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Risks and adaptation strategies in rainfed agriculture in India: An analysis

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ABSTRACT

Farmers in the rainfed regions of India have to routinely deal with risks from biotic and abiotic sources, that varies with the region and crop cultivated. An assessment of the risk sources and adaptation strategies is attempted in this paper using a total of 500 farmers combinedly from Maharashtra and Telangana. Data collected using a questionnaire in Likert scale format was analysed using principal component factor analysis. With regard to the willingness to take risk by the farmers, just below half of the farmers were risk averse. Issues faced by the farmers with regard to inputs, private information sources, public information sources, irrigation, non-institutional credit sources, custom hiring services, and institutional credit sources were perceived as major risk sources. Strategies perceived by farmers as important to adapt to the risk situations were identified as the ones related to varietal management, community support, price stabilisation mechanism, government support, and self-insurance.

Key words: Factor analysis, Rainfed agriculture, Risk adaptation, Risk incidence

The income generated from agriculture is uncertain which makes it a risky business. Incidence of extreme climatic events result in onset of risks of varying magnitudes in Indian agriculture (Swain 2014). Incidence of such risks may be profound at local level leading to lower yields and income. To combat the risks in agriculture, farmers are compelled to adopt adaptation strategies, both ex-ante and ex-post, at individual as well as community level (Kaiser *et al*. 1993). Any modification in the farming system by virtue of real or anticipated climate, which helps minimise damage, can be considered as risk adaptation (IPCC TAR, 2001). The strategies adopted ex-ante helps in minimising the loss in income from farm, whereas the ex-post strategies helps in maintaining the consumption. Farmers work under dynamic physical and social environments by undertaking adaptive strategies in the fields. It is compulsory to grasp the adaptation behaviour of the farmers completely, if one needs to study the vulnerability of agriculture to droughts (Crane *et al.* 2011).

Farmers in India have developed agriculture by identifying the potential strategies to combat risk effectively (Sathaye *et al*. 2006). Some of such strategies include modifying the time of sowing, and crop sequence, agroforestry, and crop diversification (Siddiq and Kundu 1993). For a stable output from the farm, the farmers even sow more varieties of the same crop (Kshirsagar *et a1*. 1997). Replanting, gap filling and thinning are some of the other strategies that farmers adopt when the crop fails to establish in the fields (Singh *et al.* 1995).The risk faced by the rainfed farmers of India has been debated intensively, especially in the context of prevalence of extreme farm distress. Thus an analysis of the risk incidence in the region and the risk adaption mechanism adopted by the farmers is crucial to identify the technological, institutional and political improvements to be made.

MATERIALS AND METHODS

The present study to understand the farmers' perception about risk sources and the adaptation strategies adopted by them is based on the cotton farmers in the rainfed regions of Maharashtra and paddy farmers in the rainfed regions of Telangana. The study was undertaken in the period of July-September 2015. A questionnaire developed by the authors and validated by the experts was used to collect primary data of 250 cotton farmers of Maharashtra and 250 paddy farmers of Telangana. The questions were mostly in the form of five point Likert scales ranging from 1 (stongly disagree) to 5 (strongly agree). Risk sources and adaptation strategies were studied using descriptive analysis and principal component factor analysis. The latent root criterion was used in the factor analysis to decide the number of factors to be extracted. Factor solutions were obtained through varimax rotation after multiple attempts with dissimilar number of factors. Percentage of farmers affected by various risk sources and their adaptation strategies are also presented.

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RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

The data regarding some important socio-economic variables were studied to understand the status of the farmers in the region that could indicate the extent of vulnerability towards risks as well as the scope for adapting to such situations. The average age of the sample farmers was 49.8 years in Maharashtra and 46.4 in Telangana (Table 1). The farmers in Maharashtra were better educated than that of the Telangana, as evident from their higher literacy level. The composition of SC/ ST and small farmers were higher in Telangana in comparison to Maharashtra. The average landholding also showed considerable difference among the states with 6.5 acres in Maharashtra and 3.7 acres in Telangana. The cropping intensity, irrigation and livestock possession were also better in Maharashtra.

