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Managing Risk in Agriculture under Drought Situation in Uttar Pradesh: A Case Study

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Abstract

From a case study under the village level study (VLS), it has been found that in the drought agriculture year 2002-03, the farmers of Uttar Pradesh followed their best choice and own outlook for risk aversion and invariably preferred those crops and techniques which involved damage control and low investment and provided insurance against loss. The water harvesting for irrigation, intercropping, growing of low-value crops, high concentration for fodder and grain rather than grain alone, and preferential low-use of monetary inputs are some of the means commonly used by the farmers during droughts. It has been concluded that rainfall probability analyses would be a component of agricultural managing/ reducing risk while large area of the Indo-Gagetic plains is falling in the state. The major weakness in generating this type of information and analysis is that it provides no specific information about the upcoming season with which the farmer must deal. Some suggestions have been given to mitigate risk in agriculture. Need has been pointed out for preparing a draught vulnerability index for different districts. It has been realized that the IMD's monsoon forecast methodology needs some serious re-thinking. The intensive climate information /farmer interface intensification of watershed programme; tighter agriculture risk management, and sustained crop diversification will have to be considered. It has been suggested that the preparedness measures can be taken by two different agencies: the assisting agency, and the drought-prone areas themselves. Drawing on field information assembled from drought relief performance, state government may develop a way of drawing inference from experience. A particular activity in drought situation should be analyzed and assessed by degree of success, with the region given for the results. These judgments may be recorded and filed in a retrieval system called 'lessons learnt'; which could be used as a useful reference source in deciding such question as what quantities are required

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to care for a particular number of people under a particular kind of environment or situation. The contingency plan for drinking water, irrigation water, food security, cropping system, drought warning system and research on drought- resistant varieties of crops may be updated.

Indtorudction

Natural disasters such as prolonged droughts, floods and cyclones threaten food security, directly reducing agricultural production and food supply. These disasters can disrupt local economies and reduce household's access to food by destroying infrastructure and protective assets and reducing employment opportunities. The droughts in the year 2002-2003 (agricultural year) in Uttar Pradesh (U.P.) and other parts of India led to a drastic reduction in the crops of rainy and post-rainy seasons. However, a combination of well-functioning private markets and effective farmer-coping strategies prevented big losses. Keeping these points in view, a study has been conducted on the experiences of farming community in context of droughts with the following objectives:

(i) To study the nature of drought year 2002-2003

(ii) To list the support and services specially made available

(iii) To examine the nature and adequacy/ efficiency of adoption at farmers level, and

(iv) To suggest policy options based on the findings.

Methodology

Selection of Zones/Villages and Decision-making Units

From each of the three NARP zones under area jurisdiction of the C. S. Azad University, Kanpur, one representative district was selected on the basis of rainfall percentage, area under irrigation and cropping pattern. On the basis of closeness to these values of district averages, one representative village was selected from each district. These villages had similar average agro-climatic characteristics, rainfall, and percentage area under irrigation and cropping pattern of the sub-region. The basic social unit in the traditional rural societies is usually organized along familial lines, comprising a number of related mail adults and their families. This unit, seen as an economic unit, relates the consumption unit with the work unit. Accordingly, a list of all economic/social units for the village was prepared along with their cultivated area, and were categorized into three groups (small, medium and large).

Fifteen farmers were selected from each village and all the selected sample farmers were divided randomly into each category in proportion to the number of farmers in the village. A rapid rural survey of the selected villages was conducted by interviewing 45 farmers. The information was collected with the help of a well-structured questionnaire pertaining to the impact of drought and activities adopted for minimizing risk by the farmers.

Results and Discussion

Farming: Nature and Extent of Drought

Farming in Uttar Pradesh is mainly rain-fed during rainy season and irrigation-based during the post-rainy season. But in the upland, during the scanty rainfall, canals and tube-wells supplement water needs. In Bundelkhand, crops grown during the post-rainy season are usually based on residual moisture conserved in the rainy season. The rainfall occurs both from Bengal and south-west monsoon during the months of July to September every year. Uttar Pradesh faced an abnormal drought in the year 2002-2003, which affected the crops widely. This drought was linked to decreases in the average quantum of rainfall, and water in the main rivers (the Ganga and the Yamuna). These evidently caused a decline in the yields of major crops — rice, sorghum, pearl millets, moong, urd, wheat, rapeseed, and other *rabi* pulses.

