ESTIMATION OF FARMERS' PERCEPTION ON PRODUCTIVITY CHANGE DYNAMICS OF RICE IN COASTAL AGRO-ECOSYSTEM

Anshuman Jena*

S K Acharya**

Ecosystem begets, nurtures, sustains and transforms the live and live-forms. The present study has delved deeper into the congenital effect of climate change on productivity of rice in regards to coastal agro-ecosystem through estimation of agro-ecological and metrological variables. The present study also envisaged the perceptual and situation analysis of change dynamics of rice productivity by taking 19 independent variables and dependent variable, Change in Productivity (Y_5). The study has been based on a blend between participatory rural appraisal and a conventional multivariate statistical analysis including correlation coefficient, multiple regression analysis, path analysis and canonical covariate analysis. Almost every year, within a cohort of last 53 years, coastal agriculture of Odisha has experienced brunt of 40 years of drought, flood or cyclones. This has been reflected in the stagnating yield of food crops over the couple of decades, which has negated the positive impact of modern technology and fertilizer application in the operating farms. The result shows that, the variables like, Age (X_1), Family Size (X_3), Change in Consumption of Kerosene (X_6), Changing Interaction with Extension Agent (X_{15}), Changing Cropping Intensity (X_{17}), Change in average fertilizer dose (X_{19}) change pattern of watching television, listening to radio and change in education, all have been redeemed into a dependable estimator of change dynamics of productivity of rice with respect to climate change scenario.

Keywords: Climate change, Coastal agriculture, Productivity.

* PG Scholar

** Professor

Department of Agricultural Extension, Bidhan Chandra Krishi Vishwavidyalaya, West Bengal, India-741252

Introduction

Around 7600k.m of coastal lines bordering India, itself is the world's one of the largest coastal ecosystem, increasingly vulnerable to sea level simmering and global warming. Climatic conditions influence all aspects of our life and shape the physical, chemical, biological and socioeconomic environment. Globally 2.2 billion people or 39% of the world's population live within 100km of the coast and in coral reef countries, this level is even higher, with an average of 78% of people living within 100km of the coast (Bryant, 1998). Human activities are influenced to a significant extent by weather and climatic conditions and reversibly human value and cultural system also have great impact on environmental system, Climate change has been recognized globally as an ever increasing threat to our planet. The economic and social implications of global climate change are the subject of intense national and international study in present day scenario. The mean global annual temperature increased between 0.4 to 0.7^{o}C (Singh, 2008). Frequent extreme climate events during specific crop development stages, together with higher rainfall intensity and longer dry spells, may impact negatively on crop yields (Olesen, 2006).

The present study has taken care of the perceptual analysis of change dynamics along and across the age, community, occupation of the respondents. These are organically dovetailed to the ecological phenomena of the Chillika lake coastal ecosystem and her catchment areas. It supports livelihood and nutritional security of about 0.2 million local fishermen community of 14,000 fisher familiesand agriculture is characterized by 61.55% of her total catchment area.The spill of salt from Chillika lake to agricultural land may bring a prospect to shrimp culture, but isochronously a threat to agricultural crop as well. While more areas of lands are brought under shrimp culture unnecessarily, the aspects of crop economy is sure to crop shatter. So, the study envisages the problem and threat perceptions at community level about this kind of changes and all being done to model up an empirical construct on the change dynamics of Chillika Lake.

Materials and Methods:

Research locale

The village Malud and Satapada of Krushnaprasad Block and Brahmagiri and Bentapur village of Brahmagiri Block, around Chilika coastal ecosystem of Puri district of Odisha, were selected purposively and a total number of 80 respondents were selected by simple random sampling method.

Table-1: Sampling Scheme (Multistage Random Sampling)

Step	Items	Level	Approach

1	State	Odisha	Purposive
2	District	Puri	Purposive
3	Block	Krushnaprasad, Brahmagiri	Purposive
4	Village	Malud, Satapada, Brahmagiri, Bentapur	Random
5	Respondents	80	Random

After collection of data, data were processed and analysed in accordance with the outline laid down for the purpose at the time of developing the research plan. The main statistical tools and techniques used in the present study are as follows:

1. Mean 2. Standard deviation 3. Coefficient of Variance

4. Correlation of coefficient 5. Multiple regression analysis 6. Path analysis

A Pilot study was conducted before construction of data collecting schedule.

