IMPACT OF CLIMATE CHANGE ON FARMERS' LIVELIHOOD IN A DEVELOPING COUNTRY: INDIA

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Introduction

- Agriculture and climate are mutually dependent. There is a need to understand the effect of climate change on agriculture sector both at Global as well as regional level, especially from the point of view of providing Livelihood and food security and to vulnerable section of the population.
- Some changes will affect agriculture through their direct and indirect effects on crops, soils, livestock, fisheries and pests.
- Climate change is affecting India in a big way and its impacts are many and serious erratic monsoon, changes in availability of fresh water, floods, droughts, heat waves, storms etc.

OBJECTIVES OF THE STUDY

(i) To examine the influence of climate change on cropping pattern, enterprise diversification and crop diversification.
(ii) To know the farmers perception about climate change.
(iii) To assess the influence of climate change on input use, cost of cultivation, yield levels and returns of farmers.
(iv) To study the influence of climate change on farmers livelihood in terms of changes in the income, employment, food consumption pattern and capital formation.
(v) To document the adaptation measures followed by the farmers to cope with the adverse effects of climate change.
(vi) To identify the constraints experienced by the farmers to the adverse effects of climate change.
(vii) To document the suggestions of the farmers .

AREA OF THE STUDY

- Bangalore urban district in the Eastern dry zone of Karnataka in India and is spread over a total geographical area of 17,96,838 ha covering 9.42 per cent of the geographical area of the state.
- The villages selected were Seetakempanahalli, Shanubhoganahalli, Dibburahalli and Itgalpura.
- The First two villages were selected purposively from a project area of AAS (Agromet Advisory Services) of NCMRWF (National Centre for Medium Range Weather Forecasting) which was taken up by AICRP on Agro meteorology.
- The annual average rainfall ranges from 679.1mm to 888.9mmThe rainfall pattern has two distinct peaks one in May and other in September/October.

METHODOLOGY

Primary data

- The primary data for the study were collected from the respondents by personal interview method using a pre-tested schedule.
- The data on important socio-economic characteristics, cropping pattern and enterprises of farmers, land holding, asset possession and consumption pattern, crop-wise cost and return details, perception of the farmers about the changes in climatic parameters, different adaptation measures followed by the farmers , constraints in adoption of practices and suggestions by the farmers to regarding climate change were collected from the sample farmers through personal interview.

Secondary data

- The secondary data on the weather parameters and details on cost of cultivation in the project period were collected from AICRP on Agro-meteorology, University of Agricultural Sciences, Bangalore.
- The weather data was collected for the period from 1976 to 2014.
- The data on area under various crops for Bangalore Urban district were collected for the period 2005-2014 to compute the crop diversification indices.

Analytical tools

Crop diversification

The extend and magnitude of crop diversification among AAS farmers and control farmers was examined using crop diversification indices. The Herfindhal Index (HI), Entropy Index (EI) and Modified Entropy Index (MEI) were worked out.

Descriptive statistics

The descriptive statistics like mean or averages and percentages

Probit model

- A probit model is used to study the determinants of farmer's perception about climate change.
- A bivariate probit model was employed in the study.
- The response was obtained from farmers on statements that capture the combined perception of farmers on whether there is an increase in temperature and/or scarcity of rainfall over years due to climate change.
- Stat version 10 software was used.

Logit model

- To document the adaptation measures followed by the farmers to cope with the adverse effects of climate change logit model was used.
- Adaptation is a dependent dummy variable in the data. The dummy variable was assigned a value of 1 for farmers who indicated that they had taken adaption measures in response to negative effects of climate change and a value of 0 for farmers who indicated they did not engage in any adaption measures at all in response to the negative effects of climate change.
- SPSS software was used.

RESULTS AND DISCUSSION

Socio-economic profile of the sample farmers

Sl. No	Socio-economic characteristics	AAS farmers (n=60)	Non AAS farmers (n=60)
1	Age of farmers in years	46	47
2	Farm family size in numbers	6	6
3	Farming experience in years	25	27
4	Annual family income in Rs	1,45,916.00	1,26,304.00
5	Annual income from crop production in Rs	81,016.00	71,455.00
6	Landing holding in acres	4.32	4.66
7	Number of farmers with irrigation facility	54	48
8	Number of farmers avail institutional credit facility	48	39

Crop diversification indices

SI. No.	Crop indices	AAS FARMERS		CONTROL FARMERS	
		2006-2010	2010-2015	2006-2010	2010-2015
1	Herfindal index	0.3013	**0.2267**	0.3413	0.2522
2	Entrophy index	1.5907	**1.7371**	1.4577	1.6607
3	Modified entrophy index	0.7650	**0.8354**	0.7010	0.7986

