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Risk Sources and Management Strategies of Farmers: Evidence from Mahanadi River Basin of Odisha in India

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RISK SOURCES AND MANAGEMENT STRATEGIES OF FARMERS: EVIDENCE FROM MAHANADI RIVER BASIN OF ODISHA IN INDIA

Jayanti Mala Nayak[1] and A V Manjunatha[2]

Abstract

This study utilises primary data of sample farmers from flood prone areas of Mahanadi river basin of Odisha to examine their perceptions on sources of risk and management strategies. Data was collected from 311 farmers located in three regions of river Mahanadi namely upper region (Sonepur district), middle region (Boudh district) and lower region (Kendrapada district). Factor analysis has been used to reduce 26 sources of risk and 24 risk management strategies into 8 to 10 factors. Results show that drought is the main source of risk in the upper region, problem of inadequate financial support from government in the middle region, farmers and flood in the lower region. In order to cope with the risk, the major risk management strategy followed by the farmers from upper region was varietal diversification with respect to rice, mixed cropping in the middle region and crop diversification in the lower region. The results of the study provide useful insights for improving the efficacy of management of risks in agriculture in the flood prone areas of Odisha.

Keywords: Risk sources, risk management strategies, farmers, agricultural production, Odisha, India

Introduction

Every activity of the agricultural sector is highly risky and uncertain, right from the field to the market. These risks are controllable, uncontrollable, biological and man-made (Moss, 2010). Some of the sources of risks and uncertainties are pests and diseases, weeds, faulty seeds and fertilisers or pesticides, flood, drought, cyclone, heat wave, hail storms, winds, humidity, fog and so on. These events forces farmers to take decisions under predictable and unpredictable situations. Agricultural risks are categorised into production, market and financial risk (Boehlje and Eidman, 1994). These occur due to heavy and scanty rainfall, price volatility, scarcity of labour and machinery during requirement, unavailability of proper pest control measures, insufficient cash in hand for production, change in government policies and unavailability of proper and timely government support. These risks directly affect the yield and net income (Yang, 2010) of farmers, thereby affecting the equity, efficiency and sustainability in agriculture. This fluctuating yield and price also aid in increasing the input costs and enlarge the yield gap which further increases the income risk among farmers (Akcaoz and Ozkan, 2005).

To tackle these risks of agriculture, individual farmers and governments adopt various management strategies. Different management strategies have different types of effects on production and the income of the farmers. It is worth noting that any one particular management strategy cannot provide a shield from all types of risks in production (Patrick, 1998). Risk management strategies are the methods applied by the farmers to eliminate or partly reduce the effects of factors creating risk in agriculture. To cope and survive in the agricultural production process, it is necessary to use risk coping

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strategies. The selection of risk management strategies depends on the geographical, financial and economic conditions and risk behaviour of farmers (Akcaoz and Ozkan, 2005). Risk coping strategies are classified into formal and informal to deal with production, market and financial risks. Formal risk management strategy includes formal documented policies by the government for risk management like crop insurance. Informal risk coping mechanisms used by farmers in the production process are risk smoothening and risk pooling mechanisms. These formal and informal risk mechanisms are developed to provide some kind of security during uncertain situations where the consequences of decisions are not known. In the context of the lack of formal risk management strategies, farmers largely depend on informal risk management strategies to tackle the agricultural risks (Yang, 2010). Informal risks are further divided into ex-ante and ex-post risk coping strategies, where the ex-ante coping mechanism refers to the risk avoidance strategies that the farmers take during the production process before the occurrence of risk, which mainly includes crop diversification, inter-cropping or mixed cropping. Ex-post informal strategies are the risk coping measurements applied by an individual after the occurrence of risks, which mainly include consumption smoothing and asset smoothing mechanisms (Lipton, 1989).

The risk management strategy is also classified into production, marketing and financial risk management strategies (Musser, 1998; Hardaker *et al*, 2004). Production and market strategy deal with production and market related risk, while financial strategy deals with finance related risk. Production strategies reduce risk by reducing variability in yield, whereas market response reduces the market fluctuation by narrowing the price fluctuations in the market. Financial risk can be reduced by transferring risk to others or providing financial assistance during financial requirements (Patrick, 1998).

There are several studies on the risk sources and risk management strategies of farmers (Patrick &Musser, 1997; Boehlje & Lins, 1998; Musser, 1998; Keith, 1999; Musser & Patrick, 2002). Recent work related to risk sources and management strategy was conducted in African countries, East Asian countries and a few European countries (Akcaoz & Ozkan, 2005; Mattila *et al*, 2007;Bergfjord, 2009; Yang, 2010; Le & Cheong, 2010;Korir, 2011; Gebreegziabher & Tadesse, 2014; Figueiredo *et al*, 2015; Ullah, 2015; Iqbal *et al*, 2016; Bishu *et al*, 2016; Meraner & Finger, 2017; Asravor, 2018). The risk sources and their management strategies like production, marketing, financial, health and security has been mainly discussed in these studies.

Akcaoz and Ozkan (2005) determined the risk sources and risk management strategies among three risk attitude groups, namely risk averse, risk seeking and risk neutral. Empirical results of factor analysis found environmental, price, catastrophe, input costs, production and technological, political, finance, personal, marketing, health and social security as a dimension of risk sources and diversification, off-farm income, marketing, planning, financial and security as risk management strategies followed by the farmers. Le and Cheong (2010) determined the perceptions of risk and risk management strategies of 261 catfish farmers of Mekong delta of Vietnam. Factor analysis results showed that price and production risk factors were perceived as the most important risks. Farm management and technical measures were perceived as effective risk management strategies in risk reduction. Gebreegziabher and Tadesse (2014) conducted the study among 304 smallholder dairy farm households in the urban and peri-urban areas of Tigray in northern Ethiopia and they investigated the risk sources and management strategies. Using factor analysis, they identified technological,

price/market, production, financial, human and institutional factors as major sources of risks, and disease reduction, diversification, financial management and market network are the most effective perceived risk management strategies.

Studies on agricultural risks in India have been undertaken by Binswanger (1980), Mythili (1992), Bardhan *et al*, (2006) Bahinipati & Patnaik (2014) and Dhanya & Ramachandran (2016). However, all of these studies focused mostly on the attitude of farmers towards agricultural risks. Moreover, these studies focused on only one type of risk which is climate related production risks. There are two important types of risks namely financial risks and market related risks which these studies have not taken into consideration. These two types of risks are very common and are major sources of risks for marginal and small farmers from developing countries like India. Besides, studies on agricultural risks in the context of developing countries are very few in number. Therefore, the present study attempts to address these gaps through an exploratory study which focusses on finding out the sources of risk of farmers and the management strategies in Mahanadi river basin, Odisha. Three districts of Odisha located in upper, middle and lower regions of river Mahanadi were selected for this study. These districts are highly vulnerable to flood, cyclone and drought (Annual reports on natural calamities, 2011, 2015, Government of Odisha). In view of this situation, Government of Odisha regularly provides financial support to cope with the predicament through improved production and marketing efforts. However, these policies have not been able to effectively mitigate the risks in the flood and drought vulnerable study region. In this regard, the present study aims to identify the risk sources and management strategies of farmers. The findings of the study provide useful insights in devising targeted policies and programmes for the optimal management of risk in flood and drought affected regions in general and Odisha in particular.