Variables and Empirical Measurement of the Variables

Variables comprise the constructed world of reality within which an individual received the stimuli and acts. The socio-personal, agro-economic, socio-ecological and communication variables are such type of variables, which determine the behaviour of an individual. Decadal observations have been carried out. **Change in variables refers to change from 1980 to 2010.**

Table-2: Independent Variables

No.	Variables	Notation	Score
1	Age	X_1	Chronological age
2	Education	X_2	Years of Schooling
3	Family Size	X_3	Number of family members
4	Family Education Status	X_4	Year of Schooling/Family
5	No. of Vehicles changed	X_5	In No.
6	Change in Consumption of Kerosene	X_6	Litre/month/family
7	Change in Consumption of Petrol	X_7	Litre/month/family
8	Changing Family Expenditure	X_8	Rupees/Month/Family size
9	Changing Expenditure Allocation on Farming	X_9	1-100 Scale
10	Changing Expenditure Allocation on Education	X_{10}	1-100 Scale
11	Changing Expenditure Allocation on Health	X_{11}	1-100 Scale
12	Change in Listening to Radio	X_{12}	In hours/month
13	Change in Watching T.V	X_{13}	In hours/month
14	Changing Interaction with Input Dealers	X_{14}	In hours/month
15	Changing Interaction with Extension Agent	X_{15}	In hours/month
16	Change in Farm Size	X_{16}	Holding/ Family size (ha.)
17	Changing Cropping Intensity	X_{17}	In %
18	Changing Cultivable Land	X_{18}	In ha.
19	Change in Fertilizer Application	X_{19}	Kg/Ha.

Dependent Variable: Change in Productivity (Y_5) - It refers to change in productivity of rice as per farmers' perception from 1980-2010 and calculated in kg/ha.

Results and Discussion

Table 3: Descriptive statistics of independent variables with respected to Mean, Standard Deviation values.

Sl.No.	Variables	Mean	SD	CV
1.	Age (X_1)	53.24	9.92	18.63
2.	Education (X_2)	4.94	4.15	84.01
3.	Family Size (X_3)	5.07	2.13	42.01
4.	Family Education Status (X_4)	6.09	2.30	37.77
5.	No. of Vehicles changed (X_5)	1.94	0.86	44.33
6.	Change in Consumption of Kerosene (X_6)	-2.30	1.23	-53.48
7.	Change in Consumption of Petrol (X_7)	8.59	10.45	121.65
8.	Changing Family Expenditure (X_8)	637.76	462.94	72.59
9.	Changing Expenditure Allocation on Farming (X_9)	3.38	10.90	322.49
10.	Changing Expenditure Allocation on Education (X_{10})	12.61	8.34	66.14
11.	Changing Expenditure Allocation on Health (X_{11})	7.05	5.66	80.28
12.	Change in Listening to Radio (X_{12})	-26.44	34.47	-130.37
13.	Change in Watching T.V (X_{13})	39.92	23.74	59.47
14.	Changing Interaction with Input Dealers (X_{14})	2.44	2.11	86.48
15.	Changing Interaction with Extension Agent (X_{15})	3.54	2.62	74.01
16.	Change in Farm Size (X_{16})	-0.14	0.30	-214.29
17.	Changing Cropping Intensity (X_{17})	51.71	27.40	52.99
18.	Changing Cultivable Land (X_{18})	0.10	0.69	690.00
19.	Change in Fertilizer Application (X_{19})	52.03	24.34	46.78

Coefficient of Correlation

Table No.4: Coefficient of Correlation(r): Change in Productivity (Y_5) vs 19 independent variables