Subsidiary activities taken up by farmers

Sl. No.	Subsidiary activities	AAS farmers (n=60)		Control farmers (n=60)	
		Number	Percentage	Number	Percentage
1.	**Dairy**	60	100.00	60	100.00
2.	Poultry	21	35.00	25	41.67
3.	Poultry+ Sericulture	-	-	-	-
4.	Dairy+Poultry+Sericulture	-	-	-	-
5.	**Poultry+ Dairy**	21	35.00	25	41.67
6.	Brick making	-	-	-	-
7.	Piggery	1	1.67	-	-
8.	Petty shop	6	10.00	9	15.00
9.	Sheep/ Goat rearing	1	1.67	1	1.67
10.	Flour mill	1	1.67	-	-

Change in income of farmers

Sl. No.	Particulars	AAS farmers (n=60)		Non-AAS farmers(n=60)	
		Before 2010	After 2010	Before 2010	After 2010
1	Income from crop production	68,835.90 (61.52)	81,016.00 (55.52)	62,028.11 (62.30)	71,544 (56.65)
2	Income from subsidiary sources	43,055.21 (38.48)	64,900.00 (44.48)	37,533.5 (37.70)	54,760.00 (43.35)
	Total Income	1,11,891.1 (100)	1,45,916.0 (100)	99,561.67 (100)	1,26,304.0 (100)

Perception of changes in Rainfall of total farmers (N = 120)

Sl.No.	Statements	Response of total farmers (N = 120)			
		Agree	%	Disagree	%
1	Number of rainy days (more than 2.5mm) were more	0	0	120	100
2	Amount of rainfall was more	0	0	120	100
3	There was change in the onset timing of rainfall	92	76.67	28	23.33
4	More dry spells	120	100	0	0
5	There was changes in rainfall during crop growth (july-oct)	108	90	12	10
6	There was no changes in the rainfall pattern	4	3.33	116	96.67
7	There was deficit rainfall	118	98.33	2	1.67

Perception of changes in Temperature of total farmers (N = 120)

Sl.No:	Statements	Response of total farmers (N = 120)			
		Agree	%	Disagree	%
1	There is increase in temperature	116	96.67	4	3.33
2	Experienced more extreme temperature	118	98.33	2	1.67
3	Experienced less extreme temperature	2	1.67	118	98.33
4	Experienced scorching sunshine	116	96.67	4	3.33
5	Summer is getting hotter	108	90	12	10
6	Winter is getting colder	56	46.67	64	53.33

Results of the unseemingly related biprobit model of farmers' perception of climate change

	Perception of Rainfall				Perception of temperature			
VARIABLES	Co - efficient	Standard error	Z - value	P>|Z|	Co - efficient	Standard error	Z - value	P>|Z|
Age	-0.0707	0.1710	-0.41	0.679	0.2061	0.2326	0.89	0.376
Farming experience	0.2314	0.1109	2.08	**0.046****	0.5657	0.3051	1.85	**0.074***
Education	0.4706	0.1575	2.99	**0.003*****	0.6160	0.2461	2.50	**0.012****
Extension contact	0.3797	0.7334	0.52	0.605	-1.1940	1.6387	-0.73	0.466
Climate information	3.1390	1.5490	2.03	**0.043****	3.4880	1.96	1.77	**0.077***
Irrigation	-0.6806	0.7934	-0.86	0.390	0.8840	0.8425	1.05	0.294
Constant	-7.384	5.873	-1.26	0.209	-16.762	9.382	-1.79	**0.073***

Log likelihood = -27.52 Number of observation = 120 Athrho = -0.2772
Rho = -0.2234 chi2(1) = 3.7462 prob > chi2 = 0.052
*** significant at 1% level, ** significant at 5% level, * significant at 10% level.

Adaptation strategies followed by farmers to climate change (N = 120)

SI.No.	Adaptation measures	Adapted	%	Not adapted	%
1	Use of drought tolerant varieties	108	90.00	12	10.00
2	Practicing crop diversification	112	93.33	08	6.67
3	Cultivating short duration crops	77	64.16	43	35.84
4	Integrated farming system	106	88.33	14	11.67
5	Practicing crop rotation	72	60.00	48	40.00
6	Crop insurance	0	0	120	100.00
7	Soil conservation techniques	110	91.67	10	8.33
8	Off – farm employment	68	56.67	52	43.33
9	Practicing intercropping	28	23.33	92	76.67

Estimates of binary logit regression model based on farmers' adaptation strategies to climate change effects (n=120)

Variables	Coefficient	Standard error	z-statistic	Probability
Age	-0.001	-0.00057	1.754	**0.092***
Farming experience	0.188	0.196	0.959	0.336
Education	0.177	0.1031	1.7161	**0.096***
Farm size	0.838	0.3812	2.1977	**0.036****
Co-operatives	2.445	1.001	2.4425	**0.015****
Credit	0.821	1.039	0.790	0.430
Family income	1.454	0.805	1.806	**0.071***
Constant	-8.552	4.875	-1.754	**0.079***

