Odisha Journal of Commerce and Management
ISSN : 0976-8599
Vol. 8, No. 1, 2022, pp. 133-143

Climate Change Adaptation in Rural Odisha: A Comprehensive Analysis of Rayagada District of Odisha

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Abstract: Climate change negatively affects the food security and sustainability of agriculture in India. Indian Council of Agricultural Research (ICAR) has instituted a worldwide project in the year 2004 to study the impact and implications of climate change on agriculture, especially on agriculture in India. In compliance with the objective of the project, the present study was undertaken to examine the effects of climate change on agriculture and its allied activities in the southern Odisha district of Rayagada. Widespread poverty is discernible throughout Rayagada district. It was felt that a close and intensive interaction with the farmers of the district would be very helpful to ascertain the effects and influences of climate change on the agriculture of this region, as their feedback would be based on their own direct exposure and experience with the changes in climatic conditions in their area. Accordingly, the project formed a few groups of local farmers for obtaining and recording their responses, reactions, perceptions and opinions on relevant issues relating to climate changes on agriculture in Rayagada. As many as 95 farmer's households were included in a survey in which major variables of information and data collected were mainly on issues like size of their firm, level of their income, credit facilities availed by them, and the various impacts of climatic changes on their agricultural activities. The researcher found and concluded that climate change has affected food security and the sustainability of livelihood of the rural people of Rayagada and that they would like to see various remedial measures initiated by the government to tackle the adverse effects of climate changes on the agriculture in their district.

Keywords: Climate Change, adaptation, rural Odisha.

JEL Classification: Q56, Q57, R11

1. INTRODUCTION

Disastrous effect of climate change has been found on physical and biological system all across the world. Climate change has reduced 1 to 5 % of global agricultural production per decade. Rapid and uncertain change of temperature and rainfall pattern results in a significant fall in the production of important and stable food crops. Indigenous knowledge

of coping mechanism of age-old tradition like crop intensification and diversification can be the best solutions to the crop unproductively. Climate change and food security are two very complex terminologies. Because those concepts can be accessed through different dimensions. Fulfilment of one dimension cannot mitigate the havoc of climate change and food insecurity. Indigenous people use wide varieties of cultivation of food crops to meet their nutritional needs and hunger.

Process of production of goods and services for the market makes us engaged with interactions between external environment and consumer environment. From the natural environment business inputs and transfers into finished products to meet the needs of the consumers. Therefore, the natural environment is instrumental in business growth and ultimately the economic growth. Natural environment in the contemporary world faces the pollution and hence resource depletion. No doubt modern industry has provided material prosperity of the world of business. But it has posed environmental threats to the business, future generations and all present lives. Today's business technology manipulates and controlled nature and pollutes our environment rapidly by depleting our natural resources. More than 200 billion tons of pollutants are pumped in to the air we breathe more than 45 million tons of toxic based are produced and more than 18 million gallons of pollutants are thrown into our country's waterway. Consumption of natural oil produces air pollutants. On an average, we people produce garbage of more than 1500 pounds of metal, 20000 pound of other material and over 5 pound of homely garbage everyday per year.

As per the report published in 2000 by the World Watch Institute, a group of researchers, found that this 21st century has been witnessing massive population growth, rising trend of temperature, fall of the water table, shrinking crop lands per person owing to rise of water level in oceans, eating up the coastal area all over the world used for agriculture, collapsing fisheries owing to unscrupulous fishing companies operating in earth's oceans all over the world. Further, it also witnessed shrinking forest-lands and the loss of varied animal and bird species on earth. Their Report projects population growth over 10 billion by 2050 in country's which are overpopulated. The rise in temperature owing to air pollution, water pollution and land pollution. The rising temperature owing to the atmospheric concentration of carbon dioxide, global temperature in 1971 was 14 degrees Celsius, and in 1998 it rose to 14.50 degrees Celsius. If Carbon dioxide concentration doubles, then the global temperature is likely to raise by at least 1 degree Celsius more. This will result in sea level rise by a minimum of 17 centimetre per year, and by 2100 the sea level may rise by 1 meter. This will alter the very ecosystem on earth. Coral reefs are adversely affected in all oceans.