Data and Methodology

Odisha state faces floods almost every year and drought in alternate years (Disaster Management Plan, 2014-15, Government of Odisha). Due to this reason, the production of the state also varies significantly from year to year. Primary data was collected using multi-stage random sampling from three districts of Odisha located in upper (Sonepur district), middle (Boudh district) and lower (Kendrapada district) region of Mahanadi river of Odisha. Multi-stage random sampling technique was employed to select districts, blocks, gram panchayats, villages and respondents. According to annual reports on natural calamities 2011, 19 districts were affected by flash floods. Out of these districts, all the three study districts were flood affected (i.e. Sonepur, Boudh and Kendrapada). One block has been selected randomly from each of the three districts. From each block, three revenue villages were selected randomly. Farm household data from these nine villages was collected using pre-tested questionnaire from 102 farmers located in upper, 106 in middle and 103 in lower region, aggregating to 311 farmers. It is noteworthy that farmers of the three study regions face flash flood in the kharif (rainy) season and drought in other seasons (winter and summer). Data was collected on socio-economic characteristics, risk sources and risk management strategies for the agriculture year, 2016-17.

In the first stage, to determine the sources of risk and risk management strategies, Five-point Likert scale ranging from one (not at all risky) to five (extremely risky) and one (less important) to five

(extremely important) was applied. In the second stage, data on sources of risk and risk management strategies were analysed using factor analysis. Factor analysis reduces a large set of original variables into new composite factors with minimum loss of information (Hair *et al*, 2010). The variation among factors is represented by Eigenvalues. Highly correlated variables of the factor will have the high proportion of total variance which is represented by the first few factors and the last factors contain very minimal information. As a general rule of thumb, Eigenvalues greater than one were retained in this study. The Kaiser-Meyer-Olkin (KMO) method checks the sampling adequacy. The value of KMO varies from zero to one, where one indicates that each variable is perfectly predicted without error by the other variables. KMO result of more than 0.6 indicates that the sample data is fit for factor analysis (Hair *et al*, 2010). Aditto (2011) has illustrated that KMO value of greater or equal to 0.50 is already considered to meet the minimum level in the literature. In addition, orthogonal (varimax) rotation was implemented in order to minimisethe number of variables that have high loadings on each factor to obtain factor solutions that were easier to interpret.

Results and Discussion

Socio-economic Characteristics of Farmers

Descriptive statistics on socioeconomic and demographic characteristics of farmers from upper, middle and lower region of river Mahanadi are presented in table 1. The variables used in this study comprise farmer's age, gender, family size, social categories, education, years of experience, land size and household income. Out of the 311 farmers who have been interviewed from three regions, about 97 per cent are male. The average age and experience of the farmers in the sample was 48 years and 26 years respectively. The average family size of farmers was six and the average farm size was four acres. Nearly 12 per cent of the respondents belong to general category, 57 per cent are from Other Backward Class (OBC), 28 per cent are from Scheduled Castes (SCs) and three per cent are from Scheduled Tribe (STs) category. Around 13 per cent of the total respondents were illiterates, 29 per cent belong to the category of studied up to primary school, 51 per cent up to secondary school, four per cent up to high school and three per cent up to graduation and above. The average annual net farm income of the upper Mahanadi region farmers (Rs. 99,555) was higher than middle (Rs. 50,025) and lower region (Rs. 59,138) farmers. The main reasons for such variation in annual net income was due to varying access to groundwater and surface water irrigation and average farm size which is very clearly seen from table 1.

Table 1: Farmers and Farm Characteristics

Sl.No.	Feature	Region			Overall
		Upper	Middle	Lower	
1.	Number of sample farmers	102	106	103	311
2.	Number of male headed farm HH	102	101	101	304
3.	Average family size (No.)	6	5	7	6
	Adult Male (>15 yrs)	2	2	2	2
	Adult Female (>15 yrs)	2	1	2	2
	Children (<15 yrs)	3	2	3	3
4.	Average Age of the respondent (yrs)	44	46	54	48
5.	Social Group (%)				
	General	13	1	21	12
	OBC	55	84	31	57
	SC	24	14	48	28
	ST	8	1	0	3
6.	Education (%)				
	Illiterate	7	10	21	13
	Primary (1 to 5 yrs)	28	41	18	29
	Secondary (6 to 10 yrs)	59	43	51	51
	Higher Secondary (11 to 12 yrs)	4	2	7	4
	Graduate and Above (13 & above yrs)	1	5	4	3
7.	Average farming experience (yrs)	22	25	31	26
8.	Total operational land size (Acre)	3.1	3.5	4.8	3.8
	Irrigated	1.6	0.3	0.7	0.9
	Unirrigated	1.5	3.2	4.1	2.9
9.	Average annual net farm income (INR)	99,555	50,025	59,138	69,573
	Average annual non-farm income (INR)	34,184	44,362	45,668	41,405
	Average total income (INR)	1,33,739	94,387	1,04,806	1,10,977

Source: Primary survey (2016-17)

Sources of Risk of Farmers in Upper, Middle and Lower Mahanadi Region

Nearly 26 sources of risk have been examined in three regions of Mahanadi river of Odisha. These sources were considered based on theoretical and empirical literature (Patrick *et al*, 1985, Martin, 1996, Hardaker *et al*, 2004, Akcaoz & Ozkan, 2005, Ullah *et al*, 2015), pilot survey and focus group discussion. Five-point Likert scale questionnaires were used to elicit information from farmers regarding perceptions of risk sources and management strategies.

Table 2 presents the factor loading and mean values of risk sources of farmers in the upper region of Mahanadi river of Odisha. The mean values of the risk sources influencing farm production are presented in descending order. Results of factor analysis clearly indicate drought (4.18) as the most important risk factor due to erratic and insufficient rainfall and lack of access to perennial Mahanadi river. This is followed by shortage of cash on hand (4.05), lack of savings (3.79), inadequate government support including crop insurance (3.51), unexpected rise in the input prices (3.40), pests

and diseases (3.22). The least important risk factors are change in land prices, change in the political situation, meeting the quality standard of the final product and lack of alternative markets.

Nine major factors were obtained from 26 risk sources using factor analysis, which explains about 69 per cent of the total variance for the upper region farmers. These factors include credit-related risk, input costs, market risk, financial risk, policy risk, production risk, land risk, inadequate government support and catastrophe.

