CLIMATE RISKS AND ADAPTIVE BEHAVIOUR OF PADDY FARMERS OF GANJAM DISTRICT IN ODISHA

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ABSTRACT

Ganjam district is one of the coastal districts in Odisha has experienced a number of climate risks like cyclone, flood, drought, etc. in last couple of years. On October 12, 2013, the district was hit by Cyclone 'Phailin'. Subsequently there was a cyclone called 'Hudhud' affected Odisha coastal districts in the year 2014. Last year during 2018, over 60 lakh people were affected by flood due to heavy rainfall triggered by Cyclone 'Titli'. Of the 22 blocks in Ganjam district, 13 were badly hit due to cyclone and floods. Added to cyclones, the state has experienced contrasting extreme weather conditions which include heat waves, droughts and floods. Like other parts of Odisha, Ganjam district is also very much agricultural dependent. Due to erratic climate behaviour, farmers' income is not found to be stable. Analysis of secondary time series data reveals that agricultural production cycle and actual rainfall cycle seems to be very much pro-cyclical in nature indicating that a farmer is continuously subject to production risks in a cyclical manner. Owing to such risks, farmers have adopted number of strategies like alternative employment, migration, cost cutting in agriculture, income diversification and change in cropping pattern to augment their income and livelihood. The study finds that due to cost cutting measures farmers have adopted mechanisation. There is reportedly disinvestment in bovine animal particularly bullocks, buffaloes and so also the cattle shed and harvesting yard. As a result of that farmers are not managing the crop residues properly and there is large scale paddy straw burning by almost 70 percent of the overall paddy farmers which from the environmentalists' point of is against the environmental conservation parameters. The paper suggests that there should be more sensitisation programmes for value chain development of paddy straw and against paddy-straw burning as it is against environmental conservation approaches.

Key Words: *Climate change, Agriculture, Kharif paddy production, farming*

1 Background

United Nations Framework Convention on Climate Change (UNFCCC)[1] is that climate change is the change that can be attributed directly or indirectly to

[1]The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it.

human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The Intergovernmental Panel on Climate Change (IPCC)[2] defines climate change as a change in the state of the climate that can be identified by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer. The IPCC definition of vulnerability as the extent to which climate may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions.[3]

Odisha is placed at the head of the Bay of Bengal where weather is formed. So even a slight change in the sea's behaviour can have an immediate impact on the coast. The Bay becomes the centre of low pressures causing heavy rains and cyclones in the sub-continent and especially in Orissa. A study published in Down to earth magazine states that out of the last 100 years, the state has been dis-aster-affected for 90 years: floods have occurred for 49 years, droughts for 30 and cyclones have hit the state for 11 years. Since 1965, calamities are not only becoming more frequent but striking areas that never had a vulnerability record.[4] Another study on Status of Agriculture in Odisha, by Directorate of Agriculture, Odisha, indicates that out of 52 years, only thirteen years have been normal years and in all other years the state experienced the impact of climate shocks. This study almost put the state with a 75 percent probability of being visited by some kind of climate shocks for any calendar year.

Disasters have a long-term impact, as people are forced to spend more of their earnings on basics like home and agriculture. The already stressed ecosystem is made even more fragile with each disaster. And the poor living on the margins of subsistence are forced into greater penury. With each disaster their capacity to rebuild is reduced which is called climate induced vulnerability of the farming community. About 70-75 percent of state's population is rural and depends upon agriculture. The agriculture sector contributes about 16 percent of GSDP during the year 2011-12, which has come down from a level of 53 percent in 1980-81, with almost 60 percent of land under rain fed agriculture and with water-dependent paddy, as its main crop, the agriculture sector is particularly vulnerable to vagaries of climate change. The normal rainfall of the state is 1451.2mm out of which 75-80 percent is received from June to September by the

[2] IPCC was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

[3] IPCC, 1995. Contributions of working group II to the IPCC second assessment report, IPCC-XI/Doc. 4. IPCC Geneva.

[4] Down to Earth, Thursday 11 June 2015

impact of south west monsoons. But data shows that the rainfall has decreased to 1391.3mm in the year 2012, and it was 1007.8mm in the year 2002. The year 2015 is particularly significant for long spell of drought and monsoon failure. This has affected farmers of the state.