Sl.No.	Variables	r value	Remarks
1.	Age (X_1)	0.2587	*
2.	Education (X_2)	0.0212	
3.	Family Size (X_3)	0.2961	**
4.	Family Education Status (X_4)	-0.0043	
5.	No. of Vehicles changed (X_5)	-0.1475	
6.	Change in Consumption of Kerosene (X_6)	-0.2268	*
7.	Change in Consumption of Petrol (X_7)	-0.0046	
8.	Changing Family Expenditure (X_8)	-0.1563	
9.	Changing Expenditure Allocation on Farming (X_9)	0.0484	
10.	Changing Expenditure Allocation on Education (X_{10})	-0.2165	
11.	Changing Expenditure Allocation on Health (X_{11})	-0.0737	
12.	Change in Listening to Radio (X_{12})	0.1079	

13.	Change in Watching T.V **(X_{13})**	-0.0015	
14.	Changing Interaction with Input Dealers **(X_{14})**	0.2104	
15.	Changing Interaction with Extension Agent **(X_{15})**	0.2475	*
16.	Change in Farm Size **(X_{16})**	-0.2110	
17.	Changing Cropping Intensity **(X_{17})**	0.2975	**
18.	Changing Cultivable Land **(X_{18})**	-0.1339	
19.	Change in Fertilizer Application **(X_{19})**	0.7959	**
r>0.220 significant at p=0.05(*)		r>0.287 significant at p=0.01(**)	

Table 4 presents the coefficient of correlation betweenChange in Productivity (Y_5) and 19 independent variables.

Results: It is found that variables like, Age (X_1), Family Size (X_3), Changing Interaction with Extension Agent (X_{15}), Changing Cropping Intensity (X_{17}), Change in average fertilizer dose (X_{19}), have recorded positive significant correlation where variable, Change in Consumption of Kerosene (X_6), have recorded a negative significant correlation with the dependent variable, Change in Productivity (Y_5).

Revelation: Young farmers prefer modern technologies instead of traditional, to get higher production per unit area. Acquiring knowledge on better farming in compliance with change dynamics through interacting with extension agent increases the productivity level.Also higher cropping intensity which maintains and increases nutritional status of soiland balanced fertilizer application, help to attain higher productivity. Higher cropping intensity leads toincrease better soil productivity. But those who are consuming more kerosene that means they are traditional, lagging modern technology and information, are suffering from low productivity.

Regression Analysis

Table 5: Regression analysis: Change in Productivity (Y_5) vs 19 causal variables (X_1.X_{19}) Multiple R sq.- 0.7332

S.L. No.	Variables	Beta	Beta x R	Reg. coef. B	S, error B	t value
1.	Age **(X_1)**	0.091	3.213	0.029	0.030	0.980
2.	Education **(X_2)**	0.052	0.150	0.040	0.093	0.429
3.	Family Size **(X_3)**	0.075	3.025	0.112	0.132	0.844
4.	Family Education Status **(X_4)**	0.034	-0.020	0.047	0.179	0.263
5.	No. of Vehicles changed **(X_5)**	-0.181	3.646	-0.669	0.324	2.063
6.	Change in Consumption of Kerosene **(X_6)**	-0.164	5.067	-0.425	0.249	1.706
7.	Change in Consumption of Petrol**(X_7)**	-0.120	0.075	-0.037	0.031	1.172
8.	Changing Family Expenditure **(X_8)**	-0.006	0.125	0.000	0.001	0.050
9.	Changing Expenditure Allocation on Farming **(X_9)**	-0.091	-0.598	-0.026	0.027	0.989