Factor 1 was credit-related risk which has a positive relation with four variables, namely delay in access to institutional credit, credit ceiling based on land, indebtedness and varying institutional interest rates. Credit related risk was having high loading among the first three variables. This indicates that the credit-related risk is quite severe for the farmers of this region. It is due to inadequate banking facilities as well as lengthy bank procedures. Factor 2 was named as 'input cost' which contains five variables that have a positive relation with unexpected rise in fuel prices for farm operations and transportation, unavailability of labour, change in labour cost, lack of availability of machinery and equipment and transportation problem. Factor 3 has four variables such as unexpected fall in the product prices, product quality requirement of traders, lack of alternative markets and middleman's dominance. The factor loadings are 0.786, 0.869, 0.886 and 0.498 respectively. This factor is named as 'market risk' because factor loadings are related to market related issues.

Factor 4 can be summarized as 'financial risk', which includes high factor loading variables such as lack of savings (0.85) and shortage of cash on hand (0.872). This implies the finance related risk was relatively higher for the farmers of this region because most of them are marginal and small. Factor 5 contains two variables named as drought and unexpected rise in the input prices. It can be named as 'production risk' because the loadings are related to technological input cost and environmental risk that directly relate to the farm production process. Factor 6 was referred to as the 'policy risk' because it's having high loadings of change in the political situation (0.718) and landlessness within the joint farm household and expenses on weed cleaning (i.e. costs of weed cleaning in farming are more expensive). Factor 7, 'land risk', has positive high loadings on changes in land price (0.813) and pests and diseases (0.575). Factor 8, 'inadequate government support' is associated with variables, like inadequate government support including crop insurance and lack of access to institutional credit. Lack of extension efforts and institutional credit facilities has affected agricultural production in the region. Factor 9 was named as 'catastrophe', which includes variables such as flood and unfavourable weather conditions.

Table 2: Factor Loadings of Risk Sources of Farmersin Upper Mahanadi Region

Source of risk	Mean	Factors								
		1	2	3	4	5	6	7	8	9
Drought	4.18	0.18	-0.055	0.034	0.097	**0.661**	0.249	0.169	0.006	-0.167
Shortage of cash on hand	4.05	0.167	0.089	0.006	**0.872**	-0.037	0.091	0.046	-0.049	0.106
Lack of savings	3.79	0.074	-0.141	0.173	**0.85**	0.047	-0.032	0.014	0.10	-0.052
Inadequate govt support including crop insurance	3.51	-0.117	-0.226	0.273	0.397	0.143	-0.289	-0.162	**0.454**	-0.113
Unexpected rise in the input prices	3.40	-0.086	0.05	0.003	-0.021	**0.837**	-0.025	-0.183	-0.059	-0.121
Pest and diseases	3.22	0.168	0.378	0.084	-0.006	0.047	-0.178	**0.575**	0.151	0.172
Flood	3.15	0.051	0.155	0.389	-0.178	0.028	0.189	-0.168	-0.002	**0.518**
Middleman's dominance	2.87	-0.146	-0.339	**0.498**	0.166	0.011	0.289	0.09	0.072	0.428
Lack of access to institutional credit	2.78	0.142	-0.042	0.072	-0.062	0.058	-0.029	-0.269	**0.645**	0.237
Unfavourable weather conditions during crop cycle	2.76	0.143	0.266	-0.026	-0.074	0.093	0.02	-0.235	-0.031	**0.707**
Increase in labour cost	2.68	0.039	**0.844**	-0.145	-0.029	-0.052	-0.001	0.002	0.038	0.013
Indebtedness	2.59	**0.879**	0.068	-0.026	0.082	-0.002	0.02	-0.06	0.106	0.008
Unavailability of labour	2.54	0.209	**0.752**	-0.152	-0.075	-0.043	0.013	0.055	0.035	0.137
Credit ceiling based on land	2.51	**0.892**	0.11	-0.051	0.026	0.223	0.011	-0.022	-0.052	0.077
Delay in access to institutional credit	2.48	**0.885**	0.12	-0.017	0.055	0.295	-0.065	-0.01	-0.044	-0.034
Transportation problem	2.37	0.142	**0.564**	0.291	-0.049	-0.121	0.198	-0.16	-0.012	-0.052
Unexpected fall in the product prices	2.04	-0.125	-0.175	**0.786**	0.037	0.056	0.163	-0.004	0.126	-0.101
Expenses on weed cleaning	2.04	-0.115	0.364	0.023	0.102	0.144	**0.481**	0.381	0.165	0.094
Landlessness of family member within joint farm household	1.94	-0.372	-0.311	0.107	-0.13	-0.019	0.419	0.314	-0.144	-0.073
Unexpected rise in fuel prices for farm operations and transportation	1.92	0.051	**0.497**	-0.226	0.046	0.196	-0.077	-0.259	0.172	-0.088
Varying institutional interest rates	1.86	**0.612**	0.3	0.168	0.194	-0.31	0.319	0.064	-0.017	0.135
Lack of availability of machinery and equipment	1.66	0.209	**0.46**	0.003	-0.004	0.43	-0.045	0.199	-0.006	0.31
Lack of alternative markets	1.64	0.118	-0.007	**0.886**	0.108	-0.033	-0.061	-0.02	-0.062	-0.049
Product quality requirement of traders	1.63	-0.028	-0.038	**0.869**	0.086	0.06	-0.198	0.141	-0.074	0.002
Change in the political situation	1.23	0.048	0.202	-0.059	0.11	0.3	**0.718**	-0.187	-0.006	-0.003
Change in land prices	1.07	-0.022	-0.068	0.05	0.029	-0.028	-0.126	**0.813**	-0.062	-0.077
Eigenvalue		4.58	3.26	2.04	1.77	1.44	1.38	1.22	1.09	1.09
Percentage of total variance explained		17.60	12.55	7.86	6.82	5.52	5.32	4.69	4.20	4.18
Cumulative percentage of the variance explained		17.60	30.15	38.01	44.83	50.35	55.67	60.35	64.55	68.73

Note: Factor loadings for absolute values greater than 0.4 are depicted in **bold;** Likert scale is used ranging from 1 (not at all risky) to 5 (extremely risky)

Considering the middle Mahanadi region farmers, the most important risk sources are inadequate government support which includes crop insurance (4.64), drought (4.02), and unexpected fall in the product prices (3.96), flood (3.93) and shortage of cash on hand (3.86). Whereas the less important risk factors are change in the political situation (1.11) and change in land price (1.44).

The factor loadings obtained from the Varimax rotations grouped the 26 sources of risk into eight factors for the middle Mahanadi region farmers. Eight obtained factors with Eigen values greater than one explain about 69 per cent of total variance (Table 3). Obtained factors are credit-related risk, input cost, market risk, financial risk, land risk, inadequate government support, communication gap and catastrophe.