Extent of Drought

The prevalence of drought has been similar almost in all the three regions. During June, July and August, the occurrence of total rainfall was far below the normal level. During June, which is the sowing period for rainy crops (rice, sorghum, pearl millets, mungbean, urd bean, til, maize, etc.), there were only scanty rains. Also in July 2002, the level of rainfall was far less than the normal. In August, scanty rainfall affected the sowing of rapeseed (oil crop). The trend of rainfall can be seen from Table 1.

The major crops grown in the 2002 agriculture year were paddy, moong, jowar, barley, urad, bajra, mustard, wheat, lentil gram, barseem, etc. Under drought conditions, practices such as profile modification, deep ploughing, and vertical mulching can increase water infiltration and hence deeper and more uniform soil-wetting and subsequent root proliferation and growth occur. Some farmers tried these crops but could not succeed because the minimum level of rainfall could not support the survival of crops.

Table 1. Month-wise percentage of normal rainfall in U.P.: June 2002 to May 2003

Months	Percentage of normal rainfall
June 2002	54.00
July	28.40
August	58.10
September	128.70
October	46.10
November	10.20
December	79.70
January 2003	105.7
February	236.30
March	28.90
April	120.50
May	38.10

Table 2. Livestock profile on farms: 2003-2004

Particulars	2001	2002	Change, %
Bundelkhand			
Cows	5	6	20
Young stock of cows	22	17	-23
Buffaloes	6	16	167
Sheep	-	40	100
South-west Zone of U.P.			
Cows	4	5	25
Young stock of cows	23	19	-17
Buffaloes	12	15	25
Sheep	-	-	-
Goats	2	1	-50
Central Plain			
Cows	2	2	-
Young stock of cows	-	-	-
Buffaloes	17	21	24
Goats	-	12	100
Sheep	-	-	-

Livestock

On sample farms, only young stock of cattle were liquidated during the drought period. The farmers were of the opinion that the non-productive young stock needed to be disposed off immediately because of fodder problem. The small ruminant sheep were sold due to no option for grazing not only in the southwestern arid zone but in the other surrounding areas also where they usually visited for grazing. A portion of land area too was

being used for cultivating high quality (berseem / sorghum) fodder for the livestock to facilitate its timely supply but the drought had preponderance of weeds to a large extent. The data on livestock revealed that goats and young stock of cows had been liquidated to avoid loss (Table 2).

Cropping Pattern

Crops-centred diversification is conditioned through the choice of crops with varying maturity periods, differential sensitivity to environmental fluctuations, and flexibility in end-uses of the main products and by-products. Such a diversification is often manifested through intercropping by mixing seeds and varying the row arrangements during the previous drought year, but in this drought, according to the farmers, these practices were not adopted due to early/ advance forecasting of normal rainfall by the meteorological department. However, to some extent, manipulation of plant population was made in accordance with the changing information on soil-moisture, and input-use dictated by the emerging weather (drought) conditions that also introduced flexibility into the management. The level of drought can be visualized by area allocated to different crops, given in Table 3.

Loss from Crops

Cropping strategies to obtain precipitation-use efficiencies were found to vary, depending on climate, resource-availability and farmers' needs. Farmers knew that attaining the maximum yield may not be the most economical goal. Abnormal weather, affecting the crop productivity proved that water was the most critical input during the drought period. The success cof crops ould only be ascertained in the drought when external water was available in plenty. It is certain that the rainfall factor will physically influence the efficiency and ability to produce crops under the ceteris paribus assumption. The data in Table 4 indicates that in 2002 there were drastic reductions in yields in the study areas.

Level of Fertilizer Application

Input use in the situation of water-shortages depends upon the expectation farmers have about the future water supply, based on their experiences during the previous scarcity episode. For example, farmers were not able to cut much in use of chemical fertilizers because expectations about failure of rainfall were not realized (Table 5).

