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An Assessment of Net Returns from Rice Production Practiced through Conventional and System of Rice Intensification (SRI) Methods in the Light of Climate Change in Bhandara District of Maharashtra, India

S. N. Panchabhai [a++], Saumyesh Acharya [b#*], T. K. Mandal [c†] and Rahul Tayade [d#]

[a] Department of Agricultural Extension, Anand Niketan College of Agriculture, Anandwan, Warora-442914, Maharashtra, India.
[b] Department of Agricultural Extension, Institute of Agriculture, Visva-Bharati University, Sriniketan-731236, West Bengal, India.
[c] Department of Agricultural Extension, BCKV, Mohanpur, Nadia-741252, West Bengal, India.
[d] Department of Extension Education, PDKV, Akola-444104, Maharashtra, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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[++]*Assistant Professor*
[#] *Ph.D. Research Scholar;*
[†] *Associate Professor;*
**Corresponding author: E-mail: acharyasaumyesh@gmail.com;*

ABSTRACT

Indian farming witnessed surplus production of cereals along with other food commodities. The production of rice across the Indian subcontinent has a subsistent impact on achieving food security and attaining judicious socio-economic growth for the farming community. However, it also faces certain challenges and difficulties. The phenomenon of climate change has been creating a menace against the sustainable growth of food crops. Due to this, it has become necessary to assess the economic impact of farmers practicing rice crops in terms of net returns from rice. By applying *ex post facto* research design, this study aimed to estimate the inter and intra-level of interaction between sets of predicted variables, Net returns from rice (both conventional and SRI methods), and predictor variables (x_1-x_{35}) and to generate policy at the micro-level. To conduct the study, the State, District, Blocks, and Villages were selected using purposive sampling techniques. Two hundred (200) respondents were selected from two talukas of the Bhandara district of Maharashtra using a simple random sampling method. For the purpose of data analysis, following statistical tools were used: Coefficient of Correlation, Stepwise regression analysis and Path analysis. The correlation coefficients found that farmers having a higher level of education have been showcasing higher net returns from rice produced by conventional methods. Regression results implied that 35 causal variables together have contributed 32 percent and 83.8 percent of the variance in the consequent variable, net returns from rice (y) practiced by conventional and SRI methods respectively. The results of a path analysis revealed that the variable farm size has got the highest indirect individual effect on net returns from rice practiced by both the conventional and SRI methods.

Keywords: Cereals; climate change; conventional method; economic impact; food security; net returns from rice; rice production; SRI Method.

1. INTRODUCTION

Climate change has grasped the whole world in its drastic clutches and posed a serious threat to the farm ecosystem across the horizons.

The continual change in various abiotic factors influences the farm ecology in adverse ways. There is an increased demand to evolve newer strategies to effectively manage the distortions in clamatorial conditions.

Climate change may affect the environment, food production, the well-being of humans, livestock, hydropower generation and tourism, and the economy as a whole. The agricultural effects of climate change have received considerable attention [1-7]. The integrated responses of various eco-physiological processes to a variety of environmental conditions, such as temperature, CO2, nutrients, water, and agronomic management, are what allows plants to grow and develop in an agricultural system [8]. Furthermore, crop production patterns may change as climatic conditions change because different crops respond differently to climatic changes [1]. The four main extreme climatic events that have negatively impacted agricultural production as cyclones, floods, soil salinity, and droughts [9]. Extreme rainfall can affect rice yields, and both inadequate and excessive rainfall can increase variability [10]. Due to the sensitivity of agriculture-based livelihoods to climate change, it has been affecting the equilibrium between agriculture and livelihoods [11].

Rice yields can be negatively impacted by higher temperatures in two ways: (i) high maximum temperatures that, when combined with high humidity, result in spikelet sterility and negatively impact grain quality; and (ii) higher temperatures during the night time that could reduce assimilate accumulation [12]. It has also been noted that a 1°C increase in temperature can result in a 3% decrease in rice production, and a 1°C decrease in rainfall can result in a 0.01% decrease in production [13]. Many nations are experimenting with the System of Rice Intensification (SRI), making various adjustments based on their priorities, to increase productivity while also lowering the water requirement for rice cultivation [14]. With this background, the study aimed to estimate the inter and intra-level of interaction between sets of predicted variables, Net returns from rice, and predictor variables (x_1-x_{35}).