10	Changing Expenditure Allocation on Education **(X_{10})**	-0.249	**7.365**	-0.095	0.038	2.538
11	Changing Expenditure Allocation on Health **(X_{11})**	0.002	-0.017	0.001	0.043	0.022
12	Change in Listening to Radio **(X_{12})**	0.121	1.780	0.011	0.007	1.505
13	Change in Watching T.V **(X_{13})**	0.127	-0.025	0.017	0.012	1.362
14	Changing Interaction with Input Dealers **(X_{14})**	0.003	0.091	0.005	0.132	0.036
15	Changing Interaction with Extension Agent **(X_{15})**	-0.043	-1.460	-0.053	0.109	0.481
16	Change in Farm Size **(X_{16})**	-0.053	1.532	-0.570	1.001	0.569
17	Changing Cropping Intensity **(X_{17})**	0.063	2.568	0.007	0.009	0.830
18	Changing Cultivable Land **(X_{18})**	0.146	-2.672	0.674	0.513	1.315
19	Change in Fertilizer Application**(X_{19})**	0.703	**76.157**	0.092	0.011	8.046

Step-down Regression analysis **Multiple R Sq.= 0.6615**

Variable	Beta	t-value
Changing Expenditure Allocation on Education (X_{10})	-0.168	2.522
Change in average fertilizer dose (X_{19})	0.785	11.823

The table 5 presents the Regression Analysis to estimate the causal effects of 19 exogenous variables on the respective consequent variable, Change in Productivity (Y_5).

Result: It has been found that the variables like Expenditure Allocation on Education (X_{10}), Change in Fertilizer Application (X_{19}), have contributed to the extent of 7.37 percent and 76.16 percent of variance to the total R sq. value.Change in Fertilizer Application (X_{19}) has been greatly contributed to change in productivity.

Revelation: Change in fertilizer application affect the production and productivity level of field crops. Day by day, higher in fertilizer application results the higher productivity. Change in expenditure on education leads to change in knowledge level of farmers through various training and out world exposure. Acquiring more knowledge on new technologies and methods, varieties, soil and appropriate way of application of knowledge, increases the productivity level. Higher level knowledge make the farmer aware about nutritional status of his soil that leads to balanced fertilizer application which ultimately gives more production per unit area.

Therefore, these two variables can be indicator variables to measure the Change in Productivity level. The R-sq. value is 0.7332 which implies that with the combination of 19 exogenous variables, 73.32% of variance embedded in consequent variable, Change in Productivity (Y_5).

Path Analysis

Table 6: Path Analysis: Direct, Indirect and Residual effect; Change in Productivity (Y_5) Vs 19 Exogenous Variables (X_1-X_{19})Residual effect= 0.2668

Variables	Total Effect (r)	Direct Effect (DE)	Indirect Effect (IE)=r-DE	Highest Indirect Effect
Age (X_1)	0.2587	0.0911	0.1676	0.1532(X19)
Education (X_2)	0.0212	0.0521	-0.0309	-0.0583(X10)
Family Size (X_3)	0.2961	0.0749	0.2212	0.1892(X19)
Family Education Status (X_4)	-0.0043	0.0341	-0.0384	-0.0780(X10)
No. of Vehicles changed (X_5)	-0.1475	-0.1813	0.0338	0.0755(X6)
Change in Consumption of Kerosene (X_6)	-0.2268	-0.1638	-0.0630	-0.1477(X19)
Change in Consumption of Petrol (X_7)	-0.0046	-0.1199	0.1153	0.0597(X6)
Changing Family Expenditure (X_8)	-0.1563	-0.0058	-0.1505	-0.1100(X19)
Changing Expenditure Allocation on Farming (X_9)	0.0484	-0.0906	0.1390	0.1411(X10)
Changing Expenditure Allocation on Education(X_{10})	-0.2165	-0.2495	0.0330	0.05132(X9)
Changing Expenditure Allocation on Health (X_{11})	-0.0737	0.0017	-0.0754	-0.0587(X10)
Change in Listening to Radio (X_{12})	0.1079	0.1210	-0.0131	-0.0653(X6)
Change in Watching T.V (X_{13})	-0.0015	0.1270	-0.1285	-0.0731(X10)
Changing Interaction with Input Dealers(X_{14})	0.2104	0.0032	0.2072	0.2031(X19)
Changing Interaction with Extension Agent(X_{15})	0.2475	-0.0432	**0.2907**	0.2745(X19)
Change in Farm Size (X_{16})	-0.2110	-0.0532	-0.1578	-0.1495(X19)
Changing Cropping Intensity (X_{17})	0.2975	0.0633	0.2342	0.2263(X19)
Changing Cultivable Land (X_{18})	-0.1339	0.1463	-0.2802	-0.1175(X18)
Change in Fertilizer Application (X_{19})	0.7959	**0.7016**	0.0943	0.0345(X6)

Table 6 explains the Path Analysis to depict the Total Direct Effect, Total Indirect Effect and Residual Effect of 19 exogenous variables on the consequent variableY_5.

