The Impact of Rainfall Variability on Occupational Diversification of Farm Households In Rural Assam

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Abstract: *Occupational diversification from farm to the rural non-farm sector (RNFS) has become a major livelihood option in rural India. Among the various factors affecting diversification, the impact of changing climatic condition has become a prime cause of concern. Although its impact is felt everywhere, yet the state of Assam being not only prone to frequent floods and soil erosion, is also heavily dependent on rainfall for irrigation. Therefore, any change in climatic condition is likely to affect farm output and income immensely. Further, growth of the RNFS is also highest in Assam compared to other North-Eastern states which points towards a plausible link between climate change and occupational diversification. The present paper is an attempt to empirically analyse this relation between rainfall variability and farm household's diversification strategy where not only the decision of diversification but also its intensity is studied. To fulfill the objective, a Double Hurdle model is applied where we found that farm households adopt a diversified livelihood as a response to mitigate risks associated with rainfall variability. They also increase their participation in non-farm employment where more working members shift to this sector as risk reduction strategy. Even in the presence of irrigation intensity, farm households' likelihood to engage in non-farm activities is still positive. Therefore, policies should focus on infrastructural development that is likely to facilitate easy access to farm inputs and also accelerate growth of the RNFS as well.*

Keywords: Rainfall variability, rural non-farm employment, intensity of occupational diversification, rural Assam.

INTRODUCTION

The phenomenon of occupational diversification can be witnessed in many emerging economies, particularly in regions characterized as rural. Occupational diversification implies combining farm practices with off-farm activities. Traditionally, agriculture was the primary source of livelihood but high population pressure on land, increased fragmentation of land holding and traditional techniques of production led to low returns from agriculture. As a result, farm households have started shifting towards the rural non-farm sector (RNFS). Several reasons have been highlighted which are broadly classified as "pull" and "push" factors of diversification. Diversification occurring as a result of pull factors lead to economic growth and rise in income whereas, push factors are operational when fall in income from one source pushes households to engage in other activities. Among these factors, risk arising from weather variability has become one of the prime causes of occupational diversification in recent times (Skoufias et al, 2016; Drall & Mandal, 2021). The impact of climate change is likely to be burdensome for developing countries due to their heavy dependence on rain-fed agriculture (Das, 2015). India has also started facing more erratic rainfall and ever-increasing temperatures due to climate change.

The present study focuses on the responsiveness of farm households in rural Assam to weather risks. Assam is one of the North-Eastern (NE) states of India which is characterized by not only high incidence of poverty but also backward agriculture due to lack of irrigation facilities, incidence of crop failures and heavy dependence on rainfall (Swargiary & Mahanta, 2020). Since agriculture practices in Assam is mostly dependent on weather conditions, the changing climatic situation is likely to affect farm productivity and income (Das, 2015). To cope with weather-related risks, there are several ex-ante and ex-post strategies that households adopt. Strategies such as crop insurance; plantation of weather resistant plants are some of the ex-ante strategies. Ex post strategies are adopted to minimize the shortfall in income which includes selling of household assets, assessing of formal and informal safety nets, etc. (Menon, 2009). However, diversification towards RNFS employment has emerged as one of the effective strategies to mitigate weather related risks, given the limitations of accessing loans and credit facilities. Also,compared to the other NE states, growth of non-farm sector is also highest in Assam (Das & Deka, 2023). Although migration is an alternative livelihood option adopted by many in rural Assam, yet it only leads to urban congestion and livelihood vulnerability (Das, 2015). Further, it is observed that diversification is widely adopted by low-income households to cope with external shocks (Swargiary & Mahanta, 2020). Therefore, our objective is to examine whether rainfall variability has any impact on farm household's decision to diversify towards RNFS. Such a study has not been undertaken in rural Assam despite significant influence of

climate change on agriculture is evident.