Factor 1, 'credit-related risk', comprised indebtedness, credit ceiling based on land, delay in access to institutional credit and varying institutional interest rates. These variables are having a positive relation with factor one with high factor loadings 0.911, 0.907, 0.904 and 0.86 respectively. Most of the farmers of the region are marginal and small and the location of this region is interior; therefore the facilities from the financial institutions are also very few. Due to the long distance and lack of information about bank facilities and services, the problem of inaccessibility and other bank related problems was high. There is a positive relationship between 'input cost' (Factor 2) and variables like availability of labour (0.848), change in labour cost (0.844), lack of availability of machinery and equipment (0.833), unexpected rise in fuel prices for farm operations and transportation (0.645), and pests and diseases (0.453). Factor 3 comprises the variables related to 'market risk', unexpected fall in the product prices, transportation problem, product quality requirement of traders, lack of alternative markets and expenses on weed cleaning (i.e. costs of weed cleaning in farming are higher). Due to lack of proper market facilities and their interior location, the market related risk is high in this region. Factor 4 was labelled as 'financial risk'. This is because factor 4 includes the high loading of cash on hand (0.781) and lack of savings (0.84).These two variables have a positive relation with financial risk. Since the farmers of this region are economically backward, savings related problems were relatively higher.

Factor 5, 'land risk' consists of high loading variables like unexpected rise in the input prices, landlessness within joint farm households and changes in land prices which have a positive relation with the factor. This factor includes land and land price related risks which partly arise due to increasing family size and unequal distribution of land. Factor 6 can be mentioned as 'inadequate government support' which includes 'government facilities' which include crop insurance (0.672) and drought (0.688). Farmers utilize fewer government facilities and they are also unaware of the several agricultural schemes and benefits within the known schemes due to which their productivity is relatively lower as compared to other regions. Factor 7 is termed as 'communication gap' containing variables like middleman's dominance and shortage of cash in hand. Loadings of factors are greater than 0.4. Factor 8 can be mentioned 'catastrophe', which includes higher loading variables like flood and unfavourable weather conditions during crop cycle. Since the regions was situated on the river basin, the flood situation was common during monsoons and unfavourable weather condition during remaining seasons.

Table 3: Factor Loadings of Risk Sources of Farmers in Middle Mahanadi Region

Source of risk	Mean	Factors							
		1	2	3	4	5	6	7	8
Inadequate govt support including crop insurance	4.64	-0.182	-0.128	0.107	0.075	-0.1	**0.672**	-0.048	0.057
Drought	4.02	-0.012	0.181	-0.085	0.148	0.013	**0.688**	0.006	0.003
Unexpected fall in the product prices	3.96	-0.182	0.289	**0.477**	0.115	0.208	0.144	0.118	-0.359
Flood	3.93	0.075	0.388	0.112	0.094	-0.322	0.096	0.151	**0.477**
Shortage of cash on hand	3.86	-0.157	-0.195	-0.078	**0.781**	0.043	0.225	0.166	0.075
Middleman's dominance	3.77	-0.189	-0.166	0.214	0.171	0.194	-0.055	**0.646**	-0.214
Lack of savings	3.45	0.03	-0.102	0.138	**0.84**	0.15	0.19	0.056	-0.029
Unfavourable weather conditions during crop cycle	3.22	-0.041	0.094	-0.001	0.039	0.058	0.125	0.069	**0.852**
Unexpected rise in the input prices	3	-0.045	-0.13	-0.378	0.079	**0.54**	-0.195	0.021	-0.066
Pests and diseases	2.78	-0.033	**0.453**	0.385	-0.136	0.33	0.265	-0.086	-0.062
Product quality requirement of traders	2.62	0.121	0.137	**0.767**	-0.067	0.033	-0.009	0.335	-0.103
Lack of alternative markets	2.58	0.026	0.206	**0.774**	-0.072	-0.055	-0.006	0.229	-0.09
Change in labour cost	2.43	0.091	**0.844**	0.058	-0.082	-0.092	0.081	0.108	-0.003
Unavailability of labour	2.39	0.127	**0.848**	0.082	-0.045	0.033	0.088	0.024	-0.12
Indebtedness	2.28	**0.911**	0.035	-0.045	0.051	-0.118	-0.039	0.01	-0.044
Expenses on weed cleaning	2.25	-0.072	0.148	**0.668**	0.066	-0.08	0	-0.235	0.178
Transportations problems	2.17	0.009	-0.033	**0.706**	0.13	-0.011	0.102	-0.194	-0.049
Credit ceiling based on land	2.09	**0.907**	0.029	0.04	-0.031	-0.101	-0.149	0.087	0.095
Landlessness of family member within joint farm household	2.05	0.028	-0.414	-0.277	0.165	**0.6**	-0.088	-0.209	-0.013
Lack of access to institutional credit	2	0.237	0.059	-0.127	0.021	-0.099	0.01	**0.706**	0.154
Delay in access to institutional credit	1.98	**0.904**	0.097	0.077	-0.072	-0.059	-0.076	0.074	0.056
Varying institutional interest rates	1.84	**0.86**	0.143	-0.039	-0.035	0.084	0.016	-0.055	-0.175
Lack of availability of machinery and equipment	1.81	0.122	**0.833**	0.098	-0.124	0.061	-0.082	-0.07	-0.038
Unexpected rise in fuel prices for farm operations and transportation	1.59	-0.009	**0.645**	-0.004	0.107	-0.139	-0.126	-0.136	0.182
Changes in land prices	1.44	-0.132	-0.065	-0.131	0.022	**0.772**	-0.103	0.109	0.201
Change in the political situation	1.11	-0.052	-0.207	-0.049	**-0.511**	0.161	0.36	0.125	0.074
Eigenvalues		4.59	3.41	2.39	1.88	1.51	1.34	1.23	1.13
Per cent of total variance explained		17.63	13.11	9.19	7.23	5.81	5.14	4.71	4.35
Cumulative per cent of the variance explained		17.63	30.74	39.93	47.16	52.97	58.11	62.82	67.17

Note: Factor loadings for absolute values greater than 0.4 are in **bold;** Likert-type scale is used (1= not risky to 5= extremely risky)

The results of factor analysis for lower Mahanadi region farmers are shown in table 4. With respect to the lower Mahanadi region farmers, floods (4.29), inadequate governmental support which includes crop insurance (4.19) were the most important risk sources, while transportation problem (1.22) and unexpected rise in fuel prices for farm operations and transportation (1.51) were the least important sources of risk. Factor analysis obtained nine factors from 26 sources of risk, whose Eigen

values are greater than one and it accounted for 69 per cent of total variance. This factor can be interpreted as credit-related risk, market risk, input cost, inadequate government support, financial risk, availability of machinery, policy risk, land risk and catastrophe.