Loglikelihood=63.47 McFadden R^2=0.595

*** indicates significant at 1% level, ** indicates significant at 5% level and * indicates significant at 10% level.

Garrett's ranking for the constraints expressed by the farmers.(n=120)

Sl.No.	Constraints	Garrets Scores	Garret Rank	Average Score
1	Poor transport facility	5500	X	45.83
2	Poor supply of electricity	5950	VIII	49.58
3	Higher labour wage rate (per manday)	6110	VII	50.91
4	Lack of credit/ loan from the banks	5860	IX	48.83
5	Scarcity of labour	6300	II	52.50
6	Difficult to work in the field due to severe temperature	6440	I	53.67
7	Lack of knowledge about post harvest technology	6170	V	51.41
8	Lack of knowledge regarding appropriate adaptation measures.	6150	VI	51.25
9	Higher cost of the agricultural inputs	6260	III	52.17
10	Lack of information about long term climate change	6180	IV	51.50

Suggestions to mitigate the ill effects of climate change of AAS farmers (n=60)

Sl.No.	Suggestions	More important	Important	Less important	Ignored	MSI	RANK
1	Early warning has to be given to the farmers about environmental changes	49	11	0	0	169	I
2	Creating awareness to the farmers about appropriate adaptation measures against climate change	45	15	0	0	165	II
3	Development department should ensure supplying of production inputs at appropriate time in the villages	2	30	20	6	86	VII
4	Subsidies/compensation has to be given for the crops to make up the cost of cultivation due to weather aberrations	4	32	21	5	97	III
5	Green coverage has to be increased	3	29	24	4	91	IV
6	Insurance has to be extended to all crops	2	32	20	6	90	V
7	Support price has to be given to all the crop produce based on cost of cultivation	1	22	34	3	81	IX
8	Providing financial support for soil nutrient enrichment	0	29	25	6	83	VIII
9	Creating awareness/ Support for adoption of organic farming technologies	2	30	22	4	88	VI
10	Incentives/support for increasing the green manuring	1	20	29	10	79	X

Suggestions to mitigate the ill effects of climate change of control farmers (n=60)

Sl.No.	Suggestions	More important	Important	Less important	Ignored	MSI	RANK
1	Early warning has to be given to the farmers about environmental changes	48	12	0	0	168	I
2	Creating awareness to the farmers about appropriate adaptation measures against climate change	46	14	0	0	166	II
3	Development department should ensure supplying of production inputs at appropriate time in the villages	3	29	22	6	89	VI
4	Subsidies/compensation has to be given for the crops to make up the cost of cultivation due to weather aberrations	3	33	22	2	97	III
5	Green coverage has to be increased	3	29	24	4	91	IV
6	Insurance has to be extended to all crops.	2	32	20	6	90	V
7	Support price has to be given to all the crop produce based on cost of cultivation	1	22	34	3	81	IX
8	Providing financial support for soil nutrient enrichment	0	27	26	7	82	VIII
9	Creating awareness/ Support for adoption of organic farming technologies	2	30	22	4	88	VII
10	Incentives/support for increasing the green manuring	2	20	25	10	71	X

CONCLUSION

- There is diversification of crops in both AAS and control farmers area and it may be due to the shortage of irrigation water during crop growth and increased temperature.
- The crop failures due to changes in the climatic parameters and loss in income lead through diversification of enterprises.
- The results showed that farmers with more farming experience, education and access to climate information are more likely to perceive changes in rainfall and temperature.

- The per acre cost of cultivation for most of the crops in control farmers was more than that of AAS farmers.
- This increased cost may be due to increased labor costs, increased quantity of seeds used, increased FYM and fertilizer costs because of unavailability of AAS.
- The analysis revealed that the yield levels of ragi, red gram, field bean, tomato and grapes were observed to be more for the AAS over control farmers.
- The results showed that age, education, farm size, membership in cooperatives and family income were the significant factors that influenced the adaptation strategies of farmers' to cope with climate change.
- Results showed that difficult to work in the field due to severe temperature and scarcity of labours were the major constraints of the farmers in the study area.
- Providing early warning signals to the farmers about the climate change, creating awareness among farmers about appropriate adaptation measures against climate change and provision of subsidies were the three most important suggestions given by respondent farmers.

Policy Implications

- Need to improve early warning systems about climatic parameters in order to avoid the ill effects of climate change.
- Government should provide agricultural inputs at appropriate time and insurance should be extended for all crops to sustain their lives under adverse climatic situation.
- Need for a proportionate increase in the support prices for the produces so as to make the farming profitable and support prices have to be extended to all the crops.
- As migration is a serious issue, policy makers have to initiate suitable programs to reverse the trend.
- As the farmers have initiated different adaptation measures it has to be supported by organizing training programs.
- AAS need to be developed all over the country to mitigate the effects of climate change.

THANK YOU