The record sea surface temperature over the last 3 years wiped out 80% of corals in the Indian Ocean. The temperature rise in the ocean surface is melting icecaps and glaciers. Ice

cover is shrinking in the Arctic Ocean, Antarctic Ocean, Alaska, green land, the alps, the Andes, the Tibetan plateau. The accelerated trend in ice-melting attribute original rise in average temperature of 2.5 degree Celsius since 1940. Over pumping of water as resulted in continuous fall of water table in China, India Africa, Southiarab and the United States. Over pumping of water has accelerated about 160 degree billion tons of water per year. The author understands roughly more than 10000 tons of water to produce 1 ton of grains. This is equivalent to 160 million tons of grains. The food supply of 500 million people is being produced with the unsustainable use of water. It is worth debating how to feed the projected growth in population adequately over the next 2 decades in the said scenario of shrinkage in crop line per person. If the world grain area remains same, the area per person in this world will shrink to 0.08% hector. by 2050. Humanity heavily depends on oceans for food. The trends of fall in water level, shrinking crop land area per person, levelling of the oceanic fish catch, suggest that it will the farm of difficult to keep up with the growth in world demand for food over the next half-century. It seems mankind will not stop actions until she has suffered greatly and much that she now realises upon has been destroyed. As the world is going to be crowded twice with human beings and human generations confronted with dwindling resources in the midst of mounting accumulation of waste and garbage, a steady deterioration environment we can only foresee social unrest of an intensity greater than any we have so far known. Briefly explaining the dimensions of pollution and resource depletion only air pollution aloe has brought global warming, ozone depletion, acid rain, airborne toxics and deteriorating air quality. Water pollution is going to greatly affect the next generation of humankind. The human being will not stop destroying their own environment till her suffers greatly.

BACKGROUND OF THE STUDY AREA

Bishamkatak, C.D. Block is a part of Bishamkatak tehsil under Gunupur Sub-division, located in the eastern part of Ravaged District at a distance of 48 km from District Head Quarter. It is surrounded by Muniguda. C.D. Block from North West and north. It is located in western undulating of Odisha. The geographical area of the block is 622.055 square kilometre out of which 83.49sq km in forest area. According to census 2001 report, total population of 75366 persons, 16.87% and 66.23% belongs to scheduled caste and scheduled tribe community only. The gender ratio of this block is 1069 and SC and ST population is 1032 and 1096. Out of the total population 50.48% are workers and among the total worker 15.45% and 69.38% ST. Overall literacy ratio among them are 25.90 for total population, 24.71 for SC and 17.63 for ST. Out of total area, 30.23% is cultivable area and 5.35% of the cultivable area is irrigated. Average land holding size is 1.07Hect. In this block Out of total 307 villages 122 (40%) are electrified.

Table 1: Administrative set up

Sl no	*Indicators*	*Total*
1	No. of GramPanchayats	20
2	No. of Villages	307
3	Total geographical areas	622.055sqm
4	Administrative(Adm) zone	Southern
5	Language spoken	Odia/khond/kui/telugu/savara
6	Dominant scheduled tribe	Khond/kondadora/jatapu/matya
7	Density of population(Per sq m)	121
8	Annual average rain fall	1258 mm

Source: Compiled from different sources

Table 2: Demographic profile

Sl no	*Indicators*	*Persons*	*Total*	*ST*
1	Population	Male	36432	23816
		Female	38934	26102
2	Sex Ratio		1069	1096
3	No. Of Literates	Male	11204	5467
		Female	4843	1749
4	Literacy Rate (%)	Male	37.7	28.28
		Female	15.02	8.10
5	Agriculture	Barren And Non-Cultivable Land		34233
	Land Pattern	Cultivable Waste Land		
	(In Acres)	Old Fallows		431
		Current Fallows		
				1891
				2699

Source: Compiled from different sources

3. LITERATURE REVIEW

3.1. Climate change and Adaptability

In the words of (Boyce *et al.*, 1993, DeGonzague *et al.*,1999; Kuhnlein and Receveur, 1996; Norgaard, 2005) the effects of climate change on biochemical functions, ecosystems, and organisms population Pose an increasing challenge to ethnic eating habits. Tribals are facing healthcare losses as ethnic food consumption diminishes. Fatness, diabetes, and cancers, which were once uncommon in conventional food groups, are now causing medical complications in tribal groups across the United States. For instance, the plurality of Karuk people these days, their territory runs along of the middle Klamath River in California, has seen a nearly total removal of 2 conventional mainstays from their traditional regular eating habits: salmonids

