Crop Diversification as a Risk Mitigation Mechanism in Flood Affected Agriculture: A Study of Assam Plains in Northeast India

R Mandal[1] and MP Bezbaruah[2]
[1]Department of Economics, Assam University, Silchar, Assam, India
[2]Department of Economics, Gauhati University, Guwahati, Assam, India

Abstract

Among various risks to which farmers are exposed, production risk arising from vagaries of weather is very serious. Such risks are further accentuated for farmers in flood prone areas. Diversification is often adopted as a strategy to combat risk. This paper seeks to investigate whether farmers exposed to flood risks have adopted crop diversification as a strategy to cope with such risks. The study is based on sample survey of farmers in Assam plains in Northeast India where floods occur every year but with differences in timing, intensity and frequency. Crop diversification has been measured by composite entropy index which has been regressed on the possible determinants of crop diversification using censored regression model. The flood proneness as a proxy for flood induced production risk has been captured in the analysis by using suitable dummies after categorizing sample locations into chronically flood prone, occasionally flood prone and flood free areas. The analysis of observations on a cross section of 342 randomly selected farms reveals that crop diversification has been adopted to cope with flood induced limits in agriculture. But farmers with better irrigation facility and access to institutional credit are more successful in diversifying their cropping pattern away from food grains to non food grains and within food grains from winter paddy to summer paddy. Hence policy interventions are recommended for enhancing farmers' access to both these facilities. However, provisioning such facilities in flood prone areas poses considerable challenges. The geographical conditions in flood prone areas, especially chronically flood prone areas pose additional challenge in creating and maintaining irrigation facilities. In this regard innovation in agricultural engineering is called for.

Key words: Coping mechanism, Diversification, Flood risk

Introduction

The two main sources of risk to which farmers are usually exposed while carrying out their agricultural operations are production risk and price risk. For farmers in the flood plains, the production risk is further accentuated by the possibility of floods felling standing crops and damaging crop areas from prolonged water logging. As per risk theories, diversification helps to minimize the risk involved in an enterprise or activity (Anosike and Coughenour 1990). Accordingly, crop diversification may appear as a strategy for coping with flood related uncertainties for agriculturists.

The state of Assam forms the core of India's Northeast Region which accounts for about 8% of area, 4% of population and only 2% of Gross Domestic Product of the country. Surrounded by the Eastern Himalayan Range and the Borail Range, Assam plains are comprised of the Brahmaputra and the Barak Valleys, named after the main rivers flowing through them. Lagging in industrialisation and overall economic development the state has remained more agrarian than the rest of the country. While abundance of monsoon precipitations has enabled the farming communities in the fertile river valleys to depend on rice cultivation as the principal source of livelihood, excessive precipitations in the valleys and in the surrounding mountains often result in damaging floods especially for those who inhabit close to the rivers.

Goyari (2005), based on secondary data, found that as a response to flood damage many farmers of the state have made adjustments in the cropping pattern and/or season. However, secondary data fail to capture farmers' choices, responses and strategies with respect to flood risk. A preliminary analysis of available secondary data and farm level survey data reveals that farmers are diversifying their cropping pattern away from food grains to non food grains and within food grains from winter paddy to summer paddy. Such shifts in the cropping pattern are found to be in favour of those crops which are less susceptible to flood damage. For example, winter paddy is grown during the season (sown in July-August and harvested in November-December) when flood takes the most devastating form in the state. On the other hand, summer paddy is grown during the season (sown in around November and harvested in March-April) which is mostly free from flood.

The present paper seeks to examine if crop diversification has been adopted as a strategy for coping with flood induced uncertainties and limits in Assam plains using farm level survey data. Further, policy interventions for capacitating farmers for coping with flood risk and associated damage have also been explored.

Materials and Methods

This paper is based on primary data collected from four non contiguous districts of the Brahmaputra and the Barak valley of Assam using multi-stage random sampling. They are Dhubri, Morigaon, Dibrugarh and Cachar which fall in four different agro-climatic conditions of Lower Brahmaputra Valley Zone, Central Brahmaputra Valley Zone, Upper Brahmaputra Valley Zone and Barak Valley Zone respectively. From each district six villages have been selected such that two are chronically flood prone (CFP), two are occasionally flood prone (OFP) and two are flood free (FF). Then 10 per cent of the farm (cultivator) households have been selected at random from each village as the ultimate sampling units. A total of 342 farm households, thus selected, were surveyed using a pre-tested question schedule.