In Ganjam district where extreme weather-related events have been reported and claimed considerable damages in recent years particularly after super-cyclone added with periodic floods, cyclones and droughts which has resulted in large scale crop and other damages. Viewing that rainfed farmers are the most affected by these events as they depend on rain-fed agriculture, this study investigates farmers' adaptive behaviour in the light of actual risks experienced and actual risk aversion attitudes undertaken by them during last three kharif paddy cultivations. It is in this background the study intends to examine the following objectives.

Considering that climate is an important input of food grain production of the state, the frequent climate variability might have long term impacts on the production pattern of the main crop paddy, the study intends to assess the impact of climate shocks on paddy production and behaviour of paddy farmers in Odisha.

2 Objectives of the Study

- To assess climate risks historically in the context of Odisha.
- To study the trend of paddy production in Odisha with special reference to Ganjam district in Odisha
- To examine the overall impacts of climate variability on the adaptive behaviour of farmers of Ganjam district for continuance of farming activity.

3 Methodology

The paper is based on secondary as well as primary data. Secondary data are mostly time series data which are analysed to assess the climate variability in the state. As the discussion mostly pertains to the areas of climate change, more than 50 years data on climatological factors like rainfall situation is analysed by comparing the actual annual rainfall with that of normal annual rainfall. Percentage deviations are correlated with drought and flood like situations happened in the state. Similarly, for analysing the pattern of change in agricultural production and productivity, time series data obtained from secondary sources is analysed. The adaptive behaviour of paddy farmers is studied by obtaining primary data from 501 farmer households operating under rain fed agriculture conditions spread across Ganjam, Chhatrapur, Khallikote, Beguniapada and Kabisurjya Nagar and Kodala blocks in Ganjam district. Framers households from the selected villages were chosen by following the sampling criteria that the household is in farming operations for at least last ten years. The detailed sample design is as per the following table.

Table-1: Sample Design

Sl.	Blocks	No. of GPs	No of Villages	No of Households
1	Beguniapada	2 (Beruabadi, Matha Sarasingi)	5	50
2	Chhtrapur	3 (Bhikaripalli, Bipulingi, Sundarpur)	10	85
3	Ganjam	3 (Khandadeuli, Palanga, Poirasi)	13	114
4	K S Nagar	2 (Kaniary, Subalaya)	10	101
5	Khallikote	2 (Dimiria, Kanaka)	10	100
6	Kodala	1 (Kalimeghi)	6	51
	Total	13 GPs	54	501

4 Climate Change Scenario and trend of paddy production in Odisha

Since time immemorial, paddy crop is firmly rooted in the cultural practices of Odisha people and it is commonly perceived that paddy symbolises goddess Laxmi. The folklore of Odisha bears paddy as their religion also. Agriculture in Odisha to a considerable extent means growing paddy. Age-old social customs and festivals in Odisha have strong relevance to different phases of paddy cultivation: Akhyatrutiya in May-June marks the seeding of paddy, Rajasankranti in mid-June marks the completion of sowing, Garbhanasankranti in October symbolizes the reproductive phase of paddy, while Nuakhaee and Laxmipuja coincide with the harvesting of upland and lowland paddy, respectively. Makarsankranti in mid-January is celebrated as Chaita Parab by the tribal people as by this time paddy is threshed and brought to the granary.[5] This amount to say that cultural practices are at the root of continuance of paddy cultivation by the farmers of Odisha despite any type of contingencies.

In the last two decades only, on October 29-30, 1999, Odisha was hit by a cyclone affecting all coastal districts. The Indian Meteorological Department called it a 'super cyclone' due to its high wind velocity of 170-185 miles per hour; its unprecedented storm surge, which was 16-23 feet high; and the torrential rainfall over 48 hours, which caused devastating floods in the major river basins. The intensity of the cyclone killed more than 10,000 people, caused severe economic devastation. Fourteen years after the super cyclone, on October 12, 2013, Odisha was hit by Cyclone Phailin, which was accompanied by a storm surge of 5 feet and heavy rainfall that caused extensive

[5] Das S R (2012): "Paddy in Odisha", Technical Bulletin, No-16, Los Baños (Philippines): International Paddy Research Institute.

