculture, and human resource development. Agriculture is one of the main economic activities in the Bundelkhand region. However, the lack of irrigation facilities, low productivity, unequal land distribution where a small number of medium-sized and large farmers own the majority of the land, and unscientific cultivation that refrains from using modern agricultural methods have kept state agriculture barely surviving. Further, analyzing the land ownership also confirms that the region is feudal in nature. In Bundelkhand, 67% of the total farmers are small and marginal farmers, and they own less than 2 hectares of land and are directly unable to achieve economies of scale. Not only this, fragmented and marginal size of land holdings are subjected to the lack of food security and low livelihood & wellbeing too. The study conducted by Gautam and Jha (2022) has exhibited that among marginal farmers, majority of them around 70.37% had low food security. Thus, farmers have been facing twin obstacles i.e. possess relatively lesser land size and confronting with the issue of food security. Consequently, farmers have been lacking in terms of regular and sustained income and other subsidiary ranges of opportunities that lead to high-level crises in agriculture (Kalhapure, Sah, & Tripathi, 2020; Singh et al., 2021). Thus, the prevailing scenario motivates the

identification of the determinants of agricultural diversification in the Bundelkhand region as the prime objective of the study, so that the obstacles to agricultural diversification can be identified in order to further improve the scale of agriculture and allied activities, along with improvements in the income creating standard of living of marginal, small farmers in the region.

This paper begins with an introduction to agricultural diversification in the Indian context, followed by a comprehensive literature review to identify crucial determinants and research gaps. Research methodology and approach explain the methods used for data collection and analysis. At the end, paper discusses research implications and provides policy recommendations to the state policymakers and practitioners.

2. REVIEW OF LITERATURE

Agricultural diversification refers to the practice of expanding and varying the range of crops, livestock, or other agricultural products produced on a farm. This strategy aims to enhance sustainability, improve resilience to market fluctuations, and promote overall farm profitability (Joshi et al., 2004; Pandey, Dev, & Jayachandran, 2016; Singh et al., 2022) established that a number of factors affect how quickly and in what ways agriculture diversifies from low-value to high-value crops. The forces were divided into supply and demand forces. The demand side forces were per individual income and urbanization, and the supply side forces included overall infrastructure, technology, resource endowments, and socio-economic variables. Oluwatayo (2009) found that the magnitude of factors such as gender, size of the household, level of poverty, and credit availability were positively significant. Conversely, there was a significant negative correlation found in the coefficients of variables related to geography, marital status, years of formal education, and major occupation. De and Chattopadhyay (2010) examined the irrigation system, the road system, the network, and the density of the wholesale assembly market as significant drivers of diversification.

Additionally, it was determined that characteristics that hindered agricultural diversification included small holdings and a higher electrical supply. Depending on market demand, agriculture diversification entails shifting the production portfolio from low-value to high-value commodities, including vegetables, milk, meat, eggs, and fish, opening up new opportunities for rural income sources (Ryan & Spencer, 2001). Further, the recent study by Deogharia (2018) made a compelling case for the fact that agricultural diversification has a significant positive influence on the agro-socio-economic upliftment of farming communities with limited resources. The study attempts to estimate econometrically the influence of some crucial determinants of diversification of farmers by using field survey data. Further, the earlier few studies, such as, Basavaraj, Gajanana, and Satishkumar (2016) and Ojo, Baba, Tanko, Adeniji, and Ojo (2013), used multinomial logit to analyze the factors affecting the choice of enterprises among smallholders. Rehima, Belay, Dawit, and Rashid (2013) employed two-stage OLS to assess crop diversification determinants. Singh et al. (2022) employed a panel regression approach to determine variables affecting diversification. Kurdyś-Kujawska, Zawadzka, and Sompolska-Rzechuła (2018) applied a logit model to estimate the likelihood of farm diversification. Abera, Yirgu, and Uncha (2021);Kemboi, Muendo, and Kiprotich (2020) and Meraner, Heijman, Kuhlman, and Finger (2015) used a logit model to identify the variables affecting varied cropping system participation and evaluated factors influencing the diversification of rural livelihoods using a logit model. Several studies have been conducted to understand and identify the determinants of agricultural diversification. But the Bundelkhand region merely attempts to identify the determinants of agriculture diversification. On the flip side, agriculture diversification substantially assists farmers in diversified risk in an effective manner and provides an additional source of income too (Bell, Moore, & Thomas, 2021; Jamal, Kristiansen, Kabir, & De Bruyn, 2023).

