

# 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

## 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 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 new 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. [1,2,3,4,5,6,7]. The integrated responses of various ecological physiological processes to a variety of environmental conditions, such as temperature,

CO<sub>2</sub>, 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) high 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 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.

### 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:

**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 ( $X_{35}$ )

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124 II) Dependent variable selected for the  
125 study was Net returns from rice (Y)  
126 which has been measured separately  
127 for both rice production through  
128 conventional and System of Rice  
129 Intensification (SRI) methods.

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

### 136 2.3 Method of Data Collection

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

## 152 3. RESULTS AND DISCUSSION

### 155 3.1 Coefficient of Correlation (r): Net 156 returns from rice (y) practiced 157 conventional method Vs. 158 Independent Variables ( $x_1-x_{35}$ )

160 Table 2 presents the correlation between net  
161 returns from rice (Y) practiced by  
162 conventional method and 35 independent  
163 variables. It has been found that the variables  
164 farm size, water management%, and irrigation  
165 index% have recorded a significant and positive  
166 correlation with the dependent variable with 1%  
167 level of significance, while the variable secondary  
168 occupation has recorded a significant and

169 negative correlation with the dependent variable  
170 net returns from rice with 1% level of  
171 significance. The variable education, social  
172 participation, and weed management % have  
173 recorded a significant and positive correlation  
174 with the dependent variable net returns from rice  
175 with 5% level of significance, while the variable  
176 migration, varietal change has recorded a  
177 significant and negative correlation with the  
178 dependent variable net returns from rice with 5%  
179 level of significance.

### 182 3.2 Coefficient of Correlation (r): Net 183 returns from rice (y) practiced by SRI 184 method Vs. 35 Independent Variables ( $x_1-x_{35}$ )

187 Table 3 presents the correlation between  
188 net returns from rice (Y) practiced by SRI method  
189 and 35 independent variables. It has been found  
190 that the variables, primary occupation, family  
191 income primary and farm size, have recorded a  
192 significant and positive correlation with the  
193 dependent variable net returns from rice with 1%  
194 level of significance, while the variable secondary  
195 occupation, cropping intensity and migration  
196 have recorded a significant and negative  
197 correlation with the dependent variable net  
198 returns from rice with 1% level of significance.  
199 The variable weed management% has recorded  
200 a significant and positive correlation with the  
201 dependent variable with 5% level of significance,  
202 while the variable age has recorded a significant  
203 and negative correlation with the dependent  
204 variable net returns from rice (Y) with 5% level of  
205 significance.

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

### 213 Table 2. Coefficient of Correlation (r): Net returns from rice (y) practiced by 214 conventional method Vs. 35 Independent Variables ( $x_1-x_{35}$ )

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(n=100)			
Sl. No.	Independent Variables	'r' Value	Remarks
1	Age( $X_1$ )	-0.1005	
2	Education ( $X_2$ )	<b>0.2067</b>	*
3	Family education status ( $X_3$ )	-0.1113	
4	Primary occupation ( $X_{41}$ )	0.1442	
5	Secondary occupation ( $X_{42}$ )	<b>-0.3941</b>	**
6	Caste ( $X_5$ )	0.1450	
7	Family type( $X_6$ )	0.1131	