2. MATERIALS AND METHODS

2.1 Sampling Design

Keeping in view agriculturally, areas that were socio-economically backward and areas facing major climate change impact on rice production both through SRI (System of rice intensification) and conventional method of cultivation, Bhandara district in Maharashtra was selected for the study**.** Purposive sampling was carried out in two talukas of Bhandara i.e., Bhandara and Sakoli. From each taluka, 4 villages were purposively selected i.e., 8 villages in total were selected from these two talukas. Purposive as well as simple random sampling techniques were adopted for the study. For the selection of State, District, Blocks, and Villages purposive sampling techniques was adopted because the area was ideal concerning the problem, convenient for the researcher, and had the infrastructural facilities in case of selection of farmers or respondents simple random sampling technique was taken up. A total number of 200 respondents were selected for the interaction and collection of data. Among 200 farmers (Conventional method/SRI method), 100 farmers have been randomly selected from the selected villages of Sakoli block where the SRI method is predominantly used and another 100 farmers have been randomly selected from the selected villages of Bhandara block where only conventional method is used.

Table 1. Independent variables selected for the study

1	Age(X_1)
2	Education (X_2)
3	Family education status (X_3)
4	Primary occupation (X_{41})
5	Secondary occupation (X_{42})
6	Caste (X_5)
7	Family type(X_6)
8	Family size (X_7)
9	Family income primary (X_{81})
10	Family income secondary (X_{82})
11	Farm size(X_9)
12	Social participation (X_{10})
13	Risk orientation (X_{11})
14	Index of farm mechanization (X_{12})
15	Cropping intensity (X_{13})
16	Selling% (X_{14})
17	Debt (X_{15})
18	Migration (X_{16})
19	Mass media exposure (X_{17})
20	Utilization of personal cosmopolite sources of information (X_{18})
21	Utilization of personal localite sources of information (X_{19})
22	Contact with extension personal (X_{20})
23	Seed rate% (X_{21})
24	Fertilizer% (X_{22})
25	Pesticide% (X_{23})
26	Weed management%(X_{24})
27	Water management% (X_{25})
28	Irrigation index% (X_{26})
29	Sowing time (X_{27})
30	Varietal change (X_{28})
31	Farm power (X_{29})
32	Change in rainfall pattern over last 20 years (X_{30})
33	Change pattern in temperature (day/night) over last 20 years (X_{31})
34	Change pattern in weather disaster over last 20 years (X_{32})
35	Change in seasonal pattern over last 20 years (X_{33})
36	Change pattern in insect/ pests & diseases over last 20 years (X_{34})
37	Change pattern in weed problem over last 20 years (X_{35})

2.2 Selection of Variables and Statistical Tools

The selected variables for this study had been operationalized and measured in the following manner:

I) The list of Independent variables selected for the study is listed in Table 1.
II) Dependent variable selected for the study was Net returns from rice (y) which has been measured separately for both rice production through conventional and System of Rice Intensification (SRI) methods.

Using IBM SPSS v26.0, the following statistical tools have been used to carry out the study viz, Correlation coefficient, Multiple regression analysis, Step wise regression analysis and Path analysis.

2.3 Method of Data Collection

The respondents were interviewed personally. The medium of communication was Marathi, which facilitated data collection in the state of Maharashtra. Secondary data relating to the demographic features of the state has been collected from published materials so far available from the State Agricultural Department, KVK, Census reports, and the Directorate of Economics and Statistics of Maharashtra state. Data related to the climate were collected from available on the internet and some important data were collected from literature and books.

3. RESULTS AND DISCUSSION

3.1 Coefficient of Correlation (r): Net Returns from Rice (y) Practiced by Conventional Method vs. 35 Independent Variables (x_1-x_{35})

Table 2 presents the correlation between net returns from rice (Y) practiced by the conventional method and 35 independent variables. It has been found that the variables, farm size, water management%, and irrigation index% have recorded a significant and positive correlation with the dependent variable with 1% level of significance, while the variable secondary occupation has recorded a significant and negative correlation with the dependent variable net returns from rice with 1% level of significance. The variable education, social participation, and weed management % have recorded a significant and positive correlation with the dependent variable net returns from rice with 5% level of significance, while the variables, migration and varietal change have recorded a significant and negative correlation with the dependent variable net returns from rice with 5% level of significance.

3.2 Coefficient of Correlation (r): Net Returns from Rice (y) Practiced by SRI Method vs. 35 Independent Variables (x_1-x_{35})

Table 3 presents the correlation between net returns from rice (Y) practiced by SRI method and 35 independent variables. It has been found that the variables, primary occupation, family income primary and farm size, have recorded a significant and positive correlation with the dependent variable net returns from rice with 1% level of significance, while the variables, secondary occupation, cropping intensity and migration have recorded a significant and negative correlation with the dependent variable net returns from rice with 1% level of significance. The variable weed management% has recorded a significant and positive correlation with the dependent variable with 5% level of significance**,** while the variable age has recorded a significant and negative correlation with the dependent variable net returns from rice (Y) with 5% level of significance.