floods in the major river basins. Subsequently there was a cyclone called Hudhud affected Odisha coastal districts in the year 2014. Last year during 2018, over 60 lakh people were affected by flood due to heavy rainfall triggered by Cyclone Titli. The flood situation in three south Odisha districts - Ganjam, Gajapati and Rayagada is grim as the water levels in major rivers like Rushikulya and Bansadhara have crossed their danger marks, official sources said. Of the 22 blocks in Ganjam district, 13 were badly hit due to cyclone and floods. Blocks like Aska, Purusottampur and Sanakhemundi were inundated by rainwater as well as water from Rusikulya river gushed into the villages. Added to cyclones, the state has experienced contrasting extreme weather conditions which include heat waves, droughts and floods. The state's fluctuating weather conditions suggest that it is reeling under climatic chaos.

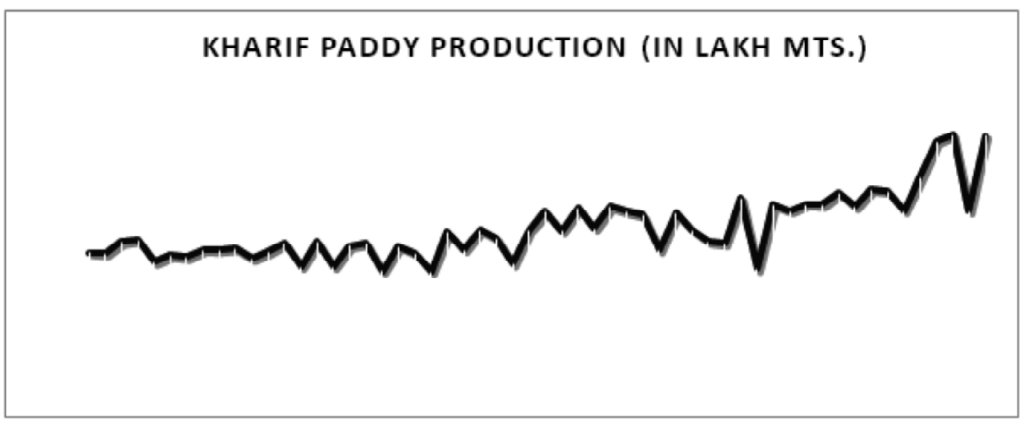
Rainfall has been more erratic sincethe1960s,with below-normal rainfall across all districts being recorded for most years. The state's average annual rainfall from1901to 1950 was1,503 millimetres. It is now 1,451 millimetres, with about 84 percent of rainfall received between June and September (State Disaster Management Plan, Odisha, August 2013). The" normal" 120 days of monsoon rain has shrunk to 60–70 days, and unusual spikes in rainfall, with torrential rainfall of over 200–250 millimetres day, are more frequent during the monsoon, frequently resulting in floods. This situation has had a strong influence on agricultural crops.[6] A heat wave is a condition of atmospheric temperature that leads to physiological stress, which sometimes can claim human life. The normal temperature is lessthan40°C.Whenthe temperature exceeds that level, it is called a heat wave. When it reaches five or six degrees above the normal temperature, it is called a moderate heat wave, and at seven degrees or more it is called a severe heat wave. In 1998 the state of Odisha faced an unprecedented heat wave situation in which 2,042 persons lost their lives. Although extensive awareness campaigns have largely reduced the number of casualtiessince1998, a good number of casualties are still being reported each year.[7] The rainfall variability in the state and kharif paddy production in the state during the period 1961 to 2018 is shown in the table in Annexure-1.

It is found that during the 58-year period, there were hardly 15 years without witnessing any type of climate risks. For rest 43 years, there were some kind of climate risks in the form of drought or flood or cyclone or some other natural calamities. Even kharif 2017 witnessed severe pest attack in major parts of Odisha. These are the reasons for which there is large scale fluctuation in paddy production. As it

[6] OSCCAC (2015-16)

[7] Ibid

can be seen from the following chart there is hardly any four yearly period witnessing continuous increase in paddy production. As a result of this farmers' economics is subject to continuous climate risks. However, during a very long period of time, the overall trend of paddy production shows an increasing trend owing to various Govt interventions like introduction of green revolution, recommended doses of practices and a number of paddy promotion programmes which has significant bearing for which paddy production has dramatically increased over a period of time. The regression results with paddy production as dependent variable explained by annual rainfall and time points out that with each successive year, there is 0.73 lakh MT increase in paddy production and with each 1 mm increase in rainfall, there is 0.02 lakh MT rise in paddy production. Karl Pearson's correlation coefficient for paddy production and rainfall is calculated at 0.45 (t value critical two tail= 2.00 significant at 0.05 level) which also denotes positive correlation between the stated variables. The results are shown in the table given below.



