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Natural Calamities, Crop Losses and Coping Strategies: An Economic Analysis from Odisha

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ABSTRACT

Agriculture in India is vulnerable to natural calamities and associated risks particularly unpredicted rainfall. These natural calamities mainly droughts and floods act as a source of distress for farmers through increase in the chance of crop losses, food insecurity, migration for work and debt, etc. Using household survey data collected from various drought prone and submergence prone villages in Odisha, this paper evaluates the economic impact of droughts and floods on Indian farmers in terms of their loss of crops. It analyses how the impact varies across various land sizes and social groups of farmers. Our results indicate that the total loss to farmers increases with their land sizes but per acre losses incurred by small farmers are greater. It has also analysed the coping strategies used by farmers to overcome the adversities caused by these stresses. We find that the large and upper caste farmers (Non-SCST) could mitigate these natural calamities by using various coping strategies such as crop insurance, short duration varieties, availing institutional credit etc. However, due to inability of small and lower caste farmers (SCST) to resort to such coping strategies, they were forced to either change their occupation, sell agricultural land or migrate to other places in search of occupation. The paper suggests use of new and improved crop technologies as an adaptive measure which could reduce yield and income losses of farmers. Further, increased public expenditure would help fight with these natural calamities and could create employment opportunities for rural households which may supplement their income.

Keywords: Natural calamities, Coping strategies, Crop loss and climate change.

JEL: D81, Q15, Q25

I

INTRODUCTION

India has a diverse climatic structure and is vulnerable to natural hazards and associated risks arising mainly due to unpredicted rainfall. Agriculture in India is strongly affected by two major abiotic stresses namely drought and floods. Sixteen per cent of India's total area is drought prone and approximately, 50 million people are annually affected by droughts (Ray, 2014). As per report of National Disaster Management Authority (NDMA) 2012, in India about 49.81 million hectares (15.2 per cent of total geographical area) is flood prone and on an average 10-12 million

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hectares is actually affected every year due to flood causing a range of losses to human life, property, forests, and crops. Simultaneous occurrence of flood in one and drought in another parts of the country are quite common.

Out of the total sown area in India, nearly 60 per cent is dependent on rainfall, hence natural calamities such as drought and flood are likely to threaten the overall economy of the country. The economic impact of these stresses on Indian agriculture is a decline in crop yields as well as production which in turn creates drastic reduction in farmers' income. Climate change is further aggravating the adversities caused by these stresses.

In the presence of these adverse impacts and the potential impact of climate change, these natural calamities act as a source of distress for farmers. Due to these calamities, farmers are forced to switch their occupation and in case of unavailability of alternative sources of employment they migrate to other places. Rafique (2003) analysed the economic impact of year 2000 monsoon flood that struck several districts in West Bengal and destroyed various paddy fields. The paper finds that the impact differed among various land class groups. While the large farmers had procured substantial paddy crops to recoup the loss in the post-flood scenario, small farmers relied on securing loans on credit. Landless labourers were however, compelled to migrate to other places in search of work.

Farmers from various states in India such as Andhra Pradesh, Karnataka, Odisha and Assam are adversely affected due to droughts and floods. Odisha is one of the poorest states of India where droughts and floods are a recurrent phenomenon (Reserve Bank of India, 1984). In the last 15 years, Odisha has been severely affected by many major floods including in 2001, 2003, and 2006, 2008 and 2011 (Rodriguez-Llanes *et al.,* 2011). Besides this, droughts have been a repeated phenomenon in the state in 2002, 2005, 2006, 2008 and 2010, 2012 and 2015.

The farmers living in these areas have developed certain coping mechanisms and adaptive strategies over time to reduce drought and flood vulnerability. Using a primary survey conducted in various drought prone and flood prone villages in Odisha, this paper evaluates the economic impact of droughts and floods on Indian farmers in terms of their loss of crops. How does the impact vary across various land sizes and social groups of farmers? What are the coping strategies used by farmers to overcome the adversities caused by these stresses? This paper aims to address these questions. The paper also gives some suggestions to the policy makers that can be used to reduce the vulnerability of farmers towards these stresses.

For the purpose, data was collected from 400 households using a primary survey conducted in various drought prone and flood prone villages in Odisha state of India. The household survey covered detailed information on household characteristics (including socio-economic and demographic characteristics), agricultural losses due to natural calamities, coping strategies, agricultural production, etc. We find that farmers incurred heavy losses due to droughts and floods. The total loss increases with their land sizes but per acre losses incurred by small farmers are greater. Further,

the paper also critically evaluates that in the absence of government support how various readiness and coping strategies are helping farmers to overcome from crop losses due to these natural calamities. It also depicts that different categories of farmers have different preferences for coping strategies.