8	Family size (X <sub>7</sub> )	0.1508	
9	Family income primary (X <sub>81</sub> )	0.1132	
10	Family income secondary (X <sub>82</sub> )	0.0010	
11	Farm size(X <sub>9</sub> )	<b>0.3499</b>	**
12	Social participation (X <sub>10</sub> )	<b>0.2223</b>	*
13	Risk orientation (X <sub>11</sub> )	0.1937	
14	Index of farm mechanization (X <sub>12</sub> )	0.0069	
15	Cropping intensity (X <sub>13</sub> )	-0.0296	
16	Selling% (X <sub>14</sub> )	0.1717	
17	Debt (X <sub>15</sub> )	-0.1431	
18	Migration (X <sub>16</sub> )	<b>-0.2450</b>	*
19	Mass media exposure (X <sub>17</sub> )	0.0004	
20	Utilization of personal cosmopolite sources of information (X <sub>18</sub> )	0.0676	
21	Utilization of personal localite sources of information (X <sub>19</sub> )	0.1146	
22	Contact with extension personal (X <sub>20</sub> )	0.1693	
23	Seed rate% (X <sub>21</sub> )	-0.0998	
24	Fertilizer% (X <sub>22</sub> )	0.0579	
25	Pesticide% (X <sub>23</sub> )	0.0394	
26	Weed management%(X <sub>24</sub> )	<b>0.2122</b>	*
27	Water management% (X <sub>25</sub> )	<b>0.3430</b>	**
28	Irrigation index% (X <sub>26</sub> )	<b>0.3819</b>	**
29	Sowing time (X <sub>27</sub> )	0.0269	
30	Varietal change (X <sub>28</sub> )	<b>-0.2043</b>	*
31	Farm power (X <sub>29</sub> )	-0.0041	
32	Change in rainfall pattern over last 20 years (X <sub>30</sub> )	0.0346	
33	Change pattern in temperature (day/night) over last 20 years (X <sub>31</sub> )	0.1056	
34	Change pattern in weather disaster over last 20 years (X <sub>32</sub> )	-0.1088	
35	Change in seasonal pattern over last 20 years (X <sub>33</sub> )	-0.0554	
36	Change pattern in insect/ pests & diseases over last 20 years (X <sub>34</sub> )	-0.0745	
37	Change pattern in weed problem over last 20 years (X <sub>35</sub> )	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<sub>1</sub>-x<sub>35</sub>)**

		(n=100)	
Sl. No.	Independent Variables	'r' Value	Remarks
1	Age (X <sub>1</sub> )	<b>-0.2768</b>	*
2	Education (X <sub>2</sub> )	0.1731	
3	Family education status (X <sub>3</sub> )	0.0858	
4	Primary occupation (X <sub>41</sub> )	<b>0.3312</b>	**
5	Secondary occupation (X <sub>42</sub> )	<b>-0.2665</b>	**
6	Caste (X <sub>5</sub> )	0.1262	
7	Family type(X <sub>6</sub> )	-0.0523	
8	Family size (X <sub>7</sub> )	-0.0320	
9	Family income primary (X <sub>81</sub> )	<b>0.4172</b>	**
10	Family income secondary (X <sub>82</sub> )	0.0740	
11	Farm size (X <sub>9</sub> )	<b>0.8902</b>	**
12	Social participation (X <sub>10</sub> )	0.0336	
13	Risk orientation (X <sub>11</sub> )	0.1481	
14	Index of farm mechanization (X <sub>12</sub> )	-0.0198	
15	Cropping intensity (X <sub>13</sub> )	<b>-0.2767</b>	**
16	Selling% (X <sub>14</sub> )	-0.1215	
17	Debt (X <sub>15</sub> )	-0.1764	
18	Migration (X <sub>16</sub> )	<b>-0.3646</b>	**
19	Mass media exposure (X <sub>17</sub> )	0.1880	
20	Utilization of personal cosmopolite sources of information (X <sub>18</sub> )	0.0033	
21	Utilization of personal localite sources of information (X <sub>19</sub> )	-0.1826	