REVIEW OF LITERATURE

Some studies (Gansonre, 2019; Demeke & Zeller, 2012; Bezu et al, 2014) that focus on the role of climate variability on occupational choice found that the adverse effect of weather is felt more by the small farm households who are the most deprived section of the society. Demeke and Zeller (2012) observed that in agriculturally prosperous regions of Ethiopia where rainfall variability is lower, farm households engage in high remunerative non-farm employment while in regions with high rainfall variability, people tend to cluster around low return but less risky non-farm occupations. Similarly, Bezu et al (2014) observes that rainfall variability affect participation in low-skilled wage work and low return self-employment non-farm activities. Menon (2009) in rural Nepal also highlighted the significance of non-farm employment for non-head household members at times of rainfall uncertainty. In rural India, Ito and Kurosaki (2006) and Rose (2001) highlights the need for off-farm labour supply as an ex-ante measure against weather variability. While the former study covers 16 Indian states, the study by Ito and Kurosaki (2006) focuses on the states of Bihar and Uttar Pradesh, where lack of credit and insurance facilities make the farmers more vulnerable to any kind of risks related to production and agricultural prices, although markets for farm inputs and outputs are well-developed. Rose (2001) observes that as the riskiness of weather increases, farm household's participation in the labour market also follows an upward trend from 32% to 51%. Similarly, for farmers in Bihar and Uttar Pradesh, the percentage of farm households entering the off-farm labour market increased from 65% to 73% with an increase in weather risk. This suggests that food security becomes a prime concern among these households when farm output and income is negatively affected by weather risks. As a result, climate change is anticipated to cause frequent floods and drought leading to an estimated crop loss of around 10 to 40 percent in India (Roy et al, 2021).

The literature review clearly indicates the significance of RNFS at times of adverse weather conditions. However, none of the studies focused on whether rainfall variability also increases the intensity of diversification. The present article, therefore, adds to the extant literatures in several ways. First, the study not only considered the decision of non-farm diversification by farm households but have also examined its intensity of diversification which has not received sufficient attention. Intensity of diversification is crucial to understand the intention of farm households to add one more member in the non-farm occupation despite this sector not being their principal source of income. Third, we employ a double hurdle model to study the determinants and intensity of diversification simultaneously, that has not been applied in the context of occupational diversification. Finally, we incorporated historical rainfall variability data covering a span of 42 years from 1970 to 2012.

METHODOLOGY

Data on employment is taken from the Employment and Unemployment Survey (EUS) of National Sample Survey Organization (NSSO) for 61st (2004-05), 66th (2009-10) and 68th (2011–12) rounds which correspond to the year 2011-12. For our analysis, we focus on rural farm households in Assam where agriculture is a dominant source of livelihood. The sample consists of 4,240 individuals. Further, annual district level data on rainfall is extracted from the India Meteorological Department (IMD) and information on irrigation intensity and cropping intensity are taken from Land Use Statistics (LUS) of the Directorate of Economics and Statistics, Government of India. To measure rainfall variability, we computed the coefficient of rainfall variation covering the years 1970 to 2012. We define a farm household as a diversified household if at least one working member is employed in the RNFS. Non-diversified households are those where all the working members are in agriculture. Following Pradhan and Narayanan (2019), we define intensity of diversification as follows-

$$\text{Diversification intensity} = \frac{\text{number of working age members engaged in non-farm employment}}{\text{number of working age members in a household}}$$

We applied a Double Hurdle model proposed by Cragg (1971) to fulfill the objective. The basic assumption is that the decision to diversify precedes the decision of the extent of diversification making this method applicable for our objective. Here, the factors determining diversification and intensity of diversification are allowed to vary since individuals would have varying degrees of risk bearing capacity, resource endowments and other socio-economic and cultural factors that is likely to affect both the decisions differently.

The first hurdle in this model is the decision of whether a farm household would diversify or not. This diversification decision is estimated with a Probit model and is described below in equation 1.

$D_i = 1 \ldots . if\ D_i^* > 0$ and $D_i = 0\ if \ldots . D_i^* \leq 0.$

$D_i^* = \alpha^* Z_i + \varepsilon_i$ .....(1)

Where D_i^* is a latent variable that takes a value of 1 if the household diversify to non-farm occupations and 0 otherwise. Z_i represents the vector of household characteristics, α^* is the vector of parameters and ε_i is the error term.