(Oncorhynchus sp.) and acorns. (Notholithocarpus and Quercus sp.). A typical Karuk diet consisted of 50% of these items. Such decline is accompanied by a sharp increasing rate of diabetes out of 21% of the population and heart disease (40% of the population) (Norgaard 2005). Global warming is believed to pose serious hazards to salmon (Mote *et al.* 2003, Dittmer 2013; Grah and Beaulieu 2013; Beechie *et al.* 2012). Salmon is essential to the psychological, physiological, and traditional well-being of several indigenous peoples (Dittmer 2013). Overfishing, habitat destruction, urban development, and water distribution for a wide range of human use have all contributed to substantial reductions in salmon populaces during the past two millennia (Mote *et al.*2003), with far-reaching consequences for the people groups whose lifestyles and societies are entangled with them. For other tribes, the loss was sudden and complete: with the completion of the Grand Coulee Dam on the Columbia River and the refilling of the lake behind that, the Colville Tribes lost access to both salmon and their traditional fishing grounds in recent years (McKay and Renk, 2002). The pace of climatic changes is potentially amplifying pre-existing stresses and introducing new ones, such as swings in stream flows as well as water extremes that restrict salmon fry survival (Mantua *et al.* 2010). It is worth noting that indigenous peoples get a long history of adjusting to sizable environmental changes caused by a variety of factors. Diminished animal and fish species, for example, as a result of commercialisation and sports purposes, have altered the habitats on whose indigenous peoples rely for sustenance and trade (Cronon 1983). Dams are another example; indigenous peoples' worries about dams and their consequences on the well-being of fish and animal species, along with health impacts, have long been reported.

3.2. Climate change and food security

Tribal attempts to increase community and property managers participation in managing to conserve and recover aspects of these ecosystems are rising. Coastal Louisiana tribes are witnessing a deterioration in traditional food supplies as a consequence of land loss, saltwater intrusion, and estuary disruption caused by increased storm activity (PNW TCCP 2012). Moose habitat is changing for Athabasca people in central Alaska. Moose are an essential staple diet, and the moose population loss has put a strain on people's dietary patterns. Apart from changes in moose range, shooters have found that moose appeared to be less healthy (Daigle and Putnam, 2009). Cold weather sea ice coverage is shrinking rapidly owing to climatic changes, and this decline is harming Pacific walrus populations, going to harm Alaskan traditional food security (Verbrugge 2010; IPCC 2007a). Throughout history, indigenous peoples have had access to various traditional meals. Tribal communities inspire innovative socioeconomic and technical systems for acquiring, processing, and storing food (Anderson and Parker, 2009). In spite of the wide regional climate stresses that lowered salmon populations and habitat quality, historical evidence in the Pacific Northwest reveals fairly steady usage of salmon over the last

7,500 years (Campbell and Butler, 2010). Climatic Change, found in strong, multilayered links to the resources consumed, adaptive resource management, and attitudes and social structures that maintained salmon harvest within sustainable levels, is the key to this resilience (Campbell and Butler, 2010).

Traditional ecological knowledge gives us how climate change may affect ethnic diets. However, limited access to a fraction of tribal lands, the competition tribes face when gathering, the ongoing effects of colonisation and urbanisation, and the current state of environmental degradation all pose significant threats to tribes' ability to maintain tribal wellness and their traditional lifestyles.

4. OBJECTIVES

1. To find out how climate change affects food security and sustainability among the rural farmers of Rayagada district.
2. To study the farmer's perception towards climate change.
3. To find out the association between climate change and sustainability.

5. HYPOTHESIS

H_1: Climate change affects the food security and sustainability among the rural farmers

H_2: There is no association between farmer's perceptions with climate change

H_3: Climate change is purely associated with the sustainability of farmers in the current situation.