Villagers' Experiences of the 2002 Drought and Their Responses

This case study was done only for one drought year 2002 which had occurred after a long gap of 16 years. The Meteorological Department of

Table 3. Cropping pattern of different sample farms under different zones in 2002-2003 and percentage change from 2001 to 2002

(area in ha)

Name of crops	0-1 ha		1-2 ha		2 ha and above		Total		
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	Change, %
A. Bundelkhnd Zone									
Jowar	0.5	0.00	1.2	0.00	3.65	0.00	5.35	0.00	-100
Moong	0.3	0.00	1.1	0.00	5.90	0.00	7.30	0.00	-100
Wheat	0.8	1.00	3.25	3.70	25.25	26.15	29.30	30.85	+5.29
Mustard	0.3	0.30	0.75	0.80	8.75	6.2	9.80	7.3	-25.51
Gram	0.2	0.20	0.70	0.65	2.35	3.35	3.25	4.2	+29.23
Lentil	0.4	0.3	0.80	0.85	3.00	4.3	4.20	5.45	+29.76
Others	0.1	0.00	0.50	0.00	0.65	0.00	1.25	0.00	-100
Net cultivated area	1.8	1.80	6.0	6.00	40.00	40.00	47.80	47.80	0
Total cropped area	2.6	1.80	8.30	6.00	49.55	40.00	60.75	47.80	-21.31
Cropping intensity, %	144.44		138.33		123.89		125.80		
B. South-west Zone									
Bajra	2.15	1.05	3.00	1.65	5.20	3.35	10.35	6.05	-41.55
Urd	1.15	0.50	0.90	0.00	3.35	0.00	5.40	0.50	-90.74
Moong	0.50	0.45	0.75	0.80	1.75	1.80	3.00	3.05	+1.67
Til	0.20	-	0.50	-	1.65	-	2.35	0.00	-100
Wheat	3.20	3.60	3.75	3.90	6.40	6.28	13.35	13.78	+3.22
Mustard	0.75	0.60	0.85	0.83	2.75	3.24	4.35	4.67	7.36
Gram	0.80	0.00	1.25	0.00	2.15	0.00	4.20	0.00	-100
Others	0.15	1.15	0.40	1.40	1.0	2.28	1.55	4.83	+211.61
Net cultivated area	4.70	4.70	5.60	5.60	12.40	12.40	22.70	22.70	0

Contd...

Table 3. Cropping pattern of different sample farms under different zones in 2002-2003 and percentage change from 2001 to 2002 — *Contd.*

(area in ha)

Name of crops	0-1 ha		1-2 ha		2 ha and above		Total		
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	Change %
Total cropped area	8.90	7.35	11.40	8.58	24.25	16.95	44.55	32.88	-26.20
Cropping intensity, %	189.36		203.57		195.56		196.04		
C. Central Plain Zone									
Paddy	2.00	1.55	3.15	2.55	7.50	0.75	12.65	4.85	-61.66
Jowar	1.15	0.20	1.20	0.70	3.80	0.25	6.15	1.15	-81.30
Moong	0.65	0.33	1.30	1.40	2.75	0.53	4.70	2.26	-51.92
Wheat	1.25	1.20	2.25	3.05	6.85	1.21	10.35	5.46	-47.25
Mustard	0.75	1.10	0.85	0.50	2.35	0.00	3.96	1.60	-59.60
Gram	0.25	0.20	0.65	1.15	1.20	0.00	2.10	1.35	-35.71
Potato	0.80	-	1.20	-	3.25	-	5.25	-	-100
Others	0.60	1.02	0.40	2.10	1.20	1.61	2.20	4.73	+115
Net cultivable area	3.80	3.60	5.80	6.60	15.60	15.60	25.20	25.8	+2.38
Total cropped area	7.45	5.60	11.00	11.45	28.90	4.35	47.35	21.4	-54.81
Cropping intensity, %	196.09		189.60		185.26		187.90		

Table 4. Average yield of different crops in 2001 and 2002 and percentage change in 2001 over 2002

(per ha)

Crop	Yield		Change in 2001 over 2002 %
	2001	2002	
Central Zone			
Paddy	32.71	21.45	-34.42
Jowar	210.00*	173.06*	-17.59
Moong	6.32	6.55	3.64
Wheat	33.42	21.41	-35.94
Mustard	11.37	8.08	-28.94
Bundelkhnd Zone			
Moong	5.22	Nil	-100
Wheat	29.61	15.02	-49.27
Mustard	9.58	7.63	-20.35
Gram	10.15	7.40	-27.09
Lentil	8.64	8.35	-3.36
South-west Zone			
Bajra	Nil	3.12	-
Urd	Nil	6.00	-
Moong	6.07	6.85	12.85
Wheat	32.40	21.08	-34.94
Mustard	11.74	8.23	-29.90
Gram	12.33	Nil	-100
Barley	Nil	15.78	-

* Jowar for fodder

India usually announces the rainfall prospects in advance through tele vision/ radio/news papers. Accordingly in 2002 summer, announcement was made for the normal rainfall occurrence. The information given in Table 6 focuses on the response of the villagers about the advance announcement of normal rainfall by the meteorological department.