The second hurdle is the intensity of diversification estimated through a truncated regression model which considers only households which have positive intensity of diversification.The truncated model is expressed as follows-

$Y_i = D_i^* if\ Y_i^* > 0\ and\ D_i^* > 0$

$Y_i = 0\ otherwise$

$Y_i^* = \beta^* x_i + v_i$ .....(2)

Here, Y_i is the intensity of diversification which can be observed when the latent variable Y_i^* is greater than zero. x_i includes the vector of household determinants and v_i is the disturbance term. The error terms ε_i and are assumed to be normally and independently distributed. The log likelihood function for Double Hurdle model is given as-

$$log\ L = \Sigma_0 ln[1 - \emptyset \propto z_i\left(\frac{\beta x_i}{\sigma}\right)] + \sum ln[\emptyset \propto z_i \frac{1}{\sigma}\varphi\left(\frac{y_i - \beta x_i}{\sigma}\right)]$$

Here, Ø is the standard normal CDF[1] and 9 is the univariate standard normal PDF[2].

RESULTS

Table 1 below provides the descriptive statistics of the variables used for the analysis.

Dependent Variable	Description	Mean	SD[1]
Diversified household	1 if at least one working member is engaged in non-farm employment, 0 otherwise	**0.188**	**0.3391**
Intensity of diversification	Number of non-farm workers to total working members in a household.	**0.058**	**0.14**
Explanatory variables			
Average age	Average age of the working members	39.71	8.99
Ratio male to female	Ratio of number of males to female workers in a household	1.26	0.8
BP & MS workers	Number of workers in a household having below primary & primary, middle & secondary level of education	2.15	1.59
HS & above workers	Number of workers in a household having higher secondary and above education level.	0.6	1.04
Vocational training	Number of workers in a household having vocational training.	0.33	0.88
Caste (Upper caste= Base category)			
ST	1 if household is a Schedule Tribe, 0 otherwise.	0.17	0.38
SC	1 if household is a Schedule Caste, 0 otherwise.	0.13	0.33
OBC	1 if household is an Other Backward Class, 0 otherwise.	0.4	0.49
Land ownership size (landless= Base category)			
Marginal	1 if the household owns marginal land size, 0 otherwise.	0.49	0.5
Small	1 if the household owns small land size, 0 otherwise.	0.19	0.39
Semi-medium	1 if the household owns semi-medium land size, 0 otherwise.	0.16	0.36
Medium	1 if the household owns medium land size, 0 otherwise.	0.11	0.31
Large	1 if the household owns large land size, 0 otherwise.	0.03	0.16
COV of rainfall	Coefficient of variation of rainfall from 1970 to 2012.	26.4	10.35
Irrigation intensity	It is gross irrigated area divided by gross cropped area	39.2	33.28
Cropping intensity	It is gross cropped area by net sown area.	126.05	70.81

Table 2: Effect of weather variability on the probability and intensity of occupational diversification for rural farm households

Variables	Probability of diversification		Intensity of diversification	
	Coefficients	Robust S.E	Coefficients	Robust S.E
Average age	-0.044*	0.009	-0.005*	0.002
Ratio male to female	0.007*	0.001	0.0003*	0.0001
BP & MS workers	0.092**	0.039	-0.033*	0.008
HS & above workers	0.803*	0.091	-0.015	0.012
Vocational training	0.543*	0.091	-0.011	0.009
Caste (other caste= base category)				
ST	1.010*	0.179	0.136*	0.022
SC	0.212	0.178	0.028	0.024
OBC	0.303***	0.161	0.249*	0.025
Land ownership size (landless= Base category)				
Marginal	0.901*	0.175	0.113*	0.043
Small	0.567*	0.171	0.045	0.036
Medium	-0.359***	0.184	-0.235*	0.024
Large	-4.083*	0.155	–	-
COV of rainfall	0.052**	0.020	0.029*	0.009
Irrigation intensity	0.079*	0.012	0.009*	0.003
Cropping intensity	0.011*	0.002	-0.002*	0.0003
Constant	-4.221*	0.659	-0.349***	0.184
Sigma			0.103*	0.005
Number of observations= 1,010 **Wald chi2 (17) = 3173.97** **Probability> chi2= 0.000** **Log pseudolikelihood = -103.72582**				

DISCUSSIONS

Our findings from table 2, reveal that with a rise in the average age of working members in a household, their probability to diversify towards non-farm occupations and the intensity of diversification also becomes negative. This suggests that worker's inclination to engage in activities outside agriculture also reduces as they become older. However, farm households having more males than females not only diversify but also has a greater intensity of diversification suggesting that a non-farm employment is a male dominant sector in rural Assam. Further, educated individuals and those with vocational training have a high preference for non-farm occupations where returns are aslo high.