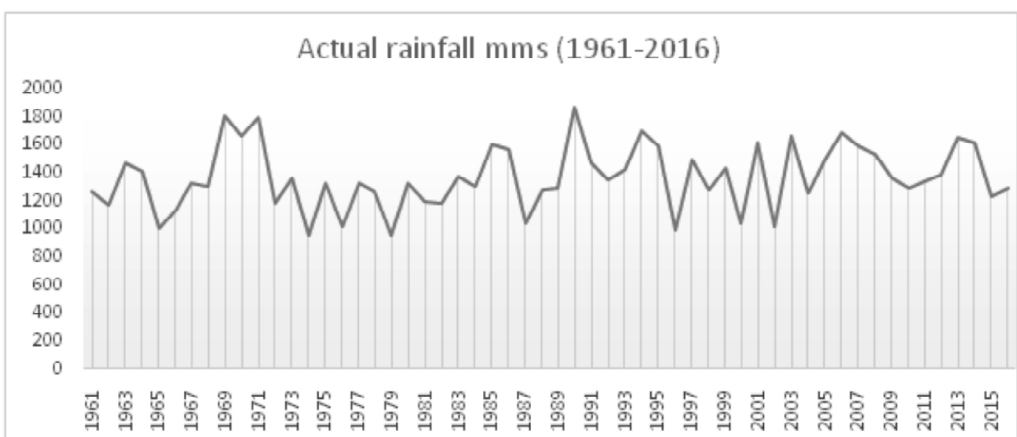


Table-2: Regression output

Sl.	Variables	Description of the Variable	Estimated Values	R Square	Adjusted R Square	"t" statistics	Significance Level
1	Dependent Variable (Y)	Annual Kharif paddy Production (Lakh MT)	$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2$	0.68	0.66		
2	Intercept (β_0)		1431.1			8.86	.01
3	Independent Variable - 1(β_1)	Time taken in completed years	0.73			8.9	.01
4	Independent Variable-2 (β_2)	Actual Rainfall (MM)	0.02			3.9	.01

5 Adaptation Behaviour of the Farmers on the basis of Sample data

Due to the heavy reliance of this agricultural sector on climate conditions, climate risks contribute and guide the climate change adaptation process of farmers and the combined influence of socioeconomic and psychological factors on their adaptive behaviour. The adaptive behaviour is partly contributed by psychological as well as socio-economic factors that explains farmers' decision-making process regarding climate change adaptation.[8] Present section after profiling the sampled-out farmers by socio-economic categories, delves into actual climate risks faced and actual climate risk aversion attitudes undertaken by them.

5.1 Socio Economic Category

Out of the total sample out farmers, majority of farmers are under OBC category and they constitute around 55.7 percent followed by General and SC category of farmers. About 56.3 percent of the households are non-BPL households and the rest are BPL households. The classification of BPL and non-BPL households was done on the basis of household possession of ration cards. If the household is having a ration card is considered as BPL household, else non- BPL household. With respect to education, about 56.5

[8] *Dang, Hoa & Li, Elton & Bruwer, Johan. (2012). Understanding Climate Change Adaptive Behaviour of Farmers: An Integrated Conceptual Framework. The International Journal of Climate Change: Impacts and Responses. 3. 255-272. 10.18848/1835-7156/CGP/v03i02/37106.*