22	Contact with extension personal (X <sub>20</sub> )	0.1014	
23	Seed rate% (X <sub>21</sub> )	0.0547	
24	Fertilizer% (X <sub>22</sub> )	-0.0298	
25	Pesticide% (X <sub>23</sub> )	-0.0974	
26	Weed management% (X <sub>24</sub> )	<b>0.2064</b>	*
27	Water management% (X <sub>25</sub> )	-0.1018	
28	Irrigation index% (X <sub>26</sub> )	0.0169	
29	Sowing time (X <sub>27</sub> )	0.0873	
30	Varietal change (X <sub>28</sub> )	-0.1596	
31	Farm power (X <sub>29</sub> )	-0.1147	
32	Change in rainfall pattern over last 20 years (X <sub>30</sub> )	-0.1821	
33	Change pattern in temperature (day/night) over last 20 years (X <sub>31</sub> )	0.0692	
34	Change pattern in weather disaster over last 20 years (X <sub>32</sub> )	0.1240	
35	Change in seasonal pattern over last 20 years (X <sub>33</sub> )	-0.1564	
36	Change pattern in insect/ pests & diseases over last 20 years (X <sub>34</sub> )	-0.0372	
37	Change pattern in weed problem over last 20 years (X <sub>35</sub> )	-0.0525	

\*\*Correlation is significant at the 0.01 level

\*Correlation is significant at the 0.05 level

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

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Dependent variable(Y)	Regression equation (Stepwise)	Variable	R <sup>2</sup>	Adj.R <sup>2</sup>	SE(est.)	Ranking of important dependent regressors
Net returns from rice in conventional method of rice (n=100)	$Y = -8213.66 - 2234.59X_{42} + 186.38X_{26} + 2604.81X_{10} + 99.45X_{24}$	(X <sub>42</sub> )- Secondary occupation (X <sub>26</sub> )- Irrigation index% (X <sub>10</sub> )- Social participation (X <sub>24</sub> )- 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)	$Y = -4593.22 + 14811.56X_9 - 15631X_{16} + 1.14X_{81} - 3252.32X_{19}$	(X <sub>9</sub> )- Farm size (X <sub>16</sub> )-Migration (X <sub>81</sub> )-Family income primary (X <sub>19</sub> )- Utilization of personal localite sources of information	0.838	0.831	11891.36	$Y = X_9 > X_{16} > X_{81} > X_{19}$

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234 **3.3 Stepwise Regression Analysis: Net returns from rice (y) practiced by conventional method Vs. Independent Variables ( $x_1-x_{35}$ )** method Vs. 35 Independent Variables ( $x_1-x_{35}$ )

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239 From **Table 4**, it has been concluded that net returns from rice (Y) 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 ( $X_{42}$ ) with 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 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.

258 It has also been found that net returns from rice (Y) 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.

269 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]

253 **3.4 Stepwise Regression Analysis: Net returns from rice (y) practiced by SRJ**

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**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 ( $x_1-x_{35}$ )**

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	0.038142	<b>0.024318</b>
Education ( $X_2$ )	0.207	0.092	0.114	0.093507	<b>0.079021</b>	0.049161
Family education status ( $X_3$ )	-0.111	-0.034	-0.077	0.057898	0.047439	0.029053
Primary Occupation ( $X_{41}$ )	0.144	-0.122	0.266	0.205419	<b>0.092886</b>	0.040631
Secondary occupation ( $X_{42}$ )	-0.394	-0.344	-0.050	0.085102	0.072809	0.037559
Caste ( $X_5$ )	0.145	-0.017	0.162	0.034745	0.03067	0.025095
Family type( $X_6$ )	0.113	-0.275	0.388	0.182845	0.058651	0.049156