All the fifteen farmers responded to the advance announcement about normal rainfall and consequently they planned to produce crops in the usual way as in previous years. In Bundelkhand, it was noticed that only 40 per cent farmers had production planning in accordance to the advance announcement. The farmers of the Southwest semi-arid tropics (Mathura) felt a jolt because nearly 86 per cent farmers had planned their cultivation based on rainfall announcement and had sown pearl millets (major crop) and moongbean after the first rain showers which had come late. But the persistent drought-spell did not allow them to save the crops in spite of availability of underground water. The underground water was highly saline,

Table 5. Changes in fertilizer application in different districts of UP

Crops	Yield		Change in 2001 over 2002, %
	2001	2002	
Central Zone			
Paddy	130.16	127.88	-1.75
Jowar	-	32.46	-
Moong	35.07	29.34	-16.34
Wheat	113.82	116.03	1.94
Mustard	81.94	54.59	-33.38
Bundelkhnd Zone			
Moong	29.52	-	-100
Wheat	79.43	95.27	19.94
Mustard	56.23	52.69	-6.30
Gram	35.68	69.94	96.02
Lentil	36.88	67.94	84.22
South-west Zone			
Bajra	-	86.79	-
Urd	-	20.0	-
Moong	32.86	23.74	-27.75
Wheat	95.38	110.68	16.04
Mustard	80.96-	52.36	-
Gram	40.04	-	-100
Barley	-	57.22	-

Table 6. Farmers' responseto meteorological news/perception about the rainfall in 2002 summer

Response	Climatic news (prediction with normal rainfall)		
	Central plain zone	Bundelkhand	South-west zone
Yes	100	40	86
No	Nil	60	14
Total, %	100	100	100
Number	15	15	15

and was not suitable for irrigation and thus all the crops were lost. Had the rainfall water been available, the underground water could be used in a conjuctive manner.

The farmers of the south-western zone were highly responsive to make plan for crop sowing soon after receiving the meteorological forecasting because their farming involved combination of external water with internal/ saline water to establish crops like sorghum and pearl millets. In Bundelkhand, tradionally the crops like wheat, linseed, gram, lentils, etc. are grown on the

rainfall residual moisture during the winter season. In the central UP, farmers went for production using canal-based assured irrigation (Table 7).

The drought forced the villagers in the upland areas to move out of their villages to find a new or additional source of income. The survey found that the majority of villagers of Gausana (Mathura) had migrated temporarily while in the central UP and Bundelkhand, they had moved out marginally (Table 8).

The effect of abnormal weather in 2002 forced the household members to earn through wage income. The data in Table 9 indicate the extent some members had temporarily moved out to cater family through the wage income. However, a larger proportion of members (adults) had gone out for wage-earning in Mathura while their proportion in Central UP and Bundelkhand was very small. However, had drought prolonged for more than one year, large-scale migration might had occurred from all the three-studied areas.

One major effect of the drought in 2002 was the crop failure, which increased the debt of households, who had borrowed money from the bank. The survey found that the amount of debt of the majority in Central as well as Southwest zones had increased (Table 10). A comparison indicates that this problem was stronger in the western UP (Mathura). This may be due to the high rate of interest on the debt borrowed from the bank.

Table 7. Adjustments to production planning after receiving the warning news about drought

Response	Production planning when drought approaches		
	Central plain zone	Bundelkhand	South-west zone
Yes	30	Nil	89
No	70	100	11
Total, %	100	100	100
Number	15	15	15

Table 8. Seeking additional income facing abnormal weather in 2002

(in per cent)

Response	Seeking additional income		
	Central plain zone	Bundelkhand	South-west zone
Yes	18	13	65
No	82	87	35
Total, %	100	100	100
Number	15	15	15

Table 9. Temporary migration of household members in 2002

(in per cent)

Response	Temporary movement		
	Central plain zone	Bundelkhand	South-west zone
Some members	8.5	5.5	37.6
All members	2.5	Nil	0.7
No members	89	94.5	61.7
Total, %	100	100	100
Number	85*	76*	75*

* Adult working members, child not included

Table 10. Increase in debt amount due to the drought in 2002

Response	Debt increase		
	Central plain zone	Bundelkhand	South-west zone
Increase	6	Nil	46
No debt	Nil	Nil	54
Decrease	Nil	Nil	Nil
Total, %	100	100	100
Number	15	15	15

The Government of UP had paid attention to this problem of water conservation and the Department of Soil Conservation had identified the suitable areas for water catchment and where ever possible, it was implemented also. After consulting the villagers, this measure was regarded as the most important to counter the effect of drought, especially in Bundelkhand (Table 11).