The first factor, 'credit-related risk' contains six variables which are having higher loadings and positive relation with it which encompasses lack of access to institutional credit (0.728), indebtedness (0.803), delay in access to institutional credit (0.885), credit ceiling based on land (0.879), varying institutional interest rates (0.706) and unexpected rise in the input prices (0.404). Availability of financial institutions and their facilities for the farmers of this region were very poor. The number of tenants is more in this region. They can't avail the bank facilities due to unavailability of land in their names. There are no such financial facilities by the government for the tenant farmers in the state. The factor 'market risk' (factor 2) has a positive relation with the unexpected fall in the product prices, pests and diseases, product quality requirement of traders and lack of alternative markets. All the variables are having high loadings greater than 0.4. Variables like availability of labour (0.786), change in labour cost (0785) and unexpected rise in fuel prices for farm operations and transportation (475) have a positive relation with 'input cost' (factor 3) and changes in land prices (-0494) have a negative relation with factor 3. Factor 4 is referred to as 'flood' because it had high loading of variable flood (0.90). The factor also contains another variable, namely inadequate government support including crop insurance (0.87). Flood due to cyclone and heavy rain is common for the farmers of this region. Farmers of this region perceive a high flood risk; it is because the government facilities are very few for the needy farmers. The facilities are mostly availed by land owners and large farmers but not the marginal and tenant farmers.

High loadings on finance related variables like shortage of cash in hand and lack of savings are found in factor 5 (financial risk). Financial shortage in agricultural production was high for the farmers because they are marginal and small, who are the main group farmers highly affected by climate change. Factor 6 can be mentioned as 'availability of machinery', which contains the variables transportation problem (0.64) and lack of availability of machinery and equipment (0.63). Unavailability of vehicles and machinery during cultivation and transportation is the main reason of lower production and income for the farmers of this region. High loaded variables like changes in economic and political situation (0.65) are positively related with factor seven (policy risk) and negative relation with the middleman's dominance (-0.73). Factor 8, 'land risk' has a high loading on landlessness within the joint farm household and expenses on weed cleaning (i.e. costs of weed cleaning in farming are higher). Factor 9, catastrophe, is having high loadings on drought (0.467) and unfavourable weather conditions (0.874).

Table 4: Factor Loadings of Risk Sources of Farmers in Lower Mahanadi Region

Source of risk	Means	Factors								
		1	2	3	4	5	6	7	8	9
Flood	4.29	-0.082	-0.041	0.073	**0.899**	0.011	-0.015	0.034	-0.052	0.084
Inadequate govt support including crop insurance	4.19	-0.114	0.021	0.10	**0.87**	0.028	-0.022	-0.049	0.011	0.016
Unexpected fall in the product prices	4.05	0.059	**0.435**	0.113	-0.294	0.161	-0.509	0.012	0.014	-0.073
Shortage of cash on hand	3.89	0.067	-0.037	-0.035	-0.038	**0.828**	0.031	-0.188	0.066	0.127
Expenses on weed cleaning	3.84	0.23	0.277	0.183	-0.195	-0.039	0.017	-0.134	**0.531**	0.329
Drought	3.67	-0.1	0.052	0.279	0.215	-0.156	0.196	-0.204	-0.173	**0.467**
Lack of savings	3.52	0.114	0.259	-0.011	0.113	**0.775**	-0.064	0.121	-0.049	-0.173
Middleman's dominance	3.39	-0.022	-0.06	0.112	-0.055	0.212	0.168	**-0.733**	-0.007	0.256
Pests and diseases	3.29	0.191	**0.495**	0.431	-0.297	0.018	0.098	0.054	-0.152	-0.057
Product quality requirement of traders	3.17	0.15	**0.789**	0.022	0.012	0.079	0.014	0.068	-0.061	0.086
unfavourable weather conditions	3.16	0.127	0.026	-0.012	0.121	-0.022	0.028	-0.019	0.009	**0.874**
Landlessness within joint farm household	3.01	-0.062	-0.267	**-0.422**	-0.168	0.223	-0.038	0.065	0.612	-0.038
Availability of labour	3	-0.099	0.014	**0.786**	-0.041	0.024	0.079	-0.031	0.192	-0.123
Lack of access to institutional credit	2.96	**0.728**	0.074	0.185	0.006	0.074	-0.225	-0.008	0.304	0.069
Lack of alternative markets	2.88	-0.121	**0.789**	0.054	0.05	0.076	0.148	0.047	0.131	0.011
Change in labour cost	2.84	0.021	0.095	**0.785**	0.045	-0.024	-0.002	-0.007	-0.081	0.106
Unexpected rise in the input prices	2.8	**0.404**	0.403	-0.027	-0.137	-0.102	0.282	-0.057	-0.312	-0.257
Indebtedness	2.69	**0.803**	-0.052	-0.083	-0.036	0.166	0.146	0.025	-0.055	-0.116
Delay in access to institutional credit	2.64	**0.885**	0.202	0.001	-0.11	-0.044	-0.022	-0.095	-0.054	0.111
Credit ceiling based on land	2.64	**0.879**	0.205	-0.061	-0.141	-0.04	-0.065	-0.067	-0.103	0.136
Change in the political situation	1.87	-0.07	0.06	0.059	-0.182	0.219	0.218	**0.654**	-0.235	0.268
Lack of availability of machinery and equipment	1.77	0.107	0.172	0.347	0.039	-0.201	**0.635**	0.058	0.228	-0.016
Changes in land prices	1.66	0.019	0.331	**0.494**	-0.401	-0.084	0.285	0.048	0.149	-0.031
Varying institutional interest rates	1.64	**0.706**	-0.279	-0.025	-0.007	0.093	0.188	0.143	0.042	0.063
Unexpected rise in fuel prices for farm operations and transportation	1.51	0.002	0.117	**0.475**	0.1	-0.147	0.312	0.461	0.11	0.09
Transportations problem	1.22	0.037	0.202	-0.016	-0.246	0.241	**0.638**	0.004	-0.099	0.027
Eigen value		4.28	2.91	2.32	1.77	1.6	1.45	1.33	1.17	1.06
Percentage of total variance explained		16.45	11.21	8.93	6.8	6.14	5.58	5.11	4.49	4.07
Cumulative percentage of the variance explained		16.45	27.65	36.58	43.38	49.52	55.1	60.2	64.69	68.77

Note: Factor loadings for absolute values greater than 0.4 are in **bold;** Likert-type scale is used (1= not risky to 5= extremely risky)

Risk Management Strategies

Twenty-four risk management strategies were considered in the case of upper Mahanadi region farmers. These variables are related to enterprise diversification, crop diversification, off-farm income, debt management, sales management and financial support from the government. The results of factor analysis are presented in table 5. The average values are presented in descending order. According to the farmers from upper Mahanadi region, growing more than one variety of crops (4.05) is the most effective strategy and selection of crop varieties with low price variability (1.16) is the least effective strategy.

Factor analysis on risk management strategies has been used considering principal component analysis and Varimax rotation. Factor analysis found nine factors of risk management strategies for upper Mahanadi region farmers (table 5). These factor loadings having greater than one Eigen values explain about 69 per cent of total variance. Factor 1 can be named as 'diversification', it includes five variables namely crop diversification (0.905), cultivating in alternate season (0.877), lift irrigation (0.849), application of monitoring and programmes for pests and diseases (0.507) and management of debt (0.54). Factor 2 is termed as 'financial security'. This factor consists of four variables, namely precautionary savings, leasing assets rather than owning them, depend on MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) and depending on government financial support. The loading of these variables is greater than 0.4. Factor 3 is referred to as 'sustainable income', it has a positive relation with farmers working off-farm in off seasons (0.401) and family members working off-farm (0.776). Farmers of this region are marginal and stay in a joint family, most of their family members go for off-farm activities such as construction workers or daily labourers. 'Financing and security' (factor 4) has high loadings on off-farm investment as off-farm investment like xerox centre, paan shop, and grocery shop, lending business and renting business and farm activities diversification towards apiculture, poultry and animal husbandry. Loadings of these two variables are greater than minimum level 0.4.