In the present study to measure the extent of crop diversification Composite Entropy Index (CEI) has been used. The index, indicated by Y has, thus, been computed as follows.

$$Y = -\left[\sum_{i=1}^{N} P_i \log_N P_i\right]\left[1-\left(\frac{1}{N}\right)\right] \quad \text{.........(1)}$$

Where, *Pi* represents proportion of acreage of the i^{th} crop in total cropped area and *Y* stands for number of crops grown. This *Y* has been regressed on the possible determinants of crop diversification. Since the focus of interest is whether crop diversification has been practiced for mitigating flood risk, flood proneness naturally arises as the principal independent factor for the regression analysis. Taking FF areas as the reference category two dummies F_1 and F_2 have been taken, where $F_1 = 1$ for OFP areas, 0 otherwise and $F_2 = 1$ for CFP areas, 0 otherwise. The control variables are farm size (FS), share cropping (SC), household size (HS), age of the head of the farm household (AGE), irrigation (IR), access to institutional credit (CR), access to extension services (EXT) and location specific agro-climatic conditions captured by dummies (L_1, L_2, L_3) (Table 1). Moreover, value of the dependent variable being 0 for many observations censored regression (censoring at lower end) model is used which has been estimated by maximum likelihood method after affecting White's heteroscedasticity correction procedure.

Results and Discussion

The prime focus of the paper being the connection of crop diversification and flood proneness, it is of interest to note that the coefficient of the dummy F_1 has not turned out to be significant whereas the same for F_2 has been found to be positive and significant. This implies that given values of the control variables crop diversification is significantly higher in chronically flood prone areas than in flood free areas. Thus the results suggest that farmers in areas where floods are regular have adopted a diverse cropping pattern to extract the most out of their land resources during the flood free period. It is quite possible that alluvial depositions as the floods recede replenish soil fertility to make such intensive use possible. On the other hand cropping patterns in occasionally flood prone areas, where uncertainties arising from irregular nature of floods are greater, are not significantly more diverse than in flood free areas. Hence the findings of the study do not allow concluding that farmers in Assam plains have been diversifying their cropping patterns to cope with flood related production risks. Instead it can be said that farmers who are restrained by floods in a regular manner have gone for an intensive and diversified cropping pattern to counter the flood induced limits on them. The positive and significant coefficients of IR and CR suggest that access to irrigation and institutional credit enable farmers to diversify their cropping pattern. Similarly positive and significant coefficient of FS implies that larger farms are in a better position to diversify their cropping pattern compared to their smaller counterparts. Statistical significance of the coefficients of L_1, L_2 and L_3 and marked differences in their values indicate that differences in agro-climatic conditions have an impact on the level of crop diversification. High pseudo R^2 values accompanied by highly significant F statistic indicate that the estimated regressions give a good fit to the data.

In conclusion, it can be said that farmers who are restrained by floods in a regular manner have adopted an intensive and diversified cropping pattern to counter the flood induced restriction on them. Since among the other factors access to irrigation and institutional credit favourably influence crop diversification policy interventions may be required for enhancing farmers' access to both these facilities. The Reserve Bank of India, India's central bank, has initiated action plan for enhancing financial inclusion, and the northeast part of India including Assam has received special reference in that scheme (RBI 2006). However, these initiatives are yet to make significant inroads into Assam's agriculture. As for irrigation, there is a need not just for investment in capacity expansion, especially privately owned small scale shallow tube well based irrigation systems because of better efficiency in their utilization, but also putting suitable institutions in place to ensure better utilization of the installed capacity of large scale

Table 1. Results of Censored Regression (Tobit) of Crop Diversification

Explanatory Variables/ Particulars	Estimated Coefficients/Values
Occasionally Flood Prone Area (F_1)	0.017 (0.031)
Chronically Flood Prone Area (F_2)	0.21*** (0.03)
Farm Size (FS)	0.03* (0.01)
Share Cropping (SC)	-0.0003 (0.0004)
Household Size (HS)	-0.008 (0.006)
Experience (AGE)	0.0003 (0.001)
Access to Irrigation (IR)	0.002*** (0.0005)
Access to Institutional Credit (CR)	0.061** (0.026)
Extension Services (EXT)	0.006 (0.01)
Morigaon (L_1)	-0.21*** (0.03)
Dibrugarh (L_2)	-0.37*** (0.03)
Cachar (L_3)	-0.36*** (0.03)
Constant	0.49*** (0.05)
F(12, 330)	29.05***
Pseudo R^2	0.97

The parenthesis represent White's heteroscedasticity corrected standard errors
b) *, ** and *** represent significant at 10%, 5% and 1% levels, respectively

government irrigation schemes which remain mostly unutilized (Dutta and Bezbaruah, 2003). Moreover, the geographical conditions in flood prone areas, especially chronically flood prone areas pose additional challenges in creating and maintaining irrigation facilities because of likely damage arising out of flood. In this regard innovation in agricultural engineering is called for.

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