Incidence of risk on farmers

The variation in farm income has increased over the years for farmers in both the states. The late onset and withdrawal of monsoon, and low rainfall were the most important weather risks identified. Untimely rainfall also emerged to be an important issue. Farmers perceived the risks out of pests and diseases next only to the risks from variation in rainfall. The risks emerging out of the input prices, quality and availability also caused considerable trouble to farming in the region. Only about 47% of the *kharif* area was irrigated by the farmers. The investment for water and soil conservation was quite low. High wage rate, lack of availability of farm labourers, and credit related issues were another key sources of risk.The farmers reported that the public sector is not effective in providing farm information, as it didn't have the manpower to cater to the information needs. However, they accord high level of reliability to the information provided by the public extension officers. High level of price variability for cotton, non-availability of public procurement, non-operation of MSP, and differentiated treatment of traders were the major risks related to prices.Idiosyncratic risks also troubled the farmers to a considerable extend.

Table 1 Socio-economic characteristics of the sample farmers

Particulars	Maharashtra	Telangana
Number of sample farmers	244	256
Average age (Years)	49.8	46.4
Literacy (per cent)	73.0	52.7
Per cent of SC/ST	18.0	24.6
Per cent of small farmers	53.7	78.5
Average land holding (acres)	6.5	3.7
Cropping intensity (per cent)	102.8	73.0
Area irrigated in kharif (per cent)	47.3	44.5
Area irrigated in Rabi (per cent)	79.7	15.6
Membership in rural co-operatives (per cent)	21.7	11.7
Livestock possession (per cent)	73.9	58.4

Source: Authors' estimates based on field survey.

Farmers' perceptions on risk sources

Farmers' perception regarding the risk sources are presented in the Table 2. Sampled farmers were requested to score the different risk sources to study the impact of various risk sources on individual farms. From the mean scores of the risk sources, one can infer that non-availability of machines on custom hiring basis, poor electricity supply for irrigation, lack of availability of climate related information from public sources, issues in seed availability etc. are the top rated risk sources followed by lack of access to other inputs and information. In order to interpret the results in a better manner, principal component factor analysis with varimax rotation was applied to the combined set of data from both the states. Factor analysis was done so as to extract the most important factors that caused the risk in the region. The analysis resulted in seven factors with an eigen value greater than 1. The suitability of the data for factor analysis was confirmed using the Kaiser-Meyer-Olkin measure of sample adequacy value (0.746) and the significance of Bartlett's test of sphericity.

The seven factors extracted accounted for about 65.18 per cent of the total variance. The factors extracted and their respective factor loadings are presented in the Table 4. Higher factor scores were considered for labelling factors with two factor loadings. The seven factors that were extracted were labelled as inputs, private information sources, public information sources, irrigation, non-institutional credit sources, custom hiring services, and institutional credit sources. Factor 1 accounted for about 17.28% of the variance and had loadings from non-availability of organic pesticides, biofertilizers, skilled labourers and poor electricity supply for irrigation. Factor 2, which accounted for 16.46% variance, had heavy loadings from non-availability of information regarding climate, crop and prices from private sources. Crop, climate and pest related information from public sources loaded heavily on the factor 3, whereas failure of bore-wells and unreliable supply of ground water loaded mainly on the factor 4. Factors 3 and 4 accounted for 7.97 and 7.39% of the variance. The remaining variance were explained by the non-institutional credit sources, custom hiring services, and institutional credit sources.