Similar studies have found that there is need for rice farmers to adopt artificial irrigation [15] and level of education [16] in order to mitigate the effect of climate change for optimum rice productivity.

3.3 Stepwise Regression Analysis: Net returns from rice (y) practiced by conventional method Vs. 35 Independent Variables (x_1-x_{35})

From Table 4, it has been concluded that net returns from rice (Y) practiced by conventional method is explained by the variable irrigation index% (X_{26}), social participation (X_{10}) and the variable weed management% (X_{24}) with their positive contribution towards net returns from rice (Y) in the light of climate change, while the variable secondary occupation (X_{42}) shows a negative impact towards reducing the magnitude of net returns from rice (Y) in the light of climate change. Total variance explained by such equation is 32% and all predictors in this equation have resulted significant regression coefficient to explain net returns from Rice (Y) in the light of climate change.

Table 2. Coefficient of correlation (r): Net returns from rice (y) practiced by conventional method Vs. 35 independent variables (x_1-x_{35})

(n=100)

Sl. No.	Independent Variables	'r' Value	Remarks
1	Age(X_1)	-0.1005	
2	Education (X_2)	**0.2067**	*
3	Family education status (X_3)	-0.1113	
4	Primary occupation (X_{41})	0.1442	
5	Secondary occupation (X_{42})	**-0.3941**	**
6	Caste (X_5)	0.1450	
7	Family type(X_6)	0.1131	
8	Family size (X_7)	0.1508	
9	Family income primary (X_{81})	0.1132	
10	Family income secondary (X_{82})	0.0010	
11	Farm size(X_9)	**0.3499**	**
12	Social participation (X_{10})	**0.2223**	*
13	Risk orientation (X_{11})	0.1937	
14	Index of farm mechanization (X_{12})	0.0069	
15	Cropping intensity (X_{13})	-0.0296	
16	Selling% (X_{14})	0.1717	
17	Debt (X_{15})	-0.1431	
18	Migration (X_{16})	**-0.2450**	*
19	Mass media exposure (X_{17})	0.0004	
20	Utilization of personal cosmopolite sources of information (X_{18})	0.0676	
21	Utilization of personal localite sources of information (X_{19})	0.1146	
22	Contact with extension personal (X_{20})	0.1693	
23	Seed rate% (X_{21})	-0.0998	
24	Fertilizer% (X_{22})	0.0579	
25	Pesticide% (X_{23})	0.0394	
26	Weed management%(X_{24})	**0.2122**	*
27	Water management% (X_{25})	**0.3430**	**
28	Irrigation index% (X_{26})	**0.3819**	**
29	Sowing time (X_{27})	0.0269	
30	Varietal change (X_{28})	**-0.2043**	*
31	Farm power (X_{29})	-0.0041	
32	Change in rainfall pattern over last 20 years (X_{30})	0.0346	
33	Change pattern in temperature (day/night) over last 20 years (X_{31})	0.1056	
34	Change pattern in weather disaster over last 20 years (X_{32})	-0.1088	
35	Change in seasonal pattern over last 20 years (X_{33})	-0.0554	
36	Change pattern in insect/ pests & diseases over last 20 years (X_{34})	-0.0745	
37	Change pattern in weed problem over last 20 years (X_{35})	0.0495	

***Correlation is significant at the 0.01 level*
**Correlation is significant at the 0.05 level*

Table 3. Coefficient of correlation (r): Net returns from rice (y) practiced by SRI Method vs. 35 independent variables (x_1-x_{35})

(n=100)

Sl. No.	Independent Variables	'r' Value	Remarks
1	Age (X_1)	**-0.2768**	*
2	Education (X_2)	0.1731	
3	Family education status (X_3)	0.0858	
4	Primary occupation (X_{41})	**0.3312**	**
5	Secondary occupation (X_{42})	**-0.2665**	**
6	Caste (X_5)	0.1262	
7	Family type(X_6)	-0.0523	
8	Family size (X_7)	-0.0320	
9	Family income primary (X_{81})	**0.4172**	**
10	Family income secondary (X_{82})	0.0740	
11	Farm size (X_9)	**0.8902**	**
12	Social participation (X_{10})	0.0336	
13	Risk orientation (X_{11})	0.1481	
14	Index of farm mechanization (X_{12})	-0.0198	

