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Managing Agricultural Production Through Vulnerability Study

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ABSTRACT

Agricultural vulnerability index is a tool for assessing vulnerability to various factors and is helpful in formulation of adaptation strategies to cope up with adverse impact of biological and physical factors. Agricultural vulnerability is dependent upon climatic, biological, social and infrastructural factors. The study was conducted in Madhubani and Patna districts situated in north and south Bihar respectively. In each district three villages in three different blocks with varied agro-ecological conditions were selected for the study. Focus Group Discussion (FGD) technique was adopted for getting information related to impact of biotic and abiotic factors. Total 36 FGDs consisting of male, female and mix group were conducted in 6 villages in both districts.Among the climatic factors, drought during different stages of crop growth, flood / water logging, and heat stress are thought to be adversely affecting the farming practices which are more or less recurrent in Madhubani and Patna. Farmers are sometimes also affected by erratic nature of rainfall. All the villages under study are severely to moderately affect by the disease, insect-pest or weeds. Among the social and technical factors, non-availability of quality inputs, manpower (especially, during peak period demand) and machinery are the most limiting factors for achieving desired level of yield. Agricultural vulnerability index was analyzed medium in both districts; while it was low (0.28 to 0.31) in two villages (one each in Madhubani and Patna districts). Villages with low vulnerability have lesser risk and lesser chance of failure of agricultural production. Agricultural vulnerability index in rest four villages varied from 0.36 to 0.48 that revealed medium vulnerability. In such villages one should adopt technologies, crops and strategies which can minimize risk from adverse climatic, social and biological factors for higher productivity.

Key words: Vulnerability index, climatic factor, biological factor, biotic factor, focus, group discussion

INTRODUCTION

Indian agriculture is primarily dependent on vagaries of weather and any deviation in its normal pattern affects agricultural production. Agriculture is not only exposed to changes in climatic conditions, biotic stress and soil condition, but also to changes in socioeconomic settings and in policies. Although agricultural productivity is influenced by varieties of factors, like soil, climate, irrigation facilities, availability of quality inputs, mechanisation, labour availability and infrastructural facilities and policies of the local government, but primarily agricultural production is affected by soil quality, drought, flood, rainfall, insects, pests and diseases, and availability of credits, quality inputs, labour and mechanisation. Some areas of the country are more vulnerable than the others depending on their adaptive capacity and socioeconomic and infrastructural facilities. The vulnerability of a particular region is characterized by physical, economic, infrastructure, and social susceptibility or sensitivity to damage from a flood event (Hebb and Mortsch, 2007). These categories of vulnerability are composed of a number of flood risk indicators that are grouped together in similar themes. Often, vulnerability is associated with existing social systems (Chakraborty *et al.,* 2005). The increasing probability of floods and droughts and other uncertainties in climate may seriously increase the vulnerability of eastern India and of resource-poor farmers to global climate change (Aggarwal, 2008). Some areas of the country are more vulnerable than the others depending on their adaptive capacity and socioeconomic status. To address climatic vulnerability, decision-makers need to prioritize their responses for different regions as the resources are limited. The decision-makers should plan climate adaptation strategies based on vulnerability assessment and mapping regions for vulnerability (Sehgal *et. al.,* 2013). Assessing agricultural vulnerability to biotic and abiotic changes is of great significance to the formulation of rational and effective adaptation strategies. The decision-makers

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should plan adaptation strategies based on vulnerability assessment. The current study was undertaken in Madhubani and Patna districts of Bihar for assessing vulnerability to biotic and abiotic changes with respect to agricultural production.

Agricultural production is mainly dependent upon climatic or abiotic, biotic or biological and other social factors.Among the climatic factors, drought during different stages of crop growth, flood/waterlogging, and heat stress are thought to be adversely affecting the farming practices which are more or less recurrent in Madhubani and Patna. Farmers are sometimes affected by erratic nature of rainfall. All the villages under study are severely to moderately affect by the disease, insect-pest or weeds. Among the social and technical factors, non-availability of quality inputs, manpower (especially, during peak period demand) and machinery are the most limiting factors for achieving desired level of'yield.