Factor 5 (managing) has a positive relation with growing more than one variety (0.717) and keeping debt low (0.705). High loading variables like hired labour in the case of need (0.811) and gathering market information such as price forecasts and trends (0.753) have a positive relation with factor 6 (planning). Factor 7, 'reducing production risk', has a positive relation with re-cultivation seedlings (0.704) and using traditional flood resistance crops (0.74). Factor 8 is labeled as 'mixed cropping' because of its high association with the variables namely growing more than one crop to tackle production risk and reducing crop loss (0.824) and arrangement of money from friends and relatives to deal with risk (0.631). Factor 9 is determined as 'reducing market risk' which is having a positive relation with spreading sales over time by storing products and selection of crop varieties with low price variability. Loadings of the variables are higher than the threshold point (0.4).

Table 5: Factor Loadings of Risk Management Strategies of Farmers in Upper Mahanadi Region

Risk management strategies	Mean	Factors								
		1	2	3	4	5	6	7	8	9
Growing more than one variety	4.05	-0.039	0.068	-0.086	-0.072	**0.717**	-0.122	-0.315	-0.144	-0.017
Application of monitoring and programmes for pests and diseases control	3.83	**0.507**	0.168	0.247	0.178	-0.08	-0.078	-0.01	0.137	-0.202
Arrangement of money from friends and relatives	3.82	-0.023	0.197	0.082	0.011	-0.123	0.082	-0.185	**0.631**	0.256
Keeping debt low	3.74	0.185	0	-0.152	0.005	**0.705**	-0.251	-0.25	-0.104	-0.041
Recultivation of seedlings	3.72	0.128	-0.055	0.081	-0.153	0.174	-0.139	**0.704**	0.064	-0.211
Lift irrigation/bore well	3.43	**0.849**	-0.009	0.118	0.104	0.121	-0.108	0.106	-0.034	0.186
Hired labour on need basis	3.25	0.229	-0.026	0.017	0.015	-0.041	**0.811**	-0.119	0.121	-0.191
Farmers working off-farm in off season	3.17	-0.163	-0.099	**0. 401**	-0.065	-0.187	-0.385	-0.228	-0.177	0.194
Crop diversification	3.16	**0.905**	0.058	-0.01	-0.013	0.108	0.047	0.107	-0.007	0.005
Cultivating in alternate seasons	3.09	**0.877**	-0.04	-0.006	-0.008	0.138	0.02	-0.05	-0.034	0
Gathering market information like price forecasts and trends	3.05	0.058	-0.147	-0.23	0.127	-0.087	**0.753**	-0.003	0.061	-0.144
Depending on precautionary savings	3.00	0.07	**0.586**	0.302	0.138	0.519	0.004	-0.001	-0.044	0.103
Family members working off-farm	2.91	0.003	-0.08	**0.776**	-0.036	-0.037	0.186	-0.106	-0.075	-0.249
Using traditional flood resistance crops	2.87	0.026	0.037	-0.049	-0.005	-0.09	0.094	**0.76**	-0.119	0.064
Leasing assets rather than owning them	2.65	-0.19	**0.667**	-0.156	0.186	-0.178	-0.161	-0.018	0.185	0.247
Depending on MGNREGA	2.61	0.263	**0.598**	0.268	0.252	0.329	-0.095	-0.1	-0.158	0.054
Management of debt	2.54	**0.54**	0.423	0.23	-0.164	-0.239	-0.014	0.078	-0.013	0
Depending on government financial support	1.74	0.245	**0.646**	-0.058	-0.182	-0.094	-0.094	0.063	0.322	-0.127
Growing more than one crop	1.72	-0.005	0.011	0.123	0.029	0.115	0.05	0.057	**0.824**	-0.05
Spreading sales	1.67	-0.065	-0.029	0.039	0.009	0.04	**0.836**	0.037	0.081	0.088
Off-farm investment	1.50	-0.013	0.199	0.141	**0.798**	0.093	0.133	0.012	-0.073	-0.082
Enterprise diversification	1.37	0.067	-0.047	-0.039	**0.83**	0.044	-0.025	-0.147	0.079	-0.049
Spreading sales over time by storing products	1.19	0.204	-0.323	-0.134	0.424	-0.173	0.081	0.157	0.138	**0.508**
Selection of crop varieties with low price variability	1.16	0.028	0.167	0.052	-0.182	0.065	-0.017	-0.132	0.072	**0.784**
Eigen values		4.08	2.31	1.99	1.80	1.59	1.34	1.22	1.16	1.02
Percentage of total variance explained		17.02	9.64	8.31	7.48	6.62	5.58	5.08	4.83	4.23
Cumulative percentage of the variance explained		17.02	26.66	34.97	42.45	49.06	54.64	59.72	64.55	68.79

Note: Factor loadings for absolute values greater than 0.4 are in **bold;** Likert-type scale is used (1= not at all important to 5= extremely important)

Farmers in the middle Mahanadi region were found growing more than one crop (3.9) as the most important risk management strategy followed by arrangement of money from friends and relatives (3.8), depending on precautionary savings (3.8), management of debt (3.7) and depending on

government for financial support (3.3), while practicing lift/bore well irrigation (0.9) as the least important strategy.

Table 6 presents the Varimax rotated factor loadings of risk management strategies for Middle Mahanadi region farmers. Nine factors were obtained from 24 perceived risk management strategies through Varimax rotations factor loadings, which explains about 68 per cent of total variance.

Factor 1, 'marketing', included five significant high loading variables namely spreading sales over time by storing product (0.914), gathering market information such as price forecasts and trends (0.876), depending on government financial support (0.877), depending on precautionary savings (0.463) and management of debt (0.516). Factor 2 (sustainable income) has a positive relation with the farmers working off-farm in off seasons (0.714) and family members working off-farm (0.747) and negative relation with keeping debt low (-0.578). Farmers and their adult male and female family members of this region go for off-farm work like construction activities, daily labour in other farms and working in a shop. The farming income was insufficient to manage their livelihood; therefore, they engaged in other sources of income. Factor 3 (reducing production risk) has a positive relation with enterprise diversification (0.781) and application of monitoring and programmes for pests and diseases (0.78) and negative relation with cultivating in alternative seasons (-0.428). Arrangement of money from friends and relatives (0.679) and leasing assets rather than owning them (0.781) are included in Factor 4 (financing and security). Farmers manage money from different sources for the production process during urgent requirements as the farmers of this region are resource poor.