II

DATA AND SAMPLING CONSIDERATIONS

This study is conducted in Odisha state of India which is a part of south eastern sub-continent. Agriculture is the main occupation in Odisha and it contributes nearly 30 per cent to the net state domestic product (NSDP). The weather of Odisha favours a lot of crops for cultivation, among these crops rice, pulses, oil seeds, jute, roselle, sugarcane, coconut and turmeric are important crops. Paddy is the most important food crop in Odisha grown throughout the state covering over 53 per cent of the gross cropped area.

We employed a multi-stage sampling approach to design our survey sample. In the first stage, the study has identified three adjacent districts in Odisha, namely, Dhenkanal, Cuttack and Jagatsinghpur, being affected by drought and/or floods. Dhenkanal is one of the eight districts in Odisha identified by the Government of India for treatment under the Drought Prone Area Programme (DPAP). Jagatsinghpur district, situated on the eastern coast of Odisha along the Bay of Bengal, is prone to natural hazards such as floods, cyclones and even drought. The third district—Cuttack-includes both the highland region prone to drought as well as the lowland region susceptible to floods.

The second stage involved stratification of blocks within Cuttack and Dhenkanal which were being affected by drought and within Jagatsinghpur and Cuttack being affected by floods. Finally, 25 households in each village were randomly selected from household lists provided by village leaders. Our sample comprises 400 households in total with 200 households from each of the drought prone and submergence prone blocks in Odisha**.**

Impact of Drought and Floods on Agriculture

The survey data collected in May-June 2013 from 8 drought prone and flood prone blocks in Odisha depict that farmers in Odisha suffered from both drought and floods in the last 5 years beginning 2008 till 2012. Although the intensity of these events varied from year to year but they negatively impacted agricultural production in Odisha in the surveyed area. The following section presents the average crop losses to various socio-economic groups of farmers in the past five years (2008-12) in the surveyed villages in Odisha.

Land Holding Distribution of Farmers in the Study Area

The distribution of land in the study area is characterised by high degree of concentration. Table 1 presents the percentage distribution of households across both land owning size category as well as social groups.

TABLE 1. PERCENTAGE DISTRIBUTION OF HOUSEHOLDS ACROSS LAND SIZE CLASS, SOCIAL GROUPS

	Number of households by social groups					
Land size class (acre)	Others	OBC	SC	ST	Muslim	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Landless(0.0)	11.3	9.3	27.0	9.7	18.2	14.5
Semi Marginal (0.0-1.25)	27.8	54.7	43.0	48.4	54.5	44.75
Marginal (1.25-2.5)	30.9	21.1	21.0	32.3	18.2	24.25
Small (2.5-5.0)	26.8	13.0	9.0	6.5	9.1	14.75
Semi Medium (5.0-10.0)	2.1	1.2	0.0	3.2	0.0	1.25
Medium (10.0-25.0)	1.0	0.0	0.0	0.0	0.0	0.25
Large(>=25.0)	0.0	0.6	0.0	0.0	0.0	0.25
All size	100.0	100.0	100.0	100.0	100.0	100

Table 2 presents the average crop loss due to drought and floods in the last 5 years (2008-2012) in terms of both total and per acre losses. It can be seen that the average loss of crops to farmers due to floods (Rs.11,253) is higher as compared to average loss due to drought (Rs.3588). The total loss to farmers due to droughts and flood is directly associated with their land size, thus, indicating that the medium/large farmers face higher total loss due to both drought and floods as compared to small and landless farmers in our surveyed villages. This is mainly on account of their greater land ownership that large farmers incurred more losses.

TABLE 2. AVERAGE CROP LOSS DUE TO DROUGHT AND FLOODS FROM 2008-12 (BOTH TOTAL AND PER ACRE) ACROSS LAND SIZE CLASS

	Average loss of agricultural crop (in Rs.)					
	Due to flood		Due to drought		Total	
Land owned category	Total	Per acre	Total	Per acre	Total	Per acre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	6649	13500	2707	5300	9404	18800
0 – 1.25	8152	16980	3078	5065	11248	22045
1.25 – 2.5	13192	6518	4505	2313	17697	8832
2.5 – 5.0	20831	6082	4068	1193	24898	7275
5.0 – 10.0	10000	1000	10000	1538	20000	2538
10.0	–25.0	90000	7500	0	0	90000
above 25.0	0	0	0	0	0	0
All Categories	11253	10107	3588	3023	14859	13130