The table elucidates that variable, Change in Fertilizer Application (X_{19}), has exerted the highest Direct Effect, whereas Changing Interaction with Extension agent (X_{15}), has exerted the Highest Indirect Effect on consequent variable. Increase in fertilizer application, increases the productivity level and the opposite prevails. So, it has got a direct effect on productivity. More interaction with extension agent makes the farmers capable of acquiring new information and modern technologies, by the help of which more productivity can be attained.The variable, Change in average fertilizer dose (X_{19}), finds maximum no. of indirect effect i.e. 8 times on the resultant variable, Change in Productivity (Y_5). As per people's perception, fertilizer application greatly influences the productivity.

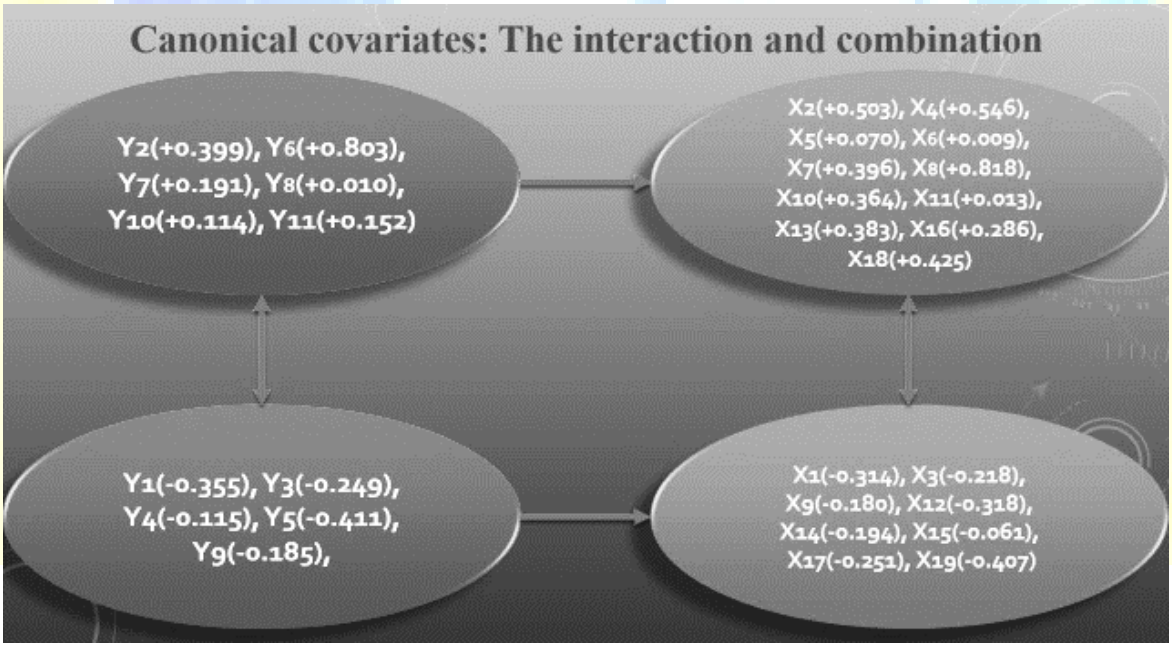
The residual effect is 0.2668, it is to conclude that even with the combination of 19 exogenous variables, 26.88% of variance embedded with consequent variable, Change in Productivity (Y_5), couldn't be expressed.

Canonical covariates: The interaction and combination

Canonical covariate analysis has been carried out to depict the clandestine interaction and combination between two sets of variable i.e. Left and Right sets of variables. This analysis has got tremendous strategic importance.