The advantage of agricultural diversification may be reached with the help of political will and a set of reforms aimed at improving the management of agricultural development and diversification in poor agriculture-led countries (Abdimomynova, Kolpak, Doskaliyeva, Stepanova, & Prasolov, 2019). Political will is reflected in the well-constructed public policy that may prevent the further diminution of land holdings while simultaneously promoting

farmers to adapt to diversification (Shekhar & Meher, 2023). Moreover, the study conducted by Barnes, Hansson, Manevska-Tasevska, Shrestha, and Thomson (2015) and Han and Lin (2021) on the ground of multinomial logistic regression indicates that farms that run additional ventures outside traditional agriculture are diversified in terms of obtaining revenue from multiple agricultural enterprises are relatively more viable compared to specialized agricultural units.

3. RESEARCH METHODOLOGY

3.1. Data Collection

In order to check the determinants of agricultural hetrogeniety in the Bundelkhand region of Uttar Pradesh state, the following sampling design has been constructed, and the primary survey of 672 samples was conducted on the basis of the same in the years 2022-23.

Figure 1. Selection of districts from Bundelkhand Region of Uttar Pradesh State in India.

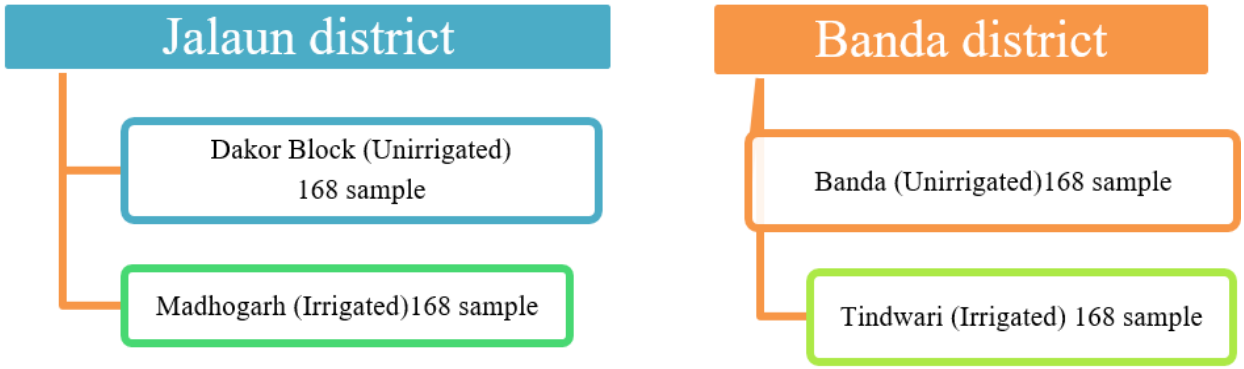

Figure 2. Selection of blocks from districts.

Figure 3. Selection of villages from blocks.

Figure 1 depicts the selection of the sampling area from India. At the top right, the red colour map represents the Uttar Pradesh, India. Further, the yellow colour in center shows the Bundelkhand region. Finally, two districts, Jalaun and Banda, are selected from Bundelkhand region for field surveys. Moreover, Figure 2 shows selection of blocks from Jalaun district and Banda district. The figure explains that Dakor Block and Madhogarh from Jalaun District were selected. While Banda Block and Tindwari Block is selected from Banda district. Subsequent Figure 3 depicts the targeted villages in the selected blocks. For instance, Aindha, Atariya, Kotra, and Goran villages are chosen from Dakor Block. Harauli, Rampura, Iton, and Tihar villages are selected from Madhogarh Block. On the other side, Adari, Bhatha, Pilani, and Tangamau villages have been selected from Jaspura Block. And similarly, Parsaunda, Bhujauli, Dhansar, and Mehedu villages from Tindwari Block are selected. As stratified purposive sampling has been used in order to target the respondents for interview schedule, a set of four villages was finalized from each of the blocks, and forty-two samples were surveyed from each village. Thus, from sixteen villages, a total of six hundred seventy-two samples had been collected to identify the responsible factors for the agricultural diversification in Bundelkhand region. Thus, the existing study included six explanatory variables in our regression model, of which three are categorical variables, and three are quantitative variables. For the purpose of econometric modelling, the dependent variable has been clubbed into two broad categories, i.e., diversified and not diversified. Diversified were those who performed allied activities along with agriculture, and non-diversified were those who were solely dependent on agriculture for sustenance.

3.2. Logit Model

Here, the logit regression model is utilized for a predictive analysis. It is the appropriate regression analysis when the dependent variable is dichotomous (binary). Here the dependent variable is dichotomous, i.e., 1= diversified and 0= non-diversified.

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \qquad (1)$$

β_0= Intercept term, β_i= slope coefficients.

X_i=Set of explanatory variables.

Y_i=1 if the individual is diversified.

= 0 non-diversified.

ε_i is random error, the assumptions of zero mean and serial independence (or non-autocorrelation) are followed, together with random error and independently distributed random variables.