Risk management or adaptation strategies

There can be different strategies for risk management. These are risk reduction strategies that the farmer adopts *ex ante* and risk coping strategies that the farmer adopts *ex post* the shock. Farmers in the region prefer to adopt strategies like mixed farming, multiple cropping, varietal diversification etc. as *ex ante* adaptation mechanism. Multiple cropping, varietal diversification and intercropping are widely practiced by the farmers, as a tool to spread risk. The varietal diversification in cotton is higher compared

Table 2 Mean scores, standard deviation and factor analysis for risk sources

Source of risk	Mean	SD	Varimax rotated component matrix						
			1	2	3	4	5	6	7
Organic pesticides are not available in required quantity	3.44	1.73	0.73		-0.11	0.32			-0.11
Bio fertilizers are not available in required quantity	3.42	1.76	0.73		-0.24	0.32			
Non-farm employment opportunities are not available	3.20	1.69	0.72	-0.20	0.15		0.14		
Labourers are not skilled	3.38	1.51	0.60	0.28					
Poor electricity supply for irrigation	3.97	1.41	0.57	0.33	-0.23	0.10		-0.14	
Climate related information not available from nearby private sources	2.77	1.62		0.84	0.17		0.15		
Crop related information not available from nearby private sources	3.01	1.60		0.78	0.17		0.11		
Information on prices of product are not available nearby	2.99	1.68	0.18	0.75	0.20				
Crop related information not available from nearby public sources	3.54	1.63		0.27	0.78				
Climate related information not available from nearby public sources	3.83	1.56		0.20	0.77	-0.17	0.11		-0.11
Lack of access to pest information system	3.25	1.73	-0.12	0.20	0.67	0.26			
Health issues of family	3.91	1.31	0.24	0.25	-0.37	0.11	0.14		-0.25
Failure of bore-wells	3.68	1.48	0.11		-0.16	0.74		0.12	0.17
Unreliable supply of ground water	3.51	1.42	0.25		0.30	0.72			
Lack of access to custom hiring services for machinery due to reasons other than cost	3.43	1.60	0.34	0.20	-0.31	0.50		0.17	
Do not get sufficient quantity of seeds	3.73	1.55			-0.12	-0.49		0.44	0.38
Non institutional credit sources are not available nearby	3.29	1.65		0.15			0.87		
Do not get sufficient credit from non-institutional sources	2.95	1.62		0.16			0.85		0.12
Machines not available on custom hiring basis	4.30	1.18				0.10		0.92	
Do not get sufficient credit from institutional sources	3.04	1.67							0.91
Variance accounted for (Total: 65.18)			17.28	16.46	7.97	7.39	5.57	5.37	5.14

Source: Authors' estimates based on field survey.

to paddy, as cotton is considered more risky. Bt cotton is resistant to certain biotic stresses, and 100 per cent cotton farmers adopt this. However, newer biotic stresses are emerging in the form of newer pest complexes. Share cropping is an important form of risk sharing. However, farmers prefer tenancy over share cropping. In view of vast amount of land left due to absentee land-lords, the tenancy regulation needs to be relooked. Farmers undertake various price stabilisation measures including loyalty to the commission agents, storing to sell at good times, support from government agencies and forward, futures and contract farming as a key *ex post* strategy. Storing of produce to sell at a future date is practiced by relatively well-off farmers, but the small and disadvantaged section were not practicing this. The income and consumption smoothening by the farmers, in extreme situations, is by attempting to mortgagee or sell some of the assets.

Farmers' perceptions on risk management strategies

The farmers were given the opportunity to mark their perception regarding the usefulness of a list of risk management strategies. The results are presented in the Table 3. Most of the strategies were given a score of moderate to high importance as per the mean values of the strategies in the table. The Standard deviation values higher than 1 suggested the difference among the farmers in the choice of adaptation strategies. Replanting with short duration varieties, use of more number of varieties, collection of feed

and fodder from common lands and the protection offered by landlords were marked as the important strategies.

Among all the risk management strategies, 15 were retained for analysis using principal component factor analysis with orthogonal varimax rotation. Other factors were removed according to their lesser extraction values in the communalities in the initial factor analysis done including all the factors. The analysis resulted in five factors with an eigen value greater than 1. The suitability of the data for factor analysis was confirmed using the Kaiser-Meyer-Olkinmeasure of sample adequacy value (0.649) and the significance of Bartlett's test of sphericity.