Sl. No.	Independent Variables	'r' Value	Remarks
15	Cropping intensity (X_{13})	**-0.2767**	**
16	Selling% (X_{14})	-0.1215	
17	Debt (X_{15})	-0.1764	
18	Migration (X_{16})	**-0.3646**	**
19	Mass media exposure (X_{17})	0.1880	
20	Utilization of personal cosmopolite sources of information (X_{18})	0.0033	
21	Utilization of personal localite sources of information (X_{19})	-0.1826	
22	Contact with extension personal (X_{20})	0.1014	
23	Seed rate% (X_{21})	0.0547	
24	Fertilizer% (X_{22})	-0.0298	
25	Pesticide% (X_{23})	-0.0974	
26	Weed management% (X_{24})	**0.2064**	*
27	Water management% (X_{25})	-0.1018	
28	Irrigation index% (X_{26})	0.0169	
29	Sowing time (X_{27})	0.0873	
30	Varietal change (X_{28})	-0.1596	
31	Farm power (X_{29})	-0.1147	
32	Change in rainfall pattern over last 20 years (X_{30})	-0.1821	
33	Change pattern in temperature (day/night) over last 20 years (X_{31})	0.0692	
34	Change pattern in weather disaster over last 20 years (X_{32})	0.1240	
35	Change in seasonal pattern over last 20 years (X_{33})	-0.1564	
36	Change pattern in insect/ pests & diseases over last 20 years (X_{34})	-0.0372	
37	Change pattern in weed problem over last 20 years (X_{35})	-0.0525	

***Correlation is significant at the 0.01 level*
**Correlation is significant at the 0.05 level*

Table 4. Best fitted regression equation following stepwise model of multiple regression equation for selecting most significant variables having prominent regression impact on consequent variable Net returns from rice (Y)

Dependent variable(Y)	Regression equation (Stepwise)	Variable	R^2	Adj.R^2	SE(est.)	Ranking of important dependent regressors
Net returns from rice in conventional method of rice (n=100)	**Y**=-8213.66-2234.59X_{42}+186.38 X_{26} + 2604.81 X_{10} + 99.45 X_{24}	(X_{42})- Secondary occupation (X_{26})- Irrigation index% (X_{10})- Social participation (X_{24})- Weed management%	0.32	0.292	12657.83	$Y=X_{42}>X_{26}>X_{10}>X_{24}$
Net returns from Rice in SRI method of rice (n=100)	**Y**=-4593.22+ 14811.56 X_9 - 15631 X_{16} + 1.14 X_{81} – 3252.32 X_{19}	(X_9)- Farm size (X_{16})-Migration (X_{81})-Family income primary (X_{19})- Utilization of personal localite sources of information	0.838	0.831	11891.36	$Y=X_9>X_{16}>X_{81}>X_{19}$

3.4 Stepwise Regression Analysis: Net returns from rice (y) practiced by SRI method Vs. 35 Independent Variables (x_1-x_{35})

From Table 4, It has also been found that net returns from rice (Y) practiced by SRI method is explained by the variable farm size (X_9) and family income primary (X_{81}) with their positive contribution towards net returns from rice (Y) in the light of climate change, while the variable migration (X_{16}) and utilization of personal localite sources of information (X_{19}) with its negative impact towards reducing the magnitude of net returns from rice (Y_1) in the light of climate change. Total variance explained by such equation is 83.80% and all predictors in this equation have resulted significant regression coefficient to explain net returns from rice (Y_1) in the light of climate change.

Similar results revealed that change in temperature due to climate change causes a reduction in rice production which, in turn, has a positive impact on the propensity to migrate [17].

Table 5. Path analysis: Decomposition of total effect into direct, indirect and residual effect: Net returns from rice (y) practiced by conventional method Vs. 35 independent variables (x_1-x_{35})

(n=100)