Family Size ( $X_7$ )	0.151	0.207	-0.056	0.050021	0.042354	0.03618
				$X_{31}$	$X_{81}$	$X_{13}$
Family income primary ( $X_{81}$ )	0.113	-0.115	0.228	<b>0.178556</b>	0.091007	0.060692
				$X_9$	$X_6$	$X_{82}$
Family income secondary ( $X_{82}$ )	0.001	0.119	-0.118	0.047749	0.034857	0.026017
				$X_{26}$	$X_6$	$X_{41}$
Farm size ( $X_9$ )	0.350	<b>0.385</b>	-0.035	0.157644	0.047867	0.037771
				$X_{42}$	$X_{10}$	$X_{22}$
Social participation ( $X_{10}$ )	0.222	0.168	0.054	<b>0.109359</b>	0.051297	0.040892
				$X_9$	$X_2$	$X_{42}$
Risk orientation ( $X_{11}$ )	0.194	0.066	0.128	0.08647	0.070288	<b>0.054685</b>
				$X_{26}$	$X_{42}$	$X_9$
Index of farm mechanization ( $X_{12}$ )	0.007	-0.221	0.227	<b>0.164071</b>	0.057954	0.032818
				$X_9$	$X_{42}$	$X_{17}$
Cropping intensity ( $X_{13}$ )	-0.030	0.283	-0.313	0.058998	0.049849	0.02796
				$X_{26}$	$X_{12}$	$X_{18}$
Selling% ( $X_{14}$ )	0.172	0.116	0.056	<b>0.069508</b>	0.031568	0.026251
				$X_9$	$X_7$	$X_{26}$
Debt ( $X_{15}$ )	-0.143	-0.121	-0.022	0.030023	0.027022	0.019644
				$X_{31}$	$X_{42}$	$X_{10}$
Migration ( $X_{16}$ )	-0.245	0.075	-0.320	0.053516	0.042204	0.041259
				$X_{31}$	$X_{81}$	$X_{25}$
Mass media exposure ( $X_{17}$ )	0.000	-0.143	0.144	0.050577	<b>0.039217</b>	0.033267
				$X_{12}$	$X_9$	$X_{31}$
Utilization of personal cosmopolite sources of information ( $X_{18}$ )	0.068	0.239	-0.171	0.034258	0.033206	0.023246
				$X_{41}$	$X_{13}$	$X_{29}$
Utilization of personal localite sources of information ( $X_{19}$ )	0.248	0.145	0.103	<b>0.089573</b>	0.088865	0.083711
				$X_9$	$X_{26}$	$X_{42}$
Contact with extension personal ( $X_{20}$ )	0.169	0.187	-0.018	0.03722	0.029089	0.016912
				$X_7$	$X_{31}$	$X_2$
Seed rate% ( $X_{21}$ )	-0.100	-0.021	-0.079	0.025743	0.021779	0.016042
				$X_{17}$	$X_{13}$	$X_{29}$
Fertilizer% ( $X_{22}$ )	0.058	0.237	-0.179	<b>0.061276</b>	0.049328	0.033698
				$X_9$	$X_6$	$X_{42}$

Pesticide% ( $X_{23}$ )	0.039	0.189	-0.150	0.042549	0.031551	0.021048
				$X_6$	$X_{12}$	$X_{28}$
Weed management% ( $X_{24}$ )	0.212	0.089	0.123	<b>0.093908</b>	0.090732	0.029376
				$X_9$	$X_{42}$	$X_{22}$
Water management% ( $X_{25}$ )	0.343	-0.078	<b>0.421</b>	0.222624	<b>0.12406</b>	0.082328
				$X_{26}$	$X_9$	$X_{42}$
Irrigation index% ( $X_{26}$ )	<b>0.382</b>	0.303	0.079	0.068888	0.055177	<b>0.045536</b>
				$X_{42}$	$X_{13}$	$X_9$
Sowing time ( $X_{27}$ )	0.027	0.047	-0.020	0.042204	0.021819	0.017601
				$X_{26}$	$X_{42}$	$X_6$
Varietal change ( $X_{28}$ )	-0.204	-0.083	-0.121	0.033278	0.026904	0.026675
				$X_{18}$	$X_{29}$	$X_6$
Farm power ( $X_{29}$ )	-0.004	-0.107	0.103	0.047707	0.043136	<b>0.031968</b>
				$X_{35}$	$X_{31}$	$X_9$
Change in rainfall pattern over last 20 years ( $X_{30}$ )	0.035	0.023	0.011	0.037481	0.034973	<b>0.030727</b>
				$X_6$	$X_{22}$	$X_9$
Change pattern in temperature(day/night) over last 20 years ( $X_{31}$ )	0.106	0.282	-0.176	0.036631	<b>0.022797</b>	0.019299
				$X_7$	$X_9$	$X_{20}$
Change pattern in weather disaster over last 20 years ( $X_{32}$ )	-0.109	-0.047	-0.062	0.022193	0.019371	0.018061
				$X_{17}$	$X_{18}$	$X_{31}$
Change in seasonal pattern over last 20 years ( $X_{33}$ )	-0.055	0.052	-0.107	0.031031	0.020766	0.019708
				$X_{18}$	$X_{15}$	$X_{31}$
Change pattern in insect/ pests & diseases over last 20 years ( $X_{34}$ )	-0.074	-0.147	0.073	0.034529	0.029342	0.019712
				$X_{26}$	$X_{35}$	$X_6$
Change pattern in weed problem over last 20 years ( $X_{35}$ )	0.049	0.182	-0.133	<b>0.033175</b>	0.024848	0.017605
				$X_9$	$X_7$	$X_{42}$