6. RESEARCH METHODOLOGY

Considering the stated objectives, the research methodology was formulated. The methodology of the present study comprises the selection of research approach, research design, population, and sample, sampling technique, development of the tool, data collection procedure and plan for data analysis. Research work can be undertaken in two broad areas viz, qualitative research and quantitative research. Present study comprises the demographic variable like age, gender, educational qualifications, marital status and income of the respondents.

Sample size of the study was 95. Purposive sampling technique was used for the present study as researcher includes all the samples who meet the inclusion criteria. The data will be analyzed by using descriptive and inferential statistics as the objective and presented in the form of table.

6.1. Sampling Technique

The study was based on primary data. The information collected through questionnaires from the respondents of Rayagada district of Odisha. Primary data about climate change among tribal farmers from four different selected blocks was considered. Both qualitative

and quantitative data are used for analyzing and drawing inferences and conclusions. The information's are collected for the purpose and objectives of the study. In this study purposive sampling techniques was used. . Total 150 questionnaires served to the tribal farmers and 95 responses were received and correct.

7. ANALYSIS AND INTERPRETATION

Table 3: Demographic profile

Demographic Profile	*Years*	*Frequency*	*Percentage %*
Age	(1). <30	10	10.5
	(2). 30-40	46	48.4
	(3). 41-50	35	36.8
	(4). >50	4	4.2
Gender	1. Male	69	72.6
	2. Female	26	27.4
	3.Transgender	0	0
Marital Status	**1.** Married	80	84.2
	2. Single	15	15.8
	3. Divorce	0	0
	4. other	0	0
Educational Level	**1.** Illiterate	35	36.8
	2. Primary	9	9.5
	3. Secondary	16	16.8
	4. Higher-secondary	19	20
	5. Graduation	15	15.8
	6.Post-graduation	0	0
	7. Dropout/others	1	1.1

Source: Compiled from different sources

In this above table 48.4% respondents are 30-40 age groups where 72.6% are male persons. In this demographic table 8.2% respondents are married and maximum persons are illiterate and nobody has passed the post graduate level.

Table 4: Income source

		Frequency	*Percentage (%)*
Income source	**1.** Arable land	80	84.2
	2. Non-arable land	5	5.3
	3. others	10	10.5
	Total	95	100.0

Source: Compiled from different sources

In this table no 4; Respondents' income source is agricultural land. From which 84.2% are arable land and they are able to do crop productions in this land.

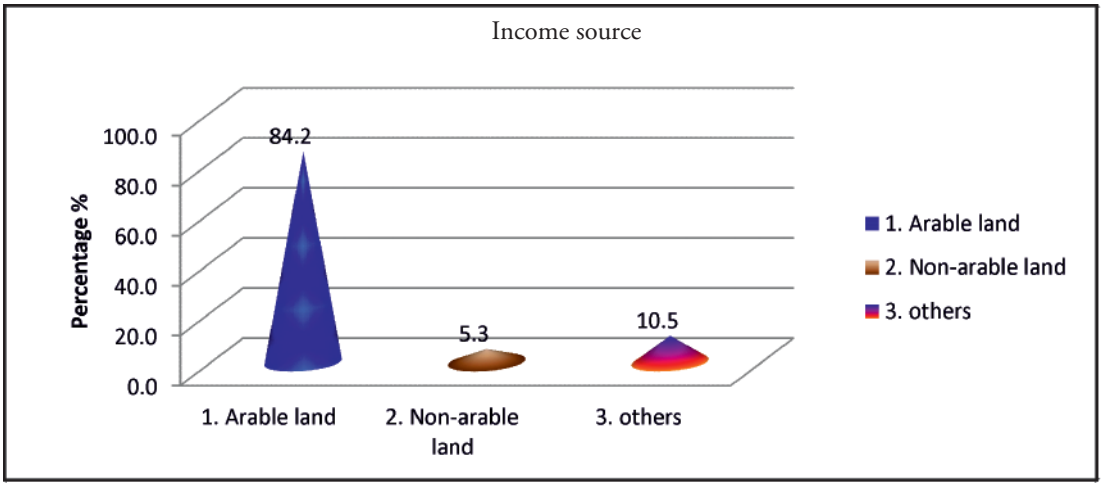

Figure 1: Income Source of the Respondents

Source: Authors' Compilation

In this above figure, most of the lands are arable land as compared to other lands.