Variables	Total Effect	Total Direct Effect	Total Indirect Effect	Substantial Indirect Effect		
				I	II	III
Age (X_1)	-0.101	-0.008	-0.093	0.050461 X_{22}	0.038142 X_{34}	**0.024318 X_9**
Education (X_2)	0.207	0.092	0.114	0.093507 X_{10}	**0.079021 X_9**	0.049161 X_{26}
Family education status (X_3)	-0.111	-0.034	-0.077	0.057898 X_6	0.047439 X_{26}	0.029053 X_{82}
Primary Occupation (X_{41})	0.144	-0.122	0.266	0.205419 X_{42}	**0.092886 X_9**	0.040631 X_6
Secondary occupation (X_{42})	-0.394	-0.344	-0.050	0.085102 X_{13}	0.072809 X_{41}	0.037559 X_{82}
Caste (X_5)	0.145	-0.017	0.162	0.034745 X_{10}	0.03067 X_{35}	0.025095 X_{13}
Family type(X_6)	0.113	-0.275	0.388	0.182845 X_7	0.058651 X_{31}	0.049156 x_{26}
Family Size (X_7)	0.151	0.207	-0.056	0.050021 X_{31}	0.042354 X_{81}	0.03618 X_{13}
Family income primary (X_{81})	0.113	-0.115	0.228	**0.178556 X_9**	0.091007 X_6	0.060692 X_{82}
Family income secondary (X_{82})	0.001	0.119	-0.118	0.047749 X_{26}	0.034857 X_6	0.026017 X_{41}
Farm size (X_9)	0.350	**0.385**	-0.035	0.157644 X_{42}	0.047867 X_{10}	0.037771 x_{22}
Social participation (X_{10})	0.222	0.168	0.054	**0.109359 X_9**	0.051297 X2	0.040892 X_{42}
Risk orientation (X_{11})	0.194	0.066	0.128	0.08647 X_{26}	0.070288 X_{42}	**0.054685 X_9**
Index of farm mechanization (X_{12})	0.007	-0.221	0.227	**0.164071 X_9**	0.057954 X_{42}	0.032818 X_{17}
Cropping intensity (X_{13})	-0.030	0.283	-0.313	0.058998 X_{26}	0.049849 X_{12}	0.02796 X18
Selling% (X_{14})	0.172	0.116	0.056	**0.069508 X_9**	0.031568 X_7	0.026251 X_{26}
Debt (X_{15})	-0.143	-0.121	-0.022	0.030023	0.027022	0.019644

Variables	Total Effect	Total Direct Effect	Total Indirect Effect	Substantial Indirect Effect		
				I	**II**	**III**
				X_{31}	X_{42}	X_{10}
Migration (X_{16})	-0.245	0.075	-0.320	0.053516 X_{31}	0.042204 X_{81}	0.041259 X_{25}
Mass media exposure (X_{17})	0.000	-0.143	0.144	0.050577 X_{12}	**0.039217** $\mathbf{X_9}$	0.033267 X_{31}
Utilization of personal cosmopolite sources of information (X_{18})	0.068	0.239	-0.171	0.034258 X_{41}	0.033206 X_{13}	0.023246 X_{29}
Utilization of personal localite sources of information (X_{19})	0.248	0.145	0.103	**0.089573** $\mathbf{X_9}$	0.088865 X_{26}	0.083711 X_{42}
Contact with extension personal (X_{20})	0.169	0.187	-0.018	0.03722 X_7	0.029089 X_{31}	0.016912 X_2
Seed rate% (X_{21})	-0.100	-0.021	-0.079	0.025743 X_{17}	0.021779 X_{13}	0.016042 X_{29}
Fertilizer% (X_{22})	0.058	0.237	-0.179	**0.061276** $\mathbf{X_9}$	0.049328 X_6	0.033698 X_{42}
Pesticide% (X_{23})	0.039	0.189	-0.150	0.042549 X_6	0.031551 X_{12}	0.021048 X_{28}
Weed management% (X_{24})	0.212	0.089	0.123	**0.093908** $\mathbf{X_9}$	0.090732 X_{42}	0.029376 X_{22}
Water management% (X_{25})	0.343	-0.078	**0.421**	0.222624 X_{26}	**0.12406** $\mathbf{X_9}$	0.082328 X_{42}
Irrigation index% (X_{26})	**0.382**	0.303	0.079	0.068888 X_{42}	0.055177 X_{13}	**0.045536** $\mathbf{X_9}$
Sowing time (X_{27})	0.027	0.047	-0.020	0.042204 X_{26}	0.021819 X_{42}	0.017601 X_6
Varietal change (X_{28})	-0.204	-0.083	-0.121	0.033278 X_{18}	0.026904 X_{29}	0.026675 X_6
Farm power (X_{29})	-0.004	-0.107	0.103	0.047707 X_{35}	0.043136 X_{31}	**0.031968** $\mathbf{X_9}$
Change in rainfall pattern over last 20 years (X_{30})	0.035	0.023	0.011	0.037481 X_6	0.034973 X_{22}	**0.030727** $\mathbf{X_9}$
Change pattern in temperature(day/night) over last 20 years (X_{31})	0.106	0.282	-0.176	0.036631 X_7	**0.022797** $\mathbf{X_9}$	0.019299 X_{20}
Change pattern in weather disaster over last 20 years (X_{32})	-0.109	-0.047	-0.062	0.022193 X_{17}	0.019371 X_{18}	0.018061 X_{31}
Change in seasonal pattern over last 20 years (X_{33})	-0.055	0.052	-0.107	0.031031 X_{18}	0.020766 X_{15}	0.019708 X_{31}