Table-3: Socio-Economic Profile of the Sample Farmers

Sl.	Particulars	Details	No of farmers (%)													
1	Social Category	SC	16	16.8	23	27.1	34	29.8	25	24.8	40	40.0		0.0	138	27.5
		OBC	55	57.9	45	52.9	65	57.0	67	66.3	45	45.0	2	33.3	279	55.7
		Total	95	100.0	85	100.0	114	100.0	101	100.0	100	100.0	6	100.0	501	100.0
		Non-BPL	62	65.3	51	60.0	41	36.0	82	81.2	42	42.0	6	100.0	284	56.7
3	Education	Illiterate	14	14.7	11	12.9	18	15.8	21	20.8	20	20.0		0.0	84	16.8
		High School/ Inter	19	20.0	28	32.9	26	22.8	21	20.8	17	17.0	3	50.0	114	22.8
		More than Graduation	1	1.1	2	2.4	3	2.6	2	2.0	2	2.0		0.0	10	2.0
4	Farmer Category	Marginal	52	54.7	50	58.8	56	49.1	49	48.5	66	66.0	1	16.7	274	54.7
		Semi medium	12	12.6	9	10.6	8	7.0	15	14.9	7	7.0	1	16.7	52	10.4
		Large		0.0	3	3.5	6	5.3	4	4.0	1	1.0		0.0	14	2.8

percent of the farmer heads of the households have primary level of education and about 22.8 percent have upto high school education. The extent of illiteracy is about 16.8 percent. Framer category wise, about 54.7 percent are marginal farmers and 31.3 percent are small farmers. Marginal and small farmers jointly account around 85.6 percent. Semi medium and medium farmers jointly account about 11.2 percent. The proportionate share of large farmers is obviously very much insignificant. This amounts to say that majority of sampled out rain fed farmers in Ganjam district are from OBC category of course non-BPL and small holder farmers.

5.2 Operated Land holding

The operated land holding of the sample farmers takes into account their own land added with share-in-land/ lease-in-land and subtracted with lease-out and share-out land arrives at total operated land. As it can be seen from the following table, overall, the sample farmers have 2.62 acres of land , 2.50 acres of land and 3.0 acres lease out land and overall total operated area is calculated at 3.25 acres of operational land holding. In all the sample blocks, operational land holding of sample farmers ranges between 3.0- 3.5 acres except Khallikote block where it is slightly lower to 3.0 acres. Overall operational landholding of the sample farmers may be rounded off to 3.0 acres. It may amount to say that the average picture operational landholding of paddy farmers is limited to 3.0 acres only, typically representing small holder farmers.

Table-4: Farmers' by operational Landholdings.

Blocks	Average Land Area (ALA) (in Acres)			
	Own Land	Lease- in -land/ Share-in-land	Lease- out/ share-out land	Total operational holding
Beguniapada	3.06	2.70		3.48
Chhatrapur	2.39	3.21		3.16
Ganjam	2.48	1.97	2.00	3.30
K S Nagar	2.66	2.76	4.00	3.58
Khallikote	2.40	1.67		2.70
Kodala	3.40	3.00	3.00	3.40
All Blocks	2.62	2.50	3.00	3.25

5.3 Type of Climate risks Faced by the Farmers

In order to examine farmers' exposure to climate risks, they were asked on what type of climate risks they had faced during last three years. On the basis of farmers' perceived climate risks, climate risk intensity of the farmers was calculated in terms of average no of kharif paddy sessions for last three years.

Climate risks on the basis of farmers' opinion were classified under seven categories spanning over moderate drought, severe drought, moderate flood, severe flood, cyclone, pest attack and crop disease. As it is seen from the following table overall intensity of climate risk for a period of 10 years' is calculated at 10 that indicates that there is at least one climate risk for each of the kharif paddy session. Maximum and minimum climate risk intensity is found for cyclone and severe flood respectively. The extent of climate risk intensity is as shown in the chart given alongside. Obviously, as the sample farmers are under rainfed conditions, only after cyclones, moderate / severe droughts are found to be of higher climate risk intensity and floods are of lower climate risk intensity. Added to these risk factor intra crop weather variations also contribute to varieties crop diseases as stated by the farmers.