Among the social group, a greater share of working members from ST, SC and OBC households choose to participate in non-farm activities compared to upper caste households. Landlessness may drive these low caste households to look for jobs outside agriculture. Again, land ownership size shows that diversification is a crucial livelihood source for marginal and small land holding household in Assam as more working members from these households prefer to work in non-farm activities rather than confine themselves in agriculture. On the contrary, agriculture is preferred by medium and large landowning households which might be because they are either getting high returns from agriculture or in the absence of proper markets for land and credit, they have no alternative option to utilise land for other productive purposes. Several studies (Gansonre, 2019; Demeke & Zeller, 2012) have found a similar effect of climate change on occupational diversification by small holder households who suffer from low agricultural potential.

Now we focus on the primary variable of interest which is the coefficient of variation in rainfall used as a proxy for weather variability. It shows that in the presence of any variation in rainfall, farm households tend to diversify more towards non-farm occupations which implies that in the absence of any coherent risk, farm households in rural Assam find it convenient to shift towards non-farm sector to cope with uncertain weather-risks which has a direct adverse impact on agriculture. Further, the fact that intensity of diversification increases in response to variations in rainfall suggests the inability of agriculture to mitigate the risk associated with such shocks. As a result, more working members look for less risky non-farm occupations,

Again, the favourable impact of irrigation intensity on the decision and intensity of non-farm diversification reflects a lack of uniform distribution of irrigation facilities for all farm households which resulted in their increased participation in activities off-the farm. Das (2015) observes that most of the farm households are dependent on rainfall and only a few of them can avail irrigation facilities. Further, cropping intensity has an unfavourable and significant impact on the intensity of diversification implying that with a rise in cropping intensity, fewer members of the household would join the RNFS for livelihood.

CONCLUSION

The present study focuses on how the adverse impact of weather condition affects the livelihood choice of farm households in rural Assam. Given the small land holding nature of agriculture and traditional methods of production, this sector has become an unviable source of income. As such, diversification towards rural non-farm employment has become a feasible source of income and among the various reasons behind diversification, the effect of climate change has become a prime cause of it. Higher the unpredictability of climatic condition, more is the risk and uncertainty related to agricultural production and in the absence of proper financial and land markets, households are likely to be affected by it. The present study examines how farm household's decision and intensity of occupational diversification are affected by rainfall variability.

By applying a double-hurdle model, we found that farm households respond to any weather-related variability that might affect their income level, by not only diversifying to non-farm employment but also increasing their intensity. This suggests that RNFS can mitigate the risk of weather

variability and might smooth the level of farm household's income due to which more working members shift towards this sector at times of uncertainty. Further, diversification is also high in households where more male working members are present compared to females. Low caste households who are the most marginalized group also have a higher likelihood to diversify compared to upper caste households. Further, diversification is high among small holder households indicating that less land acts as a push factor of diversification.

It can be inferred from our analysis that farm households in Assam are vulnerable to adverse weather conditions and adopt diversification as a coping mechanism. As a result, it is unlikely that such a strategy would benefit farm households as it would be adopted only to mitigate the risks of rainfall variability. Therefore, there is need to focus more on providing insurance against crop failures and improve the functioning of the financial markets. Easy access to credit would also balance the loss of income and consumption. Further, policies that prioritize development of infrastructure facilities as well as build physical, human and social capital would not only expand non-farm employment opportunities in rural regions of Assam but may directly benefit farmers by not only making farm inputs cheaper but also increase the availability of farm inputs within the rural periphery**.** Better infrastructure facilities would also facilitate growth of markets for agricultural output.

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