The five factors extracted accounted for about 60.61 per cent of the total variance. The factors extracted and their respective factor loadings are presented in the Table 5. Higher factor scores were considered for labelling factors with two factor loadings. The five factors that were extracted were labelled as varietal strategies, community support, price stabilisation mechanism, government support, and self-insurance. Factor 1 accounted for about 20.07 per cent of the variance and had loadings from replanting with short duration varieties, pest resistant and drought resistant varieties, as well as from using more number of varieties. Factor 2, the community level support accounted for 13.51% variance, and had heavy loadings from collection of food, feed and fodder from common lands. Entering into forward contracts and other types of formal and informal contract farming to insulate themselves from price fluctuations loaded heavily on the third factor, whereas selling to government agencies for assured prices loaded mainly on the factor 4. The remaining variance was explained by self-insurance mechanism by using farm saved seeds to reduce the farm expenditure.

Farmers' attitude towards risk

The attitude of the farmers towards risk was studied using a risk attitude scale developed according to the responses of the farmers to a given set of statements. Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree) was used for this purpose. The per cent distribution of farmers as per their agreement on various statements revealing their risk attitude are presented in the Table 4. The table revealed that most of the farmers prefer high income technologies, despite being risky, however one fourth of the farmers were indifferent about insuring their crops. This points to the need for creating more awareness about crop insurance and its benefits. They also showed their accord towards newer crop varieties in search for better yield and risk tolerance.

After adding the responses to all the statements, a median split was applied in order to classify the farmers into more risk averse and less risk averse categories (Table 5). About 49% of the farmers in our combined data set for Maharashtra and Telangana were found to be more risk averse and the remaining 51% were surprisingly fell under the category of less risk averse. Significant difference existed between the two groups as per the t test results. The results shows the need to educate the farmers so as to change their attitude towards risk. The farmers even though are aware about the potential disasters that a risk year can cause, are not really ready to averse the risk situation. This may either be due to their ignorance or their inability to successfully

Table 3 Mean scores, standard deviation and factor analysis for risk management strategies

Risk management strategy	Mean	SD	Varimax rotated component matrix				
			1	2	3	4	5
Replant with short duration varieties	3.22	1.65	0.78		-0.18		
Use more number of varieties	3.21	1.76	0.75	-0.17	-0.10	-0.29	
Use pest resistant varieties	2.80	1.72	0.73	-0.18	-0.20	-0.34	
Replant with drought resistant varieties	1.80	1.39	0.69	0.17		0.29	
Sell old cattle	2.55	1.67	0.58		0.15		
Collect more food materials from common lands	2.47	1.54	-0.14	0.88			
Collect more feed and fodder from common lands	3.12	1.66		0.83	0.13		0.11
Enter into forward contracts	1.97	1.40	-0.14		0.84		
Participate in contract farming (formal or informal)	1.95	1.40		0.17	0.71	-0.16	
Increase the number of working days	1.76	1.27	-0.24		0.43	0.38	0.19
Sell produce to government agencies	2.30	1.43				0.77	
Increase manual control of pest	2.37	1.54	0.15	0.35		-0.61	
Use farm saved seeds	1.75	1.23					0.82
Protection by landlords at nominal interest rates	3.10	1.62		0.32		-0.16	0.67
Stock foodgrains in anticipation of risk	1.96	1.42		-0.22	0.30	0.25	0.53
Variance accounted for (Total: 60.61%)			20.07	13.51	10.75	8.60	7.68

Source: Authors' estimates based on field survey.