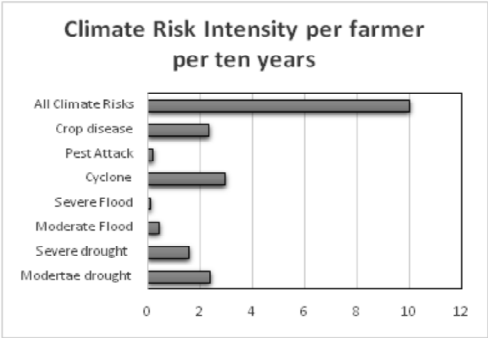


Table-5: Type of disaster faced during last three years (2016-2018)

Type of Climate Risks	Climate Risk Intensity per farmer per ten years (Average no of kharif paddy sessions)						
	Begunia pada	Chhatrapur	Ganjam	K S Nagar	Khalikote	Kodala	All Blocks
Modertae drought	0.45	0.28	0.61	0.48	0.53	0.04	2.39
Severe drought	0.45	0.20	0.40	0.21	0.33	0.00	1.58
Moderate Flood	0.13	0.03	0.10	0.11	0.06	0.01	0.44
Severe Flood	0.02	0.03	0.01	0.03	0.01	0.00	0.09
Cyclone	0.55	0.50	0.67	0.61	0.60	0.03	2.97
Pest Attack	0.01	0.05	0.05	0.03	0.05	0.00	0.19
Crop disease	0.28	0.61	0.44	0.55	0.42	0.04	2.34
All Climate risks	1.90	1.70	2.28	2.02	2.00	0.12	10.00

5.4 Paddy farmers' adaptive behaviour

The adaptive behaviour of the farmers was recorded by asking them how do they manage under a given scenario of climate risks being faced by them year by year. As per their opinion, in last couple of years' owing to the fall in profitability from the farming activity as a result of climate risks, most of the farmers have adopted alternative employment opportunities at home place, resorting to migration and adopting farm mechanisation and to some extent crop diversification.

Table-6: Coping Mechanism

Blocks	Alternative employment at home place	%	Migration	%	Agro-Mechanisation	%	Crop diversification	%
Beguniapada	31	62.0	52	104.0	72	144.0	15	30.0
Chhatrapur	26	30.6	29	34.1	59	69.4	1	1.2
Ganjam	44	38.6	65	57.0	83	72.8	10	8.8
Kabisurjyanagar	43	42.6	60	59.4	74	73.3	13	12.9
Khallikote	53	53.0	60	60.0	77	77.0	15	15.0
Kodala	2	3.9	1	2.0	6	11.8	1	2.0
All Blocks	199	39.7	267	53.3	371	74.1	55	11.0

Alternative Employment: In the background of climate risks, the small holder farmers are found to be employed as construction workers at the nearby towns as well as employed in the MGNREGA works. It was indicated by them that in recent years, construction works are also going on in their villages due to various Govt. schemes like IAY, Biju Pucca Ghar and National Housing scheme. Besides, number of new houses are constructed as a result of remittances received by the migrant households. During interaction with the villagers it was also found that foremost priority of the migrant households is construction of a pucca house at village which is contributing towards creation of employment opportunities at the village.

Migration: As year by year there are climate risks in agriculture and expected profitability is very less, farmer heads of the household prefer to migrant with a view to generating some additional income for the household. As it can be seen from the following table the farmer heads who undertake out migration, broadly they migrate in three important directions, which are classified under Berhampur- Bhubaneswar Corridor, Berhampur- South Corridor (Kerala & Chennai) and Berhampur- West Corridor (Mumbai, Surat and Gandhidham). The type of work undertaken by the labourers at the destination place is shown in the box given alongside. Berhampur-West corridor is the predominant corridor followed Berhampur – Bhubaneswar corridor and Berhampur- south corridor.

Sl.	Place of Migration	Type of work done
1	Bhubaneswar	Construction worker
2	Kerala	Construction worker
3	Chennai	Casual Labour in Garment Manufacturing units
4	Surat	Textile Mills Labourer
5	Gandhidham	Ship Dismantling

On an average the migrant farmers' stay duration at the destination place is calculated at around 140 days per annum.

Table-7: Migration Patterns of farmer heads

Blocks	No of migrants (%)								Average migration period*
	Berhampur-Bhubaneswar Corridor	%	Berhampur - South Corridor (Chennai, Kerala)	%	Berhampur - West Corridor (Mumbai, Surat)	%	All Corridors	%	
Beguniapada	11	15.5	13	18.3	47	66.2	71	100.0	159.3
Chhatrapur	21	39.6	7	13.2	25	47.2	53	100.0	120.0
Ganjam	19	33.9	6	10.7	31	55.4	56	100.0	120.7
KS Nagar	3	7.5	18	45.0	19	47.5	40	100.0	145.0
Khalikote	23	41.8	18	32.7	14	25.5	55	100.0	120.0
Kodala	16	34.0	6	12.8	25	53.2	47	100.0	180.0
All Blocks	93	28.9	68	21.1	161	50.0	322	100.0	139.8

Note:* Calculated per Year, innumber of days.