However, the table depicts a different picture if we compare loss in per acre terms. We know that the impact of droughts and floods is felt unevenly over different land areas. Thus, per acre loss varies across various land sizes. Moreover, small farmers have higher per acre cost due to diseconomies of scale. Hence, per acre loss

for small farmers is higher. Some of our surveyed respondents pointed out that large farmers are able to tackle drought by using various coping strategies like extracting groundwater and nurturing their crops, and using short duration varieties which although increased their cost but saved them from crop failure. However, small farmers with limited resources and capital, are not able to protect their crops, thus resulting in major crop losses. Similar to Table 2, we find that the total loss due to droughts and floods are higher for upper caste groups i.e., general followed by OBC and Muslims. However, per acre loss is higher among lower caste groups (SC and STs).

III

READINESS AND COPING STRATEGIES

Readiness is seen as a means where one prepares oneself against the anticipated adverse effects of extreme events, whereas coping strategies represent the measures actually undertaken to adjust once the event has occurred. While the former represents an advance action before the event occurs whereas the latter indicates post measures to overcome the adverse effects of an event. For the present study we look at both the pre and post measures (either readiness or coping strategies) taken by the farmers to overcome the crop loss generated due to natural calamities. Such measures become increasingly important in a state like Odisha where on the one hand farmers experience regular occurrence of natural calamities and on the other hand there is lack of support to them from the government due to resource scarcity and problems like poverty and under development. Table 3 and 4 presents few important readiness and coping measures reported by farmers in rural Odisha and also gives the per hundred household distribution across land owned categories and social groups respectively.

(1) *Diversifying Income Sources*

Farmers in Odisha earn income from several sources to minimise their risk against these natural calamities. Apart from rice which is their principal crop, most of the farmers diversify their income sources by growing high value horticultural crops and other crops such as moong, biri, groundnut etc. Moreover, about 42 per cent farmers were involved in activities like livestock and poultry rearing. More specifically, landless and semi marginal/marginal farmers mainly belonging to lower caste (SC, ST and OBC) were indulged in low income generating livestock and poultry rearing such as piggery, goat, sheep rearing and backyard poultry (Table 3 and 4). However, medium and large farmers were keeping high value and comparatively higher income generating animals like dairy animal to diversify their risk from crop losses. Around 22 per cent farmers were engaged in self employment activities such as rope making, mat weaving, handicraft work, running shops etc. Out of these, farmers with either no land or small piece of land were engaged in activities

which required less investment with own or family labour such as rope making, mat weaving, handicraft work whereas, comparatively greater land owning farmers were involved in activities which require comparatively greater investment. Apart from this, about 45 per cent farmers were engaged in wage earning from agricultural and non agricultural activities. Out of these total wage earners, around 60 per cent belong to either landless or semi marginal category, Also, after looking at the social category of these wage earners we can conclude that more than 60 per cent farmers belonged to lower caste (SC and ST) category. However, some of the farmers in our sample reported earning from multiple sources at the same time e.g. involved in wage earning along with animal rearing etc. These activities not only helped them in meeting their day to day household consumption but also supplemented their cash income.

TABLE 3. READINESS AND COPING STRATEGIES USED BY PER HUNDRED FARMER HOUSEHOLDS ACROSS LAND OWNED SIZE CATEGORIES

Readiness/Coping strategies (1)	Per cent (2)	Landless (3)	Semi-Marginal (4)	Marginal (5)	Small (6)	Semi-medium (7)	Medium (8)	Large (9)
1. Diversifying income sources								
(a) Livestock rearing	42	62	27	45	56	80	100	100
Bovine animal rearing	17	0	7	20	50	80	100	100
Other Small animal rearing	30	62	25	36	9	0	0	0
(b)wage earning along with farming	45.25	59	64	28	9	0	0	0
(c) Self employment activities	21.5	24	20	17	26	80	100	100
(d) Salaried employment	12	9	9	11	20	60	100	100
2. Using short duration varieties	23	0	8	28	73	100	100	100
3. Risk minimising strategies								
(a) Crop Insurance	6	0	1	3	27	60	100	0
(b) Sharecropping	34.25	84	39	14	5	20	0	0
4. Seeking institutional support/ Post loss management								
(a) Government assistance	46	7	26	30	51	20	100	0
(b) Credit availed	29	2	17	18	34	20	100	0
(c) Migration and forced to change their occupation	4	10	3	3	2	0	0	0
(d) Sale of land	2	10	1	1	0	0	0	0