METHODOLOGY

The study was conducted during the year October 2015 to May 2016 in Madhubani and Patna districts situated in north and south Bihar respectively. In each district three villages in three different blocks with varied agro-ecological conditions were selected for the study. Madhubani and Patna district comprises of 21 and 23 blocks respectively. Three villages– Korahia (26.53313 N; 086.15513 E), Nanore (26.33079 N; 086.32599E) and Khairi (26.19350 N; 086.29942 E) respectively from Jainagar, Andhrathadi and Lakhnaur blocks of Madhubani were selected for undertaking the studies. Three villages- Rampur (25.53495 N; 0 84.97517 E), Khajuri (25.46185 N; 0 84.98224 E) and Sangarmpur (25.45143 N; 0 84.88996 E) respectively from Phulwarisharif, Naubatpur and Bikram blocks of Patna were selected for undertaking the studies.These villages have diverse agro ecological situations. Majority of agricultural lands in Nanore and Korahia are medium and uplands; whereas Khairi have lowlands with lesser irrigation facilities. Around 30-40 per cent area in Nanore and Korahia are irrigated. Majority of lands in Rampur and Khajuri are medium and uplands with around 60 per cent and 75 per cent area respectively are irrigated. Irrigation from tube well is prominent in village, Rampur. In Khajuri, most of lands are irrigated by canal as well as by tube well. In Sangrampur, majority of lands are of low and medium topography and most of the area is irrigated by canal.

Focus Group Discussion (FGD) technique has been adopted for getting information related to biophysical changes in the particular village and its people. FGDs were done for exploring issues with a community or group for a couple of purposes, Understanding resources of the area, existing crops, technologies and human capital, Evaluate farmer perceptions of the suitability, benefits, costs and risks of the technologies being adopted by the farmers. Get responses from farmer/community groups about the agricultural vulnerability in the area. FGDs have been carried out by interacting thoroughly with 6 (six) focus groups separately in each village (2 male, 2 female and 2 mix groups). Each Focus Group consists of 08-15 individuals (men/women or mix). Thus, total 36 FGDs (12 each with male, female and mix group) were conducted. Every care has been taken for representation from each category (landless, marginal farmers, small farmers, large farmers, small traders, farm women *etc.*) of household duringFGDsin the selected village. Help of village panchayat, SHGs and other institutions were also taken to get village related data.

Table 1 describes the factors and sub-factors used to compute the vulnerability of agricultural production. The vulnerability index was calculated by summing the factor scores, using the equation:

$$\text{Agricultural Vulnerability Index} = \frac{\text{Climate + Biological + Socialfactor Score}}{\text{3 x Maximum attainable score}}$$

The factor scores were determined by summing the scores of the sub-factors and dividing by the number of sub-factors.

Table 1: Factors and sub-factors affecting agricultural vulnerability

Factors	Sub-factors	Sub–factor Score	Value
Climate& Soil	Drought Flood Soil degradation Heat Stress Erratic rainfall	Based upon severity and frequency of occurrence of sub-factors or events scores are given ranging from 1 to 3	Severity Mild = 1 Moderate = 2 Severe = 3
Biological	Insect Diseases Weed		Frequency Infrequent=1 Sometimes=2
Social factors	Financial Crunch Non-availability of quality inputs Farm Machinery non-availability Non-availability manpower		EveryYear/Season =3

Based upon severity and frequency of occurrence of the sub-factor, maximum attainable score was 9 (3x3). Thus, maximum attainable score for climatic and soil factor was 45 (9x5).Similarly, for biological and social factors maximum attainable score were 27(9x3) and 36(9x4) respectively. To compute Vulnerability Index, the values are scaled between 0 (very less vulnerable) and 1 (high vulnerable). Extent of vulnerability was calculated based on the following index scores:

Extent of vulnerability	Index score
Low	≤ 0.33
Medium	0.34 to 0.66
High	≥ 0.67

RESULTS AND DISCUSSION

Total 36 focus group discussions were conducted in all six selected villages. Table 2 reveals composition of groups in each village from which responses were collected. Participants in each village include Purely Land Owner who don't leased in lands from others; Part-tenants who owned lands and also leased in lands from others, and Purely Tenant who don't have own lands but leased in lands from others. In Madhubani district,Nanore has maximum percentage (82%) of pure land owners. Khairi has maximum involvement (63 %) of part-tenants and involvement of purely tenant is maximum (24%) in Korahia.Similarly in Patna district, purely land owners are maximum in village Sangrampur (87 %) followed by Rampur (77 %). Village Khajuri has maximum (19%) part-tenant in Patna district. Since tenants or part-tenants have to pay rent for the leased-in land and are mostly economically poor they apply relatively lesser inputs for producing crops in comparison to land owners and hence they are also likely to more vulnerable to biotic and abiotic factors.