Agro- Mechanisation: With a view to compensate falling income and profitability added with labour shortage due to migration of farmer heads leads to multiple adaptation behaviour of the farmer households. First, the female heads of the households lead agricultural operations from land preparation upto harvesting. Second, As women heads most often leading agricultural operations, they prefer to adopt mechanisation in agriculture through ploughing by using tractors and power tillers and harvesting by power threshers that are available on rent in the villages. Agricultural mechanisation is also adopted with a view to expedite agricultural operations and as it becomes quicker, there is better option for migration. Thirdly, as agro mechanisation has taken place massively particularly for paddy harvesting and transplanting, maintaining drought bullocks by the farmers households is no longer a dominant practice and it was alos found about 70 percent of the farmer households in sample villages don't have bullocks. So farmer is not required to preserve paddy straw for the whole year to use as fodder for the bovine heads previously he was owning. Fifthly, it has further led to alternative use of harvesting yard as well as cattle shed. In some cases, there has been disinvestment in these two distinct households by the farmer households. Most importantly as about 70 percent farmer households don't have cattle, and they don't require preservation of paddy straw they dump the straw at fields for some period of time and ultimately by the end of March burn these straws while starting land

preparations for the next kharif crop paddy. Such type of large-scale paddy-straw burning owing to mechanisation is major contributor for carbon dioxide emission to the environment, which requires a further study to estimate volume of carbon emission to the environment.

Crop Diversification: Due to climate risks, overall 11 percent of the farmers in the study area have adopted crop diversification. It was found that the farmers previously doing paddy in high land areas have marginally shifted to millet particularly ragi which is very much drought resistant. This is particularly promoted by Odisha Millets Mission and climate resilient crop promotion programmes run under FPOs/ FPCs functioning in the study area.

5.5 *Key Findings*

→ It is found that during the 58-year period, there were hardly 15 years without witnessing any type of climate risks. For rest 43 years, there were some kind of climate risks in the form of drought or flood or cyclone or some other natural calamities.

→ Y- on Y basis, there is large scale fluctuation in paddy production.

→ There is hardly any four yearly period witnessing continuous increase in paddy production. As a result of this farmers' economics is subject to continuous climate risks.

→ However, during a very long period of time, the overall trend of paddy production shows an increasing trend.

→ With each successive year, there is 0.73 lakh MT increase in paddy production and with each 1 mm increase in rainfall, there is 0.02 lakh MT rise in paddy production. Karl Pearson's correlation coefficient for paddy production and rainfall is calculated at 0.45.

→ Majority of sampled out rain fed farmers in Ganjam district are from OBC category of course non-BPL and small holder farmers.

→ Overall operational landholding of the sample farmers may be rounded off to 3.0 acres. It may amount to say that the average picture operational landholding of paddy farmers is limited to 3.0 acres only, typically representing small holder farmers.

→ Overall intensity of climate risk for a period of 10 years' is calculated at 10 that indicates that there is at least one climate risk for each of the kharif paddy session.

→ Farmers are under rainfed conditions, only after cyclones, moderate / severe droughts are found to be of higher climate risk intensity and floods are of lower climate risk intensity. Added to these risk factor intra crop weather variations also contribute to varieties crop diseases as stated by the farmers.

→ Owing to climate risks, farmers have adopted alternative employment opportunities at home place, resorting to migration and adopting farm mechanisation and to some extent crop diversification.

→ Migration of farmer heads as a part of adaptive strategy has led to increased participation of women in agricultural operations, more mechanisation in agriculture for ploughing, transplantation and harvesting.

→ Agro- mechanisation has led to disinvestment in drought bullocks, cattle sheds and harvesting yards the distinct assets of the farmer households.

→ Such disinvestments has further led to large-scale paddy- straw burning which is supposed to be an emerging contributors for carbon dioxide emission to the environment in Ganjam district.

6 Way Forward

It is high time to sensitise the farmers about the harmful effects of paddy straw burning and equip farmers about value addition aspects of paddy straw, one of massive crop residues under paddy cultivation.