As Y_i takes on either 1 or 0 values, we can describe the probability distribution of Y_i by letting

$P_i = Prob(Y_i = 1)$= diversified

&

$1 - P_i = Prob(Y_i = 0)$= non-diversified

Using Eq. 1 we may write

$$P_i = \beta_0 + \beta_1 X_i \quad (2)$$

X is a set of independent variables and $P_i = E\left(\frac{Y_i}{X_i}\right)$means that the respondent is diversified

$$P_i = \frac{1}{1+e^{-(\beta_0+\beta_1 X_i)}} \quad (3)$$

For ease of exposition, we write Equation 2 as

$$P_i = \frac{1}{1+e^{-Z_i}} = \frac{e^{Z_i}}{1+e^{Z_i}} \quad (4)$$

Where $Z_i = \beta_0 + \beta_1 X_i$

Equation 4 represents what is known as the (cumulative) logistic distribution function.

$$1 - P_i = \frac{1}{1+e^{Z_i}} \quad (5)$$

Therefore, we can write.

$$\frac{P_i}{1-P_i} = \frac{1+e^{Z_i}}{1+e^{-Z_i}} = e^{Z_i} \quad (6)$$

$P_i/(1-P_i)$ is the odds ratio that favors diversified respondents; that is, it is the ratio of the sample respondent's probability of being diversified to its probability of not being diversified.

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i$$

$$= \beta_0 + \beta_1 X_i \quad (7)$$

In other words, L, the log of the odds ratios is linear both in the parameters and in X. Since L is known as the Logit, models such as equation are referred to as the Logit Model in Equation 7.

For estimation purposes, we can rewrite Equation 6 as follows:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + u_i \quad (8)$$

A brief description of the variables is given below in the Table 1.

Table 1. Description of the chosen variable.

Variables	Labels	Coefficients	Type	Description
Age (Absolute age of households)	X_1	β_1	Continuous	Age of the household's head (Years).
Household size (Absolute size of family)	X_2	β_2	Continuous	The number of occupants in the home
Education (1 for literate & 0 for illiterate otherwise)	X_3	β_3	Dummy	Whether household head attended school
Operational holding	X_4	β_4	Dummy	Whether marginal or small
Income (Absolute income size)	X_5	β_5	Continuous	Total income of the respondents
Social group (1=Schedule caste, schedule tribe, other backward class) & (0=Otherwise general)	X_6	β_6	Dummy	To which category respondent belongs
Agricultural training	X_7	β_7	Continuous	Total No. of Hours training in a year

Table 2estimates of the logistic regression model.

Table 2. Results of the model.

Diversified crop produce	Coef.	Odds ratio	Std. error	t-value	p-value	Sig.
_Cons.	492.999	1.30	146.034	3.38	0.001	***
Age	-14.57	0	4.585	-3.18	0.001	***
Household size	13.629	0	3.264	-4.18	0	***
Income1	-0.001	0.999	0	-7	0	***
Social group (1=SC, ST &OBC)	0	1	.	.	.	.
Social group (General)	1.201	3.325	0.785	1.53	0.126	.
Illiterate (#)	0	1	.	.	.	.
Literate	2.559	12.92	1.207	2.12	0.034	**
Operational holdings- Marginal#	0	3.482	0.851	1.83	0.030	**
Small	1.25	3.49	1.049	1.19	0.233	.
Agricultural training	4.284	0	3.726	3.28	0.013	**
Mean dependent var	0.34		Standard deviation dependent var		0.474	
Pseudo r-squared	0.759		Number of obs.		672	
Chi-square	408.648		Prob > chi2		0	
Akaike crit. (AIC)	148.086		Bayesian crit. (BIC)		184.45	

Note: *** p<0.01, ** p<0.05, * p<0.1.
Source: Primary survey data (2022-23).

4. ESTIMATED RESULTS AND DISCUSSION

Application of the empirical model explains that educational status is statistically significant at a 5%. Keeping other variables fixed. Results show that literate farmers probably had more chances of diversifying their agricultural operations, as the coefficient value is positive. Further, major reason behind this finding is that if farmers are illiterate consequently, the majority will not aware of the spread effect of diversification in terms of income creation capacity and risk mitigation. Thus, compared to less educated or illiterate farmers, more educated farmers adapt more quickly and effectively to the changes exercised in the name of agriculture diversification (Hojo, 2004; Paltasingh & Goyari, 2018). The next chosen variable to influence agriculture diversification is the social group. Keeping other variables constant, for the estimated coefficients of social group, it has been found that there is a positive relationship between diversified agriculture operations and particular social category of the farmer, such as ST, SC, or OBC. As the estimated coefficient was positive, it means that farmers belonging to SC, ST, and OBC were less likely to diversify in contrast with the social category, *i.e.*, general. The ST, SC, or OBC farmers usually possess marginal and small land holdings, and they lie in the cluster of illiterate farmers too, and these twin features substantially lead to poor socio-economic background that further demoralizes them to hold agricultural diversification openness (Behera & France, 2016; Birthal, Roy, & Negi, 2015). On the same line, the third chosen variable is income of the farmers, and it is statistically significant at a 1% level of significance, keeping other variables constant.