The model depicts that, from the left side (Set-I) variables (Y), the following consequent variables like, Change in Perceived effect of T.V. (Y_2), Change in Family income (Y_6), Change in Weed diversity (Y_7), Change in Crop Disease intensity (Y_8), Perceived Climate change effect (Y_{10}), Perceived Climate change effect on Agriculture ($_{11}$), have shown clear choices to select the following exogenous variables i.e. from the right sets of variables like, Education (X_2), Family Education Status (X4), No. of Vehicles changed (X_5) , Change in Consumption of Kerosene (X_6), Change in Consumption of Petrol (X_7), Changing Family Expenditure (X8), Changing Expenditure Allocation on Education (X_{10}), Changing Expenditure Allocation on Health (X_{11}), Change in Watching T.V (X_{13}), Change in Farm Size (X_{16}), Changing Cultivable Land (X_{18}).

Model



The model shows that, at the first stage, the combination of consequent variables, Y_2, Y_6, Y_8, Y_{10}, Y_{11}, can be branded together as **Climate Change Perception**, that have selectively been ductile to the set **of agricultural modernity variables** (X_2, X_4, X_5, X_6, X_7, X_8, X_{10}, X_{11}, X_{13}, X_{16}, X_{18}), which again can be collectively branded as Agricultural Modernity and similarly, at the stage 2, the consequent variables like, Change in Perceived Effect of Radio (Y_1), Change in Perceived Effect of Input dealer (Y_3), Change in

Perceived Effect of Extension agent (Y_4),Change in Productivity (Y_5), Change in Insect-pest intensity (Y_9), have shown clear choices to select the following exogenous variables i.e. from the right sets of variables like, Age (X_1), Family Size (X_3), Changing Expenditure Allocation on Farming (X_9), Change in Listening to Radio (X_{12}), Changing Interaction with Input Dealers (X_{14}), Changing Interaction with Extension Agent (X_{15}), Changing Cropping Intensity (X_{17}), Change in average fertilizer dose (X_{19}). It shows that. The combination of left side variables (Y_1, Y_3, Y_4, Y_5, Y_9) can be termed as Cosmopolite Information on Productivity Factor and have been ductile to the following set of right side variables (X_1, X_3, X_9, X_{12}, X_{14}, X_{15}, X_{17}, X_{19}), which again can be branded as Family Resource and Interaction Character.

Conclusion

With the intensification of the brunt of climate change, the productivity of crop and livestock are going to be affected badly. The undulation and zig-jag course of crop production over time is a threat to ensuring food security as well as inclusive growth. The perception as well as empirical analysis show that the practicing farmers who are having more knowledge and in close contact with extension agent and active in fertilizer application, have become a good predictor of productivity changes in a response to climate change occurrences. The coastal ecosystem of Odisha especially the Chilika lake areas are undergoing faster changes in land use pattern that might again be due to expansion of tourism and urbanite echelons to at disequilibrium to the ecological Holon but it has also been well discernible that the person who are educative and culturally relegated to farming, have also become a good estimator of the impact of change dynamics.

References

Bryant, D., Burke, L., McManus, J., and Spalding, M. (1998). Reefs at Risk: A Map-based Indicator of Threats to the World's Coral Reefs. World Resources Institute. 56 pp. http://www.wri.org/wri/reefsatrisk/.

Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007: Impacts, Adaptation, and Vulnerability. Summary for Policymakers. Contribution of Working Group II to the Fourth Assessment Report of the IPCC.

Olesen, J.E., Carter, T.R., Fronzek, C.H., S., Heidmann, T., . Hickler, T., Holt, T., Minguez, M.I. (2006). Uncertainties in projected impacts of climate change on European agriculture and terrestrial ecosystems based on scenarios from regional climate models: Climate Change.

Singh, P. K. (2008). 'Climate change leads to psychiatric illness'. <http://sify.com/news/scienceandmedicine> (Apr. 08. 2008).