Factor 5 was termed as 'mixed cropping' because it has a high loading on crop diversification (0.491), growing more than one variety (0.453), re-cultivation of seedlings (0.595) and selection of crop varieties with low price variability (0.829). For producing more and tackling production risk, the farmers of this region are diversifying towards pulses by reducing paddy production, practicing mixed cropping and they are also re-cultivating their crops after the occurrence of floods. Factor 6 was named as 'labour', which has a positive relation to labour related variables like hired labour whenever the need arises (0.557) and depending on MGNREGA (0.562) and negative relation with growing more than one crop (-0.708). Factor 7 has a positive relation with the variable like spreading sales (0.797). Factor 8 (reducing flood risk) has a high loading on using traditional flood resistance crops (0.835). Farmers used traditional flood resistance crops to tackle floods as the area was flood-prone during monsoons.

Table 6: Factor Loadings of Risk Management Strategies of Farmers in Middle Mahanadi Region

Risk management strategies	Mean	Factors							
		1	2	3	4	5	6	7	8
Growing more than one crop	3.9	-0.074	-0.138	0.125	0.019	0.023	**-0.708**	0.302	-0.05
Arrangement of money from friends and relatives	3.8	-0.008	0.059	0.058	**0.679**	0.168	-0.229	-0.055	-0.278
Depending on precautionary savings	3.8	**0.463**	0.104	0.195	0.087	-0.109	0.13	0.05	0.071
Keeping debt low	3.7	0.162	**-0.578**	-0.271	-0.359	0.214	0.169	0.149	-0.194
Depending on government for financial support	3.3	**0.877**	-0.137	0.138	-0.062	0.052	0.054	0.084	-0.011
Cultivating in alternate seasons	3.3	-0.181	0.258	**-0.428**	0.08	0.078	-0.102	-0.025	-0.137
Enterprise diversification	3.2	0.236	-0.014	**0.781**	-0.013	0.105	-0.012	-0.208	0.013
Farmers working off-farm in off seasons	3.2	-0.003	**0.714**	-0.282	-0.018	0.174	-0.014	-0.102	-0.036
Spreading sales over time by storing products	3.1	**0.914**	0.03	0.017	-0.016	0.008	0.104	-0.03	0.019
Gathering market information like price forecasts and trends	3.1	**0.876**	0.038	0.001	-0.096	0.066	0.01	0.047	-0.1
Growing more than one variety	3.1	-0.019	0.303	-0.052	-0.028	**0.453**	-0.091	-0.339	0.347
Hired labour on need basis	3.0	0.055	-0.262	0.26	0.03	0.038	**0.557**	0.427	0.036
Application of monitoring and programmes for pests and diseases control	2.9	0.01	0.153	**0.78**	-0.054	0.015	-0.054	-0.192	0.198
Leasing assets rather than owning them	2.7	-0.149	-0.046	-0.081	**0.781**	-0.006	0.27	0.127	-0.031
Depending on MGNREGA	2.6	0.272	-0.392	0.188	0.204	0.167	**0.562**	0.175	0.001
Management of debt	2.5	**0.516**	-0.235	0.187	0.395	-0.141	-0.015	-0.1	0.161
Using traditional flood resistance crops	2.1	-0.036	-0.147	-0.109	-0.099	0.092	0.055	-0.012	**0.835**
Family members working off-farm	1.7	-0.062	**0.747**	-0.009	-0.057	-0.045	0.1	0.157	-0.247
Crop diversification	1.5	0.204	-0.058	0.037	-0.34	**0.491**	0.145	0.222	0.255
Recultivation of seedlings	1.5	0.04	0.201	0.205	0.115	**0.595**	0.467	-0.09	-0.026
Selection of crop varieties with low price variability	1.3	0.03	-0.043	-0.011	-0.012	**0.829**	0.008	0.083	0.061
Off-farm investments	1.3	0.16	**0.55**	-0.119	-0.078	0.191	-0.122	0.482	0.112
Spreading sales	1.2	0.012	0.076	-0.003	0.089	-0.04	-0.075	**0.797**	-0.042
Lift/bore well irrigation	0.9	-0.189	0.018	0.048	**0.47**	0.12	0.034	-0.063	-0.185
Eigen value		4.59	3.41	2.39	1.85	1.52	1.44	1.15	1.04
Percentage of total variance explained		17.59	11.02	9.13	8.72	6.76	5.99	4.78	4.31
Cumulative percentage of the variance explained		17.59	28.61	37.74	46.46	53.22	59.21	63.99	68.3

Note: Factor loadings for absolute values greater than 0.4 are in **bold;** Likert-type scale is used (1= not at all important to 5= extremely important)

Among the lower Mahanadi region farmers, farm crop diversification (4.11) was found to be most influential, whereas selection of crop varieties with low price variability (1.34) was less influential. Ten factors were obtained using factor analysis from 24 risk management strategies for lower Mahanadi region farmers. Factor 1, 'diversification' included high loadings on crop diversification (0.826), cultivating in alternative seasons (0.759) and growing more than one crop (0.634). Lower region was more prone to floods, therefore farmers of this region take crop holiday for kharif season and cultivate in rabi and summer season. They also diversify their crop towards pulses like black gram, horse gram and green gram. They are practicing mixed cropping to avoid crop loss. Factor 2 was named as 'reducing financial risk' because it included the financial assistance variables like depending on MGNREGA, off-farm investments, depending on government for financial support and selection of crop varieties with low price variability. Loadings of these variables are greater than the threshold point 0.4. Factor 3 was named as 'financing and security' which has a positive relation with arrangement of money from friends and relatives (0.619), and management of debt (0.74) and negative relation with spreading sales over time by storing the products (-0.494). Factor 4 can be explained as 'irrigation' which includes two variables namely, lift/bore well irrigation (had a positive relation) and depending on farmer groups (had a negative relation). The variables are having higher loadings greater than 0.4. Factor 5, 'enterprise diversification', having a positive relation with enterprise diversification (0.788) and negative relation with farmers working off-farm in the off season (-0.644).