Table 5: Water Source Availability

		Frequency	*Percentage (%)*
Water source availability	1. Canal	0	0.0
	2. Deep tube well	0	0.0
	3. Rain Fed	64	67.4
	4. Both deep tube -well & Rain-fed	17	17.9
	5. River	14	14.7
	Total	95	100.0

Source: Compiled from different sources

In this figure most of the respondents are depending upon the rainfall of water.67.4% of respondents told about the rain fed in this areas. So it will very difficult for them to cope with the climate for production.

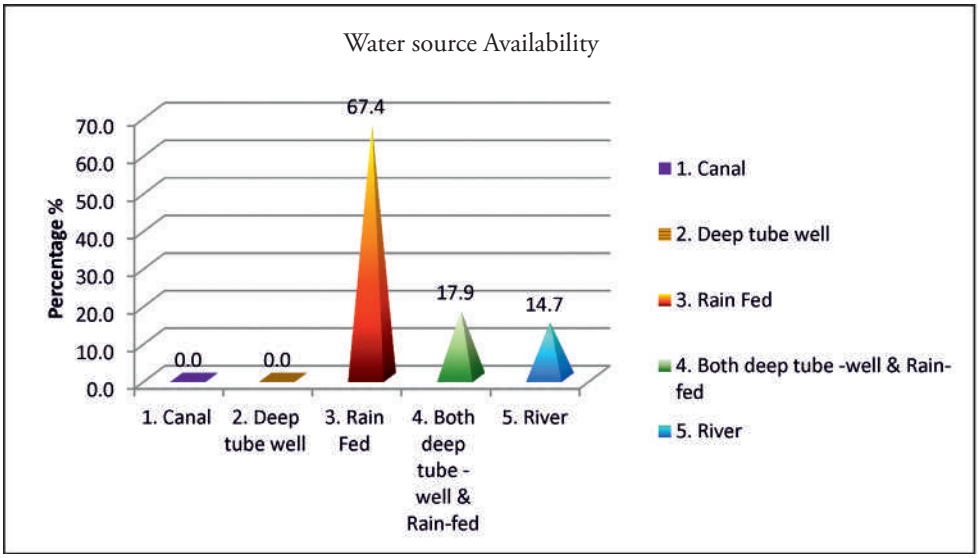

Figure 2: Water Source Availability

Source: Authors' Compilation

Table 6: Association between Farmer's Perception about Climate Change Risks, levels of Security with Selected Demographic Variables

Demographic variables	*Chi-square value*	*DF*	*p-value*
Age (years):	4.82	6	.567
Gender	5.65	2	.059
Marital status	1.73	2	.420
Education Level	7.92	10	.637
What do you do whole day?	1.52	6	.958
Income source	1.62	4	.806
Land preparation	1.03	4	.906
Ploughing per year	0.33	2	.850
Water source availability	4.17	4	.383

Source: Compiled from different sources
p≤0.05 (significant)

From the above Chi-square table we found that the p-value is greater than 0.05.So it is not significant. But null hypothesis is accepted. That means there is no association between farmer's perceptions about climate change risks, levels of security with selected demographic variables. But in case of Gender p-value is equal to 0.059 that is significant but null hypothesis is rejected that means there is association between farmer's perception about climate change risks, levels of security with selected demographic variables

Table 7: Correlation between Farmer's Perception towards Climate Change and Insecure Livelihood on Crops Production

Climate change / Insecure livelihood on crops production	r=0.96

Source: Compiled by author

The above correlation table shows that Karl-Pearson's coefficient of correlation is 0.96. So there is a high positive correlation. Crop production directly depends upon the effect of climate change.

8. CONCLUSION

There is an association between farmers' perceptions towards climate change risks with the selected demographic variables. The correlation coefficient between climate change and livelihood on crop production is 0.96. That means there is a strong positive correlation exists between climate change and adaptability. Climate change has also affected food security and sustainability of livelihood of the rural people of Rayagada and they would like to see various remedial measures initiated by the government to tackle the adverse effects of climate changes on the agriculture in their district

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