Variables	Total Effect	Total Direct Effect	Total Indirect Effect	Substantial Indirect Effect		
				I	II	III
Change pattern in insect/ pests & diseases over last 20 years (X_{34})	-0.074	-0.147	0.073	0.034529 X_{26}	0.029342 X_{35}	0.019712 X_6
Change pattern in weed problem over last 20 years (X_{35})	0.049	0.182	-0.133	**0.033175 X_9**	0.024848 X_7	0.017605 X_{42}

Residual effect: 0.62; Highest Indirect Individual effect: x_9 (18)

Table 6. Path analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Net returns from rice (y) practiced by SRI method Vs. 35 Independent Variables (x_1-x_{35})

(n=100)

Variables	Total Effect	Total Direct Effect	Total Indirect Effect	Substantial Indirect Effect		
				I	II	III
Age (X_1)	-0.277	-0.079	-0.198	0.013898 X_7	0.009886 $X1_7$	0.008093 X_{82}
Education (X_2)	0.173	0.076	0.097	**0.084253 X_9**	0.033553 X_{81}	0.022326 X_{16}
Family education status (X_3)	0.086	-0.012	0.098	**0.034737 X_9**	0.029563 X_{81}	0.027042 X_7
Primary occupation (X_{41})	0.331	-0.033	**0.364**	**0.301802 X_9**	0.021971 X_2	0.01883 X_{81}
Secondary occupation (X_{42})	-0.267	0.000	-0.266	0.016233 X_{41}	0.013111 X_2	0.010767 X_{31}
Caste (X_5)	0.126	0.049	0.078	**0.075889 X_9**	0.017325 X_{15}	0.015955 X_{33}
Family type (X_6)	-0.052	0.003	-0.055	**0.065032 X_9**	0.01691 X_1	0.012435 X_{28}
Family size (X_7)	-0.032	-0.066	0.034	**0.073011 X_9**	0.016614 X_1	0.013109 X_{28}
Family income primary (X_{81})	0.417	0.146	0.271	**0.248899 X_9**	0.024498 X_7	0.017467 X_2
Family income secondary (X_{82})	0.074	-0.077	0.151	0.063176 X_{81}	**0.024709 X_9**	0.021541 X_2
Farm size (X_9)	**0.890**	**0.794**	0.096	0.045717 X_{81}	0.020543 X_1	0.017386 X_{16}
Social participation (X_{10})	0.034	-0.010	0.043	**0.033659 X_9**	0.027219 X_2	0.020563 X_{81}
Risk orientation (X_{11})	0.148	0.053	0.095	**0.071036**	0.013976	0.011645

Variables	**Total Effect**	**Total Direct Effect**	**Total Indirect Effect**	**Substantial Indirect Effect**		
				I	**II**	**III**
				X_{9}	X_{15}	X_{34}
Index of farm mechanization (X_{12})	-0.020	-0.037	0.017	0.023721 X_{11}	0.019755 X_{31}	0.013475 X_{34}
Cropping intensity (X_{13})	-0.277	-0.058	-0.218	0.019345 X_{28}	0.014604 X_{82}	0.009872 X_{25}
Selling% (X_{14})	-0.122	-0.053	-0.068	0.018768 X_{81}	0.010222 X_{31}	0.008645 X_{28}
Debt (X_{15})	-0.176	-0.083	-0.093	0.01632 X_{82}	0.009303 X_{23}	0.009301 X_{35}
Migration (X_{16})	-0.365	-0.071	-0.293	0.013274 X_{17}	0.010461 X_{19}	0.007291 X_{23}
Mass media exposure (X_{17})	0.188	-0.070	0.258	**0.157307** **X_{9}**	0.046006 X_{2}	0.031006 X_{81}
Utilization of personal cosmopolite sources of information (X_{18})	0.003	-0.033	0.036	**0.01642** **X_{9}**	0.015092 X_{33}	0.013099 X_{82}
Utilization of personal localite sources of information (X_{19})	-0.183	-0.089	-0.093	0.012472 X_{26}	0.011099 X_{5}	0.008334 X_{16}
Contact with extension personal (X_{20})	0.101	0.008	0.093	**0.083665** **X_{9}**	0.018205 X_{14}	0.018155 X_{1}
Seed rate% (X_{21})	0.055	0.025	0.030	0.021658 X_{15}	**0.014893** **X_{9}**	0.012699 X_{1}
Fertilizer% (X_{22})	-0.030	0.058	-0.088	0.008726 X_{24}	0.007971 X_{28}	0.006667 X_{29}
Pesticide% (X_{23})	-0.097	-0.077	-0.020	0.012696 X_{28}	0.010044 X_{15}	0.006715 X_{16}
Weed management% (X_{24})	0.105	0.067	0.038	0.013777 X_{16}	0.011666 X_{2}	0.009834 X_{26}
Water management% (X_{25})	-0.102	0.059	-0.161	0.018149 X_{23}	0.016786 X_{34}	0.008972 X_{82}
Irrigation index% (X_{26})	0.017	0.074	-0.057	0.035592 X_{16}	0.030976 X_{81}	0.017052 X_{2}
Sowing time (X_{27})	0.087	0.031	0.056	**0.082595** **X_{9}**	0.017187 X_{81}	0.010126 X_{13}
Varietal change (X_{28})	-0.160	0.065	-0.225	0.007107 X_{22}	0.006569 X_{11}	0.004503 X_{82}
Farm power (X_{29})	-0.115	-0.030	-0.085	0.014944 X_{31}	0.014592 X_{26}	0.011066 X_{1}