Further, the level of income and diversification are negatively correlated. Farmers are less likely to be diversified as their income rises and is sustained. The majority of the farmers in the surveyed area are marginal and small, and they have been facing the income generation crisis for a longer period of time. Thus, due to this push factor, these farmers are urged and willing to adapt more agricultural diversification as compared to the medium and semi-medium farmers in Bundelkhand region. However, the findings of this extant study for this variable contradictthe findings of Ali, Awan, Ahmad, Saleem, and Akhtar (2012), who declared that there is a positive and significant correlation between agricultural diversification toward high-value crops and income. Age of the farmers is the fourth variable in the model, and it has been found valid at the 1% level of significance. There is an inverse relationship between the age of the farmer and diversification. As age increases, farmers are less likely to be diversified. This observed datum is similar to the findings of Abawa and Ayele (2018); Dinku (2018); Gebreyesus (2016) and Rehima et al. (2013). In the continuation of the determinants, the next variable is absolute family size of the farmers, and this variable was found to be positive and statistically significant at a 1% level of significance. This

finding is supported by Oluwatayo (2009) and Singh, Jain, and Sain (1985) who maintained that, on a local level, dairy income and family size were directly correlated with diversification. The next variable that may influence agriculture diversification is farm size, which has been found to be a statistically significant determinant at the 5% level of significance. There are probably more chances of agricultural heterogeneity associated with marginal and small farms since they possess fewer parcels of land, so optimum utilization via diversification is significantly more effective for income creation. Finally, the last chosen determinant of diversification is agricultural training on technology adaptation, and it has been found to be positive and significant at 5% level. Farmers who have taken agricultural training are more likely to be diversified (Morris, Henley, & Dowell, 2017; Revoyron et al., 2022). Lastly, the value of R square-goodness of fit stood at 0.759, indicating that 75% of the variation in the dependent variable is explained by the independent variable and the rest by the error term. It indicates how well the surveyed data fits the model. A chi-square value of (408.648) indicates that the model is relevant to the study's chosen nominal and ordinal variables' independent behavior. Thus, the all the chosen determinants in the study have scope for improvement in order to stimulate agricultural diversification, except the social groups, whose coefficient is not significant as per the above summary model.

5. CONCLUSION

The study has found that diversification in agriculture can be escalated in the Bundelkhand Region of Uttar Pradesh state by improving factors such as age, farm size, agriculture training in technology, literacy level, family size of the farmers, and the respective social category to which farmers belonged. It can be concluded that agriculture diversification is potentially and more likely to be affected by selected variables, i.e., farm size, age, households' size, literacy, and agricultural training on technology demonstration. Further, the above-mentioned variables were statistically significant under the study and thus able to produce a noteworthy impact in escalating the practices of agriculture diversification in the region. Thus, if these selected independent variables in logistic model gradually improve, there will be more likely chances of improvement in the diversification practices in agricultural operations, and thus consequently, it can play a crucial role in generating sustained income for the farmers of the Bundelkhand region and similar areas in Uttar Pradesh. This would help them not only in mitigating the risk associated with agriculture in the region but also assist the state in reducing the footmark of poverty and backwardness for the marginalized group in the Bundelkhand region.

6. POLICY RECOMMENDATION

Agriculture diversification is not an end in itself but a means to reach a better quality of life for the farmers. Therefore, the present study suggests the following policy suggestions: Primarily, the study found a positive association between education and agriculture diversification, so there is need to restructure education in rural areas and incorporate regional agriculture literacy into the school curriculum.

This makes the young generation in rural areas better equipped to meet the needs of the rural economy. Special training or literacy programme must be conducted specifically targeting small and marginal farmers, as the study found them more enthusiastic about adopting diversified agricultural practices. Further, there is an acute need for agriculture due to ongoing land diminution, as excessively marginal land sizes are not effective for diversified agricultural practices.

Not only has this, but it further aggravated the need for diversification as it brings more farmers below the marginal landholding every year. Apart from this, demonstrations of technology in allied activities need to be conducted on a periodic basis in front of the farmers so that they can get motivated to follow agricultural diversification.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Upon a reasonable request, the supporting data of this study can be provided by the corresponding author.
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