Table 10: Factor Loadings of Risk Management Strategies of Farmers in Lower Mahanadi Region

Risk management strategies	Mean	Factors									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Crop diversification	4.11	**0.826**	-0.002	-0.042	-0.054	-0.007	0.002	0.04	0.234	0.083	-0.013
Cultivating in alternate seasons	3.88	**0.759**	0.117	0.167	-0.132	0.075	-0.212	-0.037	0.074	-0.145	-0.004
Growing more than one crop	3.85	**0.634**	0.203	0.041	0.211	-0.125	-0.105	0.016	-0.059	0.208	0.174
Application of monitoring and programmes for pests and diseases control	3.7	-0.066	0.018	0.001	0.157	0.112	-0.017	**0.818**	0.06	0.094	-0.066
Hired labour on need basis	3.61	0.119	-0.155	-0.021	-0.422	0.245	0.363	**0.48**	-0.021	0.073	-0.374
Arrangement of money from friends and relatives	3.52	0.116	-0.089	**0.619**	0.05	0.149	-0.304	0.211	0.038	0.071	-0.2
Gathering market information, such as price forecasts and trends	3.5	0.053	0.041	0.024	-0.133	0.19	0.027	-0.022	**0.867**	0.032	0.033
Depending on precautionary savings	3.33	0.328	0.207	0.273	0.093	-0.076	-0.108	**0.454**	-0.013	-0.272	0.301
Growing more than one variety	2.96	0.163	0.036	0.32	-0.144	-0.031	0.153	-0.041	0.2	**0.622**	-0.232
Leasing assets rather than owning them	2.86	0.055	-0.143	0.173	0.15	0.132	**-0.704**	0.143	-0.048	0.331	0.069
Keeping debt low	2.83	0.004	-0.033	0.135	0.015	-0.065	0.137	-0.064	0.098	**-0.84**	-0.152
Family members working off-farm	2.75	0.086	-0.153	-0.098	-0.115	-0.101	-0.046	-0.064	0.052	0.049	**0.814**
Management of debt	2.58	0.071	0.24	**0.74**	-0.01	-0.172	0.031	-0.023	0.085	0.001	-0.015
Farmers working off-farm in off seasons	2.43	-0.08	-0.229	0.123	0.245	**-0.644**	0.139	-0.35	0.022	0.146	-0.037
Using traditional flood resistant crops	2.41	-0.263	-0.12	0.042	0.153	0.095	**0.74**	0.111	0.062	0.169	-0.023
Spreading sales	2.27	0.187	-0.03	0.13	0.395	-0.071	0.123	0.098	**0.631**	-0.068	0.06
Spreading sales over time by storing products	2.25	0.154	0.186	-0.494	0.061	-0.24	-0.093	0.241	**0.433**	0.058	-0.177
Depending on MGNREGA	2.17	0.151	**0.599**	0.026	0.072	0.387	0.148	0.135	-0.104	-0.004	0.368
Enterprise diversification	2.11	-0.075	-0.009	0.024	0.139	**0.788**	0.04	-0.03	0.13	0.138	-0.154
Off-farm investment	2.08	0.09	**0.65**	0.224	-0.158	0.218	0.101	-0.003	0.112	-0.066	-0.031
Depending on farmer groups	2.05	-0.343	0.32	0.005	**-0.599**	-0.115	-0.148	0.062	0.143	0.12	0.246
Lift/bore well irrigation	1.99	-0.102	0.072	-0.031	**0.74**	0.001	-0.042	0.131	0.077	-0.023	-0.029
Depending on government for financial support	1.58	0.029	**0.401**	0.353	-0.266	-0.154	0.298	0.375	0.146	-0.1	0.03
Selection of crop varieties with low price variability	1.34	0.093	**0.762**	-0.057	0.092	-0.162	0.028	0.002	0.004	0.097	-0.242
Eigen values		2.99	2.26	1.79	1.67	1.57	1.52	1.34	1.27	1.10	1.02
Percentage of total variance explained		12.49	9.43	7.48	6.94	6.56	6.32	5.58	5.29	4.59	4.24
Cumulative percentage of the variance explained		12.49	21.91	29.39	36.34	42.89	49.22	54.79	60.10	64.67	68.91

Note: Factor loadings for absolute values greater than 0.4 are in **bold;** Likert-type scale is used (1= not at all important to 5= extremely important)

Factor 6, 'reducing flood risk' which included two variables using traditional flood resistance crop and leasing assets rather than owning them, which have positive and negative relationship with traditional method respectively. Factor 7, 'reducing production risk' as high loadings on application of

monitoring and programmes for pests and diseases (0.818), hired labour whenever there is a need (0.48) and depending on precautionary savings (0.45). For better production, farmers of this region use plant protection chemicals for control of pests and diseases, hire more labour and save money for urgent requirements for farm production. Factor 8 was mentioned as 'marketing' which included market related variables like gathering market information, such as price forecasts and trends (0.867) and spreading sales (0.631). For tackling market related risk, farmers of this region gather market price related information before selling the products and sell their products by storing. Factor 9 (mixed cropping) encompasses variables like growing more than one variety and keeping debt low. Factor 10 can be named as 'family income' because it includes variables like family members working off-farm (0.814). Most of the farmer families have more than one adult member and they generally work in off-farm activities for meeting the family expenses.

Comparing the results of the three regions shows thatdrought is the most important source of risk for farmers in upper Mahanadi region. To tackle this risk, farmers cultivate different varieties of drought resistant paddy crops like Shankar, Rudra and Konark.

With respect to the farmers of middle region, the main issue is inadequate government support. This is mainly because the farmers in this region are economically weak and have small land holdings. Since the villages are located in interior areas, the government support doesn't reach them even though they are in great need of this support. The farmers are provided with relatively less financial support for agricultural investment. Even though government support in the form of lift irrigation facilities are provided to them, these are not operational. In this situation, farmers tackle agricultural risks by engaging in mixed cropping (which includes combinations of paddy and pigeon peas; pigeon peas and green gram or black gram; pigeon peas and groundnuts). They borrow money from friends and relatives and depend on off-farm incomes like daily labour activities in construction work to meet their financial needs.

In the case of lower region farmers, the risk of flood and cyclone are more prevalent. The farmers of this region are also lacking in adequate government support. Most of the farmers who are affected by these agricultural risks are marginal, small and tenant farmers who are in great need of government support but are deprived of it. Hence for this reason, these farmers tackle this problem by diversifying their crops towards flood resistant paddy crops like Sonamani, Lunishree and Heera. A few farmers started cropping in rabi and summer seasons and others diversified their crops toward pulses like green gram and black gram, oil seeds like sesame and ground nuts and vegetables.

Conclusions

This study examines farmers' perceptions on the sources of risk and risk management strategies from upper (Sonepur district), middle (Boudh district) and lower regions (Kendrapada district) of Mahanadi river of Odisha, using factor analysis. These regions are affected by flash floods in rainy season and drought in the summer season. Most of the farmers in these areas are marginal and small. Hence the farmers in all these three regions face production risk, financial risk and market related risks.

Factor analysis was applied to reduce 26 sources of risk and 24 risk management strategies into 8 to 10 factors. The sources of risk common to all the three regions are credit-related risk, input

costs, market risk, financial risk, political risk, production risk, land risk, inadequate government support and catastrophe. To manage these risks, risk management strategies followed in all the three regions were advance planning, crop and enterprise diversification, off-farm income, off-farm investment, financial security, financial arrangement, smart farming, labour management, sales at different points of time and traditional farming methods. Among the sources of risk, drought was the major one in upper region, the problem of inadequate financial support from government in the middle region and floods in the lower region. Varietal diversification was the major management strategy to cope with the risk in the upper region, mixed cropping in the middle region and crop diversification in the upper regions.

The findings of the study provide useful information for the policy makers and extension experts at local level to know about the sources of risk and ways to manage them in addition to suggestions for improving the efficacy of the present management strategies.

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