Risk Management

Risk management practices embodied in the cropping strategies can be subdivided into those that relate primarily to diversification of resources and enterprises and those that relate to adjustments within the cropping systems. These popular and potentially important risk management practices are presented in Table 12. Farmers exploit vertical, horizontal, and temporal dimensions of the natural resource-base to reduce production risks. Planting on a top sequence is a mild form of vertical diversification, which allows flexibility in production, conditional on the timing and quantity of rainfall at planting.

Table 11. Water resource development

Response	Water resource development		
	Central plain zone	Bundelkhand	South-west zone
Very useful	Nil	100	28
Useful	Nil	Nil	Nil
Useless	100	Nil	72
Total, %	100	100	100
Number	15	15	15

Spatial scattering offers scope for improving crop-income stability to the extent that production risks are not perfectly correlated across microenvironments. Likewise, staggered plantings and sequential diversification reduce variability to the extent that production risks are not perfectly covariate across time.

Drought Relief Programmes

Drought preparedness includes information on potential sources of disaster, predicting the nature of possible disaster, preparing inhabitants of disaster-prone areas in ways to react in the case of a disaster, as well as stockpiling of goods, and organizing information in various fields to make possible the most efficient response from the government and relief agencies when a disaster strikes. Relief assistance agencies have called upon the medical people, urban planners, environmental engineers, sociologists, nutritionists, criminologists, geologists, agricultural specialists and a myriad of other experts to cooperate in pooling together the information that might

Table 12. General risk/loss-management strategies adopted in Uttar Pradesh

Loss-management strategies	Risk-management strategies
• Interlinked consumption and production	• Spatially scattered planting
• Informal mutual aid	• Planting crops with multiple uses
• Storages and recycling	• Planting crops with insurance potential
• Linkages and agricultural factor markets	• Planting crops insensitive to temporal variability
• Depletion and replenishment of assets	• Mixed cropping and farming
• Labor market participation and foraging	• Plant spacing (thinning and gap-filling)
• Public relief	• Splitting and skipping in input-use
	• Top sequential planting
	• Temporally diverse planting

be used in disaster prediction and in taking the advance decisions on the probable appropriate countermeasures, as well as in listing the supplies that need to be stockpiled near the potentially affected region.

It has been found that under the drought relief programmes calamity relife of Rs 130 per family was allocated in all the three zones, viz. central plain zone, south-west zone and Bundelkhand zone. However, no relief was provided for (i) cattle feed, (ii) fodder transporation, (iii) drinking water supply, (iv) seed supply, and (v) one-time drought relief.

Conclusions and Suggestions

It can be concluded that rainfall probability analyses should be a component of agricultural management strategy, especially in the larger areas of the Indo-Gangetic Plains. The major weaknesses for generating this type of information and analysis are non-provision of specific information about the forthcoming season. To mitigate risk in agriculture, some suggestions are given below :

- There is a need to prepare a drought vulnerability index for different districts in the state.
- The IMD's monsoon forecast methodology needs some serious rethinking.
- The intensive climate information /farmer interface in watershed programme, tighter agriculture risk management, and sustained-crop diversification will have to be considered.
- Preparedness measures can be taken by two different agencies: the assisting agency, and the drought-prone areas themselves.
- Drawing on field information assembled from the drought-relief performance, state government may develop ways of drawing inference from the experience.
- The particular activity in drought situation should be analyzed and assessed by the degree of success.
- These judgments should be recorded and filed in a retrieval system called 'lessons learnt'. It could be used as a useful reference source for deciding such questions as what quantities are required to care for a particular number of people under one kind of environment or situation.
- The contingency plans for drinking water, irrigation water, food security, cropping system, drought warning system and research on drought-resistant varieties of crops may be updated.

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