(2) *Using Short Duration Varieties*

Short duration provides a means of escaping the abiotic stress such as—drought or flood. Short duration allows farmers to either delay transplanting (in the case of

TABLE 4. READINESS AND COPING STRATEGIES USED BY PER HUNDRED FARMER HOUSEHOLDS ACROSS DIFFERENT SOCIAL GROUPS

Readiness/Coping strategies (1)	Per cent (2)	SC (3)	ST (4)	OBC (5)	Others (6)	Muslim (7)
1. Diversifying income sources						
(a) Livestock rearing	42	55	68	35	37	0
Bovine animal rearing	17	6	3	16	35	0
Other Small animal rearing	110	50	65	21	6	0
(b) wage earning along with farming	45.25	64	65	49	15	20
(c) small business	21.5	32	19	15	20	50
(d) Salaried employment	12	15	23	9	11	0
2. Using short duration varieties	23	16	13	25	31	20
3. Risk minimising strategies						
(a) crop insurance	6	5	10	4	9	0
(b) share cropping	34.25	47	19	34	22	8
4. Seeking institutional support/Post loss Management						
(a) Government assistance	46	34	3	31	25	20
(b) credit availed	29	14	3	23	15	30
(c) Migration and forced to change their occupation	4	3	0	5	5	0
(d) Sale of land	2	2	0	3	1	0

delayed monsoon onset) or harvest a fully mature crop without creeping into *rabi* season land preparation. Second, short duration may allow farmers to grow another short duration crop between the *kharif* and *rabi* crops which could enhance their farm income and also provide income diversification. Third, short duration rice may provide farmers with a window of time in which farmers can pursue non-agricultural income. Around 23 per cent of farmer households in our sampled area have reported growing short duration varieties to combat droughts and floods. These farmers mainly belong to Upper caste (Others) and Other backward caste (OBC) groups. Moreover, almost all medium and large farmers were seen growing short duration varieties as compared to small and marginal farmers.

(3) *Risk Minimising Strategies*:

Sharecropping is the one possible ways to reduce the risk of crop loss due to natural calamities for both the landowner and the tenant as it involves sharing of cost as well as output. Thus, it is being increasingly followed in our study villages. It enables division of resource base for instance labour amongst the tenants and inputs by the landlords. Around 35 per cent farmer households in our sample have reported

reliance on sharecropping for managing the impact of calamities. Another strategy used by farmers in our sampled areas is crop insurance but it is not very popular amongst farmers. Only 6 per cent of the farmer households are using crop insurance to minimise their risk.

(4) *Seeking Institutional Support/Post Loss Management*

The study indicated that out of the total sample of 400 farmers, around 242 (more than 60 per cent) reported loss incurred due to droughts and floods. Out of these total households incurring loss, around 46 per cent received government assistance in terms of cash transfers, around 29 per cent have availed credit from various institutional and non-institutional sources. We find disparities in the sources of availing credit by different groups of farmers. Large farmers availed credit from mainly institutional sources such as Kisan Credit Cards (KCC), commercial banks whereas small farmers mainly relied on money lenders for availing credit. Although selling agricultural land is a rare choice for farmers but we still find 2 per cent of farmer households who sold their land and around 4 per cent farmers reported migration and change in their occupation due to the natural calamities such as drought and floods. These farmers were either landless or with semi marginal/ marginal land ownership (Table 3).

Other strategies: Besides all these strategies, there are other strategies reported by the farmers in the study area. These are water management through either pumped irrigation which improves soil moisture or harvesting run-off water which is a common practice in Odisha. In flood prone areas farmers also reported raising of embankments in order to protect their agricultural fields.

IV

NEW AND IMPROVED CROP TECHNOLOGIES: A POSSIBLE SOLUTION

New and improved crop technologies that are tolerant to biotic (disease, pests, etc.) and abiotic stresses (droughts, floods, salinity, etc.) have been developed by various research institutes owned by public and private sector in India. Such technologies are being developed for many crops like brinjal, rice, mustard, okra, etc. and are at a developmental stage (James, 2014). Abiotic stress tolerant seeds such as drought, submergence, salinity tolerant varieties are seen as an adaptive measure to combat the negative impact of droughts and floods.

Rice is one such crop for which scientists are using various scientific methods such as conventional breeding, marker assisted selection, genetic modification to develop seeds with desired attributes. Many scientists in public and private sector institutes in India and globally are engaged in rice biotechnology research and are attempting to develop drought tolerant (DT) and submergence tolerant (SubT) rice seeds that have potential to increase rice production and reduce its variability.