Table 4 Risk attitude of the farmer

Statement	Agreement (%)				
	Strongly agree	Somewhat agree	No opinion	Somewhat disagree	Strongly disagree
I prefer high income technologies though they are risky	38.9	18.4	17.1	8.4	17.3
I never insure the crops	27.4	11.7	26.3	6.3	28.3
I was the first among the few to adopt Bt cotton/ pest resistant paddy varieties	32.6	14.3	16	10.2	27
I always have adequate life insurance	20.3	4.8	30.5	5.6	38.9
I cultivate less risky varieties also along with the highest yielding variety	24.2	23.8	16.2	7.3	28.5
I always like to adopt the newer technologies	35.2	21.6	15.6	6.3	21.4
I store produce to sell at a high price later	22.5	15.6	13	13.8	35.2
I never grow some crop other than the crop which was traditionally grown in our village	39.3	10.4	13.8	17.7	18.8
I never enter into contract farming	24.2	10.4	13.4	13.6	38.4
I am always prepared in advance with contingency plans	24.8	13	14.5	12.1	35.6

Source: Authors' estimates based on field survey.

Table 5 Risk attitude comparison of more and less risk averse farmers

Statement	Split half				t	Sig.
	More risk averse		Less risk averse			
I prefer high income technologies though they are risky	228	2.92	235	4.12	9.44	.000
I never insure the crops	228	2.54	235	3.51	7.07	.000
I was the first among the few to adopt Bt cotton/ pest resistant paddy varieties	228	2.29	235	3.99	13.32	.000
I always have adequate life insurance	228	2.41	235	2.83	2.97	.003
I cultivate less risky varieties also along with the highest yielding variety	228	2.28	235	3.85	12.58	.000
I always like to adopt the newer technologies	228	2.56	235	4.28	14.51	.000
I store produce to sell at a high price later	228	2.07	235	3.43	10.15	.000
I never grow some crop other than the crop which was traditionally grown in our village	228	3.14	235	3.53	2.71	.007
I never enter into contract farming	228	2.19	235	3.16	6.67	.000
I am always prepared in advance with contingency plans	228	2.19	235	3.38	8.47	.000

Source: Authors' estimates based on field survey

respond to the forthcoming risk situation.

Conclusion

An attempt is made here to study the major risks faced by the rainfed farmers and the risk management strategies followed by them. The perception of the farmers towards risk and their risk attitude are also examined. With regard to the willingness to take risk by the farmers, just below half of the farmers were risk averse. Issues faced by the farmers with regard to inputs, private information sources, public information sources, irrigation, non-institutional credit sources, custom hiring services, and institutional credit sources were perceived as the major risk sources. The strategies perceived by farmers as important to adapt to the risk situations were identified as the ones related to varietal management, community support, price stabilisation mechanism, government support, and self-insurance.

The study also points to the need for availability of location specific farm technologies that can be made use of at times of crisis. Development of crops/varieties and management practices that is suitable for different biotic and abiotic stresses are need of the hour. Technologies for risk reduction need to gain some focus, and returns per risk need to be a criteria for technology evaluation. Farm extension system needs to be strengthened in terms of manpower and funds notably public extension. The markets for the inputs like seed, fertilizer and pesticides are having several lacunae notably with regard to their quality and the price.

The timely availability of fertilizer is a major concern, and black marketing and hoarding is reported to be a problem. Other than this, the status of risk transfer through insurance need urgent revamping. The insurance is perceived as an additional expenditure, but not as a risk management mechanism. The farmers highlighted multitude of factors towards the disinterest in the insurance schemes. These issues need closer look and revamping of the insurance is need of the hour.

Finally, the farmers have to face various forms of risks in an aggregated manner. The issues and concerns of the farmers at the ground level has to be keenly studied and understood in order to prepare effective policies and programmes. Tailor made policies to address region specific problems are the need of the hour. Good understanding of vulnerability is required to improve adaptive capacity. Controlling all the risk sources are definitely beyond ones control, but it is definitely possible to empower the farmers to rise to the situation by adopting suitable management practices. For this, first and foremost the habit of making use of available opportunities should be inculcated in them.

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