Table 2: Village wise composition of participants in FGD

Villages	Total no. of Participation in FGD	Male	Female	Purely Land Owner	Part-tenant	Purely Tenant
Madhubani						
Khairi	68	35	33	19	43	6
Korahia	67	37	30	46	05	16
Nanore	56	30	26	46	05	05
Patna						
Rampur	66	35	31	51	10	05
Khajuri	63	34	29	43	12	08
Sangrampur	41	25	16	36	03	02

Agricultural vulnerability is dependent upon climatic, biological, social and other infrastructural factors. Both the districts, Madhubani and Patna are medium vulnerable as vulnerability index of both districts are 0.39 and 0.37 respectively. Villages, Khairi in Madhubani and Rampur in Patna district have lesser agricultural vulnerability index and hence there is lesser chance of failure of crop production. Social index in these two villages varies between 0.21 to 0.24 which indicates favourable social factors for agricultural production. Agricultural vulnerability in other four villages (Korahia, Nanore in Madhubani and Khajury and Sangrampur in Patna district) is medium (table 3). Agricultural vulnerability index in these four villages varies from 0.36 to 0.48 that reveals that one should adopt technologies, crops and strategies which can minimize risk from adverse climatic, social and biological factors. Table 3 also reveals that Nanore is more affected by climatic factors (climatic index 0.41) as it has lesser irrigation facilities. Korahia has maximum biological index score (0.65) and is more affected by biotic factors, like insect, diseases and weeds etc. and hence more care is needed for selection of crops and varieties that is resistant to insect and diseases. Further, adequate crop management practice should be adopted to minimize the risk of biotic factors. Korahia village is socially more vulnerable due to poor availability of credit, manpower, machinery and quality inputs needed for good agricultural production. Hence, establishment of 'Farmers Resource Centre' or promotion of custom hiring services through farmers club or by rural youth in the vicinity of these villages may be an important intervening option to minimise social vulnerability.

Table 3: Agricultural vulnerability score of each village

Factors	Sub-factors	Pooled Score of each village*							
		Madhubani				Patna			
		Khairi	Korahia	Nanore	Madhubani district	Rampur	Khajuri	Sangrampur	Patna District
Climatic &Soil	Drought	4.33	3.67	3.33	3.78	3.5	3	2.33	2.94
	Flood/ Water logging	3.67	2.33	4.67	3.56	1.33	3.67	5.67	3.57
	Soil degradation	3.83	2.33	3.67	3.28	2.33	2.33	2.33	2.33
	Heat Stress	2.67	3	3	2.89	2.67	2.83	3.83	3.11
	Erratic rainfall	2.33	2.33	3.83	2.83	3.67	3.83	3.67	3.72
	Total climate score	16.83	13.66	18.5	16.34	13.5	15.66	17.83	15.67
	Climate score	3.37	2.73	3.7	3.27	2.7	3.13	3.57	3.13
	Climate Index	0.37	0.3	0.41	0.36	0.3	0.35	0.4	0.35
Biological/	Diseases	2.83	5.33	2.17	3.44	2.17	3.67	2.17	2.67
Biotic	Insect	2.33	5.33	2.33	3.33	3.67	4.67	4.33	4.22
	Weed	4.33	7	2.17	4.5	2.33	5.33	3.83	3.83
	Total biological score	9.49	17.66	6.67	11.27	8.17	13.67	10.33	10.72
	Biological score	3.16	5.88	2.22	3.76	2.72	4.56	3.44	3.57
	Biological Index	0.35	0.65	0.25	0.42	0.30	0.51	0.38	0.40
	Financial Crunch	1.33	1.5	5.33	2.70	2.33	2.73	2.17	2.41
	Non-availability of quality inputs	2.5	5.33	5.33	4.39	2.17	5.67	4.67	4.17

Social factor	Farm Machinery non-availability	2.33	5.67	2.33	3.44	1.33	2.5	2.67	2.16
	Non-availability of manpower	1.33	5.67	2.33	3.11	2.73	4.67	5.33	4.24
	Total social score	7.49	18.17	15.32	13.64	8.56	15.57	14.84	12.98
	Social score	1.87	4.54	3.83	3.41	2.14	3.89	3.71	3.25
	Social Index	0.21	0.5	0.43	0.38	0.24	0.43	0.41	0.36
Agricultural Vulnerability Score		2.8	4.38	3.25	3.48	2.52	3.86	3.57	3.32
Agricultural Vulnerability Index		0.31	0.48	0.36	0.39	0.28	0.43	0.40	0.37

*Based on 6 FGDs in each village.

CONCLUSION

Agricultural vulnerability index is a tool for assessing risk proneness of agricultural production in a particular area or village with diverse climatic, biological, social and infrastructural situation.Villages with low vulnerability have lesser risk and lesser chance of failure of agricultural production. Based on vulnerability index one can adopt technologies, crop and varieties and plan strategies for risk minimization and for improving crop productivity.

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