ANNEXURE-I

Table: Rainfall behaviour in Odisha

Sl.	Year	Normal Rainfall mms	Actual rainfall mms	Rainfall Deviation (%)	Kharif Paddy Production (in lakh Mts.)	Remarks
1.	1961	1502.5	1262.8	-16	36.99	
2.	1962	1502.5	1169.9	-22	36.32	
3.	1963	1502.5	1467.0	-2	42.47	
4.	1964	1502.5	1414.1	-6	43.59	
5.	1965	1502.5	997.1	-34	31.89	Severe drought
6.	1966	1502.5	1134.9	-24	35.37	Drought
7.	1967	1502.5	1326.7	-12	34.43	Cyclone & Flood
8.	1968	1502.5	1296.1	-14	38.48	Cyclone & Flood
9.	1969	1502.5	1802.1	20	38.39	Flood
10	1970	1502.5	1660.2	10	39.13	Flood
11.	1971	1502.5	1791.5	19	33.76	Flood, Severe Cyclone
12.	1972	1502.5	1177.1	-22	37.35	Drought, flood
13.	1973	1502.5	1360.1	-9	41.91	Flood
14.	1974	1502.5	951.2	-37	29.67	Flood, severe drought

15.	1975	1502.5	1325.6	-12	42.74	Flood
16.	1976	1502.5	1012.5	-33	29.58	Severe drought
17.	1977	1502.5	1326.9	-12	40.50	Flood
18.	1978	1502.5	1261.3	-16	41.89	Tornados, hail storm
19.	1979	1502.5	950.7	-37	27.34	Severe drought
20.	1980	1502.5	1321.7	-12	40.31	Flood, drought
21.	1981	1502.5	1187.4	-21	36.63	Flood, drought, Tornado
22.	1982	1502.5	1179.9	-21	27.07	High flood, drought, cyclone
23.	1983	1502.5	1374.1	-9	47.63	
24.	1984	1502.5	1302.8	-13	38.50	Drought
25.	1985	1502.5	1606.8	7	48.80	Flood
26.	1986	1502.5	1566.1	4	44.56	
27.	1987	1502.5	1040.8	-31	31.03	Severe drought
28.	1988	1502.5	1270.5	-15	48.96	
29.	1989	1502.5	1283.9	-15	58.40	
30.	1990	1502.5	1865.8	24	48.42	Flood
31.	1991	1502.5	1465.7	-2	60.30	
32.	1992	1502.5	1344.1	-11	49.76	Flood, drought
33.	1993	1502.5	1421.6	-5	61.02	
34.	1994	1502.5	1700.2	13	58.31	
35.	1995	1502.5	1588.0	6	56.48	
36.	1996	1502.5	990.1	-34	38.27	Severe drought
37.	1997	1502.5	1493.0	-1	57.51	
38.	1998	1502.5	1277.5	-15	48.85	Severe drought
39.	1999	1502.5	1435.7	-4	42.75	Severe Cyclone (Super Cyclone)
40.	2000	1502.5	1035.1	-31	41.72	Drought & Flood
41.	2001	1482.2	1616.2	9	65.71	Flood
42.	2002	1482.2	1007.8	-32	28.26	Severe drought
43.	2003	1482.2	1663.5	12	61.99	Flood
44.	2004	1482.2	1256.7	-15	58.84	Moisture stress
45.	2005	1451.2	1497.7	3	62.49	Moisture stress
46.	2006	1451.2	1682.8	16	61.96	Moisture stress/Flood

47.	2007	1451.2	1583.2	9	68.26	Flood
48.	2008	1451.2	1525.5	5	60.92	Flood, Moisture Stress
49	2009	1451.2	1362.6	-6	70.22	
50	2010	1451.2	1293.0	-11	69.31	Flood
51	2011	1451.2	1338.1	-8	58.95	
52	2012	1451.2	1384.1	-5	76.13	
53	2013	1451.2	1653.2	14	94.88	Cyclonic storm 'Phailin'
54	2014	1451.2	1608.7	11	98.45	Flood, cyclonic storm 'Hudhud
55	2015	1451.2	1224.8	-16	58.75	Severe drought
56	2016	1451.2	1283.1	-12	97.94	Severe drought
57	2017					
58	2018					Cyclone “Titli”

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