Variables	**Total Effect**	**Total Direct Effect**	**Total Indirect Effect**	**Substantial Indirect Effect**		
				I	**II**	**III**
Change in rainfall pattern over last 20 years (X_{30})	-0.182	-0.019	-0.164	0.022238 X_{28}	0.016657 X_{19}	0.015059 X_{34}
Change pattern in temperature(day/night) over last 20 years (X_{31})	0.069	0.113	-0.044	0.00792 X_{7}	0.005201 X_{24}	0.005188 X_{41}
Change pattern in weather disaster over last 20 years (X_{32})	0.124	-0.007	0.131	**0.10931** **X_{9}**	0.016846 X_{34}	0.01222 X_{15}
Change in seasonal pattern over last 20 years (X_{33})	-0.156	-0.061	-0.095	0.014101 X_{81}	0.011894 X_{31}	0.008179 X_{18}
Change pattern in insect/ pests & diseases over last 20 years (X_{34})	-0.037	-0.075	0.038	**0.02375** **X_{9}**	0.009911 X_{5}	0.008796 X_{82}
Change pattern in weed problem over last 20 years (X_{35})	-0.053	0.039	-0.091	0.0077 X_{22}	0.006664 X_{1}	0.005849 X_{7}

Residual effect: 0.32; Highest Indirect Individual effect: x_9 (17)

3.5 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Net returns from rice (y) practiced by conventional method Vs. 35 Independent Variables (x_1-x_{35})

Table 5 presents the path analysis to explain the direct, indirect and residual effect of exogenous variables on consequent variables i.e., net returns from rice cultivation (Y) practiced by conventional method in the light of climate change.

It has been observed that the variable, farm size (X_9) exerts highest direct effect and the variable, water management % (X_{25}) exerts highest indirect effect on net returns from rice cultivation over the other 35 exogenous variables in the light of climate change. The variable, farm size (X_9) has been found to channelize the substantial indirect effect of, as many as, 18 times to define its tremendous impact over the other exogenous variables to ultimately characterize the performance of consequent variable.

As the residual effect is 62%, it could be concluded that with the combination of 35 variables in this investigation in the form of exogenous variables had been able to explain 38% of the variation in the consequent variable i.e., net returns from rice cultivation practiced by conventional method in the light of climate change.

3.6 Path Analysis: Decomposition of Total Effect into Direct, Indirect and Residual Effect: Net returns from rice (y) practiced by conventional method vs. 35 Independent Variables (x_1-x_{35})

Table 6 presents the path analysis to explain the direct, indirect and residual effect of exogenous variables on consequent variables i.e., net returns from rice cultivation (Y) practiced by SRI method in the light of climate change.

The above results found that the variable, farm size (X_9) exerts highest direct effect whereas the variable, primary occupation (X_{41}) exerts highest indirect effect on net returns from rice cultivation over the other 35 exogenous variables in the light of climate change. The variable, farm size (X_9) has been found to characterize the substantial indirect effect of, as many as, 17 times to extend its wider impact over the other exogenous variables to ultimately characterize the performance of consequent variable.

The residual effect being 32%, it could be concluded that the combination of 35 variables in this investigation in the form of exogenous variables had been able to explain 68% of the variation in the consequent variable i.e., net returns from rice cultivation practiced by SRI method in the light of climate change.

These results are in contrast with those of the study conducted by Bello in which farm size have been found to have a significant correlation with adaptation to climate change among rice farmers in Western Zone of Bauchi State, Nigeria [18].

4. CONCLUSION

The study focused on assessing the net returns from rice production in light of climate change by comparing both the conventional and SRI methods. The results indicated that variables like family size, weed management %, social participation, and migration among others are playing a significant role in receiving net returns from producing rice in the context of climate change. It is evident that various mitigating steps have to be taken in order to provide safe and secure livelihood opportunities to farmers including alternative farming practices and crop diversification which will also take care of income perspectives. By increasing cultivar demands for higher growing degree days and improving current rice crop management practices and technologies, it is possible to lessen the negative effects of climate change. As it has become very important on a global level, this research framework has a lot of potential for conducting further studies across agro-climatic zones of Maharashtra as well as across India.