Various studies have reported a high willingness to pay of farmers for such seeds (Ward *et al.*, 2014, Arora, 2015)

Most of these seeds are still in the regulatory pipeline but some have been commercialised in few parts of Bihar and Odisha. These seeds are increasingly becoming popular in a state like Odisha where droughts and floods are a recurrent phenomenon (personal communication with scientists at CRRI). Thus, such seeds could be seen as a potential avenue to cope up with droughts and floods. Although these seeds are expensive as compared to traditional varieties, but if government could provide subsidies/compensation on such seeds, then it could be one of the possible solutions to combat various natural calamities such as droughts and floods. Also, for equitable and wider adoption of these new and improved seeds, it is necessary that subsidies be targeted towards small land owning and lower caste farmers which in turn could ensure food security in India.

V

CONCLUSION

Natural calamities such as droughts and floods have severely constrained poor farmers through crop losses, increasing debt, etc., and has forced them even to change their occupation and migrate to other places. In the presence of climate change, these natural calamities act a source of distress for farmers. In Odisha, droughts and floods occur almost each year or every alternate year. With 2/3rd population of the state below the poverty line, this segment of the population becomes more vulnerable to natural disasters. Using a primary survey on 400 households, this paper examines the impact of natural calamities in various drought prone and flood prone villages in Odisha in terms of their average annual crop losses. We find huge variation in crop losses across various land sizes and social groups. There exist a direct relationship between land size and total crop loss that is large farmers incurred greater crop loss as compared to small farmers. This is mainly on account of their large land ownership that large farmers incurred more losses. However, a different picture emerged if we compare per acre losses. The small farmers incurred greater per acre loss as compared to large farmers. This is likely to have been on account of lower ability of small, resource-poor, farmers to invest and make use of coping strategies like crop insurance and adopting short-duration varieties. Similarly, non-scheduled group of farmers incurred greater total loss as compared to SCST farmers. However, greater per acre loss is borne by scheduled caste (SCST) farmers vis-a-vis their counterparts.

In order to combat the negative impact of these natural calamities, farmers living in these areas have developed certain coping mechanisms and adaptive strategies. These are namely diversifying income sources, use of short duration varieties, risk minimising strategies such crop insurance, share cropping and seeking institutional support/post-loss management.

We find differences in crop losses amongst different caste and land holding size of farmers. A similar pattern of inequality persists in farmers preferences for various coping strategies. For eg. small and marginal farmers belonging to lower caste were indulged in low income generating livestock and poultry rearing like piggery, sheep etc whereas large farmers were keeping high value and comparatively higher income generating animals like dairy animals and big poultry farms to diversify their risk from crop losses. Also, small and marginal farmers were engaged in self employment activities involving less investment as compared to large farmers. Most of the expensive and risk involving coping strategies such as use of crop insurance, short duration varieties are mostly used by large and upper caste group of farmers. Similarly, we find that large farmers were dependent on KCCs and commercial banks for availing credit whereas small and marginal farmers relied on money lenders for credit during their crop losses.

We find that small and marginal farmers are severely affected due to natural calamities as compared to large farmers. These small and marginal farmers constitute a major proportion of total households in the study area and the per acre loss incurred by them is very high. Further, due to their inability to use high value coping strategies that could help them to combat the negative impact of natural calamities, their situation is very vulnerable in this area. This could be because government policies are focusing more in favour of developed states and large farmers within these states, keeping the benefits of such policies away from small farmers and relatively less developed/ backward states.

It can be argued that the state policies which were designed to overcome the negative impact of natural stresses have not been able to provide support to small and marginal farmers. Thus, in the absence of adequate support from the government, some possible strategies that could protect the interest of farmers could be to provide subsidised loans, free insurance etc. New and improved variety of seeds such as short duration, drought tolerant, submergence tolerant seeds are increasingly becoming popular amongst farmers in Eastern India particularly Bihar and Odisha which have been severely affected by droughts and floods. Adoption of such new and improved technologies could be seen as an adaptive measure against natural calamities. Several studies have documented their potential benefits but for wider and equitable adoption of such seeds, it is advisable that these be provided at a subsidised rate to small land owning farmers as well as lower caste groups. Also, government should increase investment in public expenditure in the form of construction of canals, check dams for states like Odisha where droughts and floods are a recurrent phenomenon. This would not only help to fight against these natural calamities but would also create employment opportunities for rural households and could supplement their income. These measures may encourage farmers to stay in the farming and prevent them from migration and changing their occupation.

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