5. FUTURE RECOMMENDATION

The present investigation is an endeavor to identify the climatic factors associated with the management of rice production. Besides there are other areas left unattended where a lot of scopes of further research can be done jotted down.

(i) More numbers of variables can be included for greater precision.
(ii) Post harvest technology and value addition.
(iii) Gender dimension involved in rice management.

(iv) Cost effectiveness of the production – consumption pattern.
(v) Marketing information, marketing strategy.
(vi) Export potentiality of the rice grower.
(vii) Advance strategies to combat the climate change.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adams, RM, Hurd, BH and Reilly, J. Agriculture & global climate change: A review of impacts to U.S. agricultural resources. February 1999. Prepared for the Pew Center on Global Climate Change; 1999.
2. Adams RM, Hurd BH, Lenhart S, Leary N. Effects of global change on agriculture: an interpretative review. Climate Research. 1998;11:19–30.
3. Lewandrowski J, Schimmelpfennig D. Economic implications of climate change for U.S. agriculture: Assessing recent evidence. Land Economics. 1999;75:39–57.
4. McCarthy, JJ, Canziani, OF, Leary, NA, Do kken, DJ and White, KS. 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability, Intergovernmental Panel on Climate Change, Cambridge University Press; 1999.
5. Bryant CR, Smit B, Brklacich M, Johnson T, Smithers J, Chi otti, Q, Singh, B. Adaptation in Canadian agriculture to climatic variability and change. Climatic Change. 2000;45:181–201.
6. Polsky C, Easterling WE. Adaptation to climate variability and change in the U.S. Great Plains: a multiscale analysis of Ricardian climate sensitivities. Agriculture, Ecosystems and Environment. 2001;85(1–3):133–44.
7. SEI (Stockholm Environment Institute) Economics of Climate Change Kenya, Project Report ; 2009 (Retrieved 24.03. 15)
8. Kim HY, Ko J, Kang S, Tenhunen J. Impacts of climate change on paddy rice yield in a temperate climate. Global Change Biology. 2013;19(2):548-562.
9. Rashid MH, Islam MS. Adaptation to climate change for sustainable development of Bangladesh Agriculture. Bangladesh Country Paper, APCAEM, November; 2007.
10. Akter M, Sarker MMR. Impacts of climate factors influencing rice production in Bangladesh. International Journal of Environment and Climate Change. 2021;11(1):43–52. Available:https://doi.org/10.9734/ijecc/2021/v11i130336.
11. Sheikh R, Akter T. An assessment of climate change impacts on livelihood patterns: A case study at Bakergonj Upazila, Barisal. Journal of Health and Environmental Research. 2017;3:42–50.
12. Wassmann R, Jagadish SVK, Heuer S, Ismail A, Redona E, Serraj R, Sumfleth K. Climate change affecting rice production: The physiological and agronomic basis for possible adaptation strategies. Advances in Agronomy. 2009;101:59-122.
13. Arora P, Devi R, Chaudhry S. Impact of climate change on the production of major food and commercial crops in India: A five decadal study. International Journal of Environment and Climate Change. 2019;9(9):477–485. Available:https://doi.org/10.9734/ijecc/2019/v9i930133
14. Palanisamy J, Geethalakshmi V, Ramanathan SP, Senthil A, Balajikannan. Evaluating the suitability of system of rice intensification practices for enhancing rice and water productivity in semi-arid environment, Tamil Nadu, India. International Journal of Environment and Climate Change. 2022;12(10), 419–424. Available:https://doi.org/10.9734/ijecc/2022/v12i1030814
15. Oyita E, Okoh R, Gbigbi T. Effect of rice production input variables and climate change variables on rice output in Nigeria. 2023;19:1 - 14.
16. Nyirandorimana E, Ndunda E, Muriuki J. Factor influencing adaptation choices employed by farmers against climate change to improve rice yield in Bugarama Wetland in Rwanda. East African Journal of Agriculture and Biotechnology. 2020;2 (1):12-22. Available:https://doi.org/10.37284/eajab.2.1.137
17. Baronchelli Adelaide, Ricciuti Roberto. Temperature shocks, rice production, and migration in Vietnamese households. Ecological Economics. 2022;193:107301.

DOI:10.1016/j.ecolecon.2021.107301.

18. Bello AS, Ibrahim A, Yakubu S. Analysis of adaptation to climate change among rice farmers in western zone of Bauchi State, Nigeria. Journal of Agripreneurship and Sustainable Development. 2023;6:188-201. DOI:10.59331/jasd.v6i1.407

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