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

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**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<sub>1</sub>-X<sub>35</sub>)**

(n=100)

Variables	Total Effect	Total Direct Effect	Total Indirect Effect	Substantial Indirect Effect		
				I	II	III
Age (X <sub>1</sub> )	-0.277	-0.079	-0.198	0.013898 X <sub>7</sub>	0.009886 X <sub>17</sub>	0.008093 X <sub>82</sub>
Education (X <sub>2</sub> )	0.173	0.076	0.097	<b>0.084253</b> X <sub>9</sub>	0.033553 X <sub>81</sub>	0.022326 X <sub>16</sub>
Family education status (X <sub>3</sub> )	0.086	-0.012	0.098	<b>0.034737</b> X <sub>9</sub>	0.029563 X <sub>81</sub>	0.027042 X <sub>7</sub>
Primary occupation (X <sub>41</sub> )	0.331	-0.033	<b>0.364</b>	<b>0.301802</b> X <sub>9</sub>	0.021971 X <sub>2</sub>	0.01883 X <sub>81</sub>
Secondary occupation (X <sub>42</sub> )	-0.267	0.000	-0.266	0.016233 X <sub>41</sub>	0.013111 X <sub>2</sub>	0.010767 X <sub>31</sub>
Caste (X <sub>5</sub> )	0.126	0.049	0.078	<b>0.075889</b> X <sub>9</sub>	0.017325 X <sub>15</sub>	0.015955 X <sub>33</sub>
Family type (X <sub>6</sub> )	-0.052	0.003	-0.055	<b>0.065032</b> X <sub>9</sub>	0.01691 X <sub>1</sub>	0.012435 X <sub>28</sub>
Family size (X <sub>7</sub> )	-0.032	-0.066	0.034	<b>0.073011</b> X <sub>9</sub>	0.016614 X <sub>1</sub>	0.013109 X <sub>28</sub>
Family income primary (X <sub>81</sub> )	0.417	0.146	0.271	<b>0.248899</b> X <sub>9</sub>	0.024498 X <sub>7</sub>	0.017467 X <sub>2</sub>
Family income secondary (X <sub>82</sub> )	0.074	-0.077	0.151	0.063176 X <sub>81</sub>	<b>0.024709</b> X <sub>9</sub>	0.021541 X <sub>2</sub>
Farm size (X <sub>9</sub> )	<b>0.890</b>	<b>0.794</b>	0.096	0.045717 X <sub>81</sub>	0.020543 X <sub>1</sub>	0.017386 X <sub>16</sub>
Social participation (X <sub>10</sub> )	0.034	-0.010	0.043	<b>0.033659</b> X <sub>9</sub>	0.027219 X <sub>2</sub>	0.020563 X <sub>81</sub>
Risk orientation (X <sub>11</sub> )	0.148	0.053	0.095	<b>0.071036</b> X <sub>9</sub>	0.013976 X <sub>15</sub>	0.011645 X <sub>34</sub>
Index of farm mechanization (X <sub>12</sub> )	-0.020	-0.037	0.017	0.023721 X <sub>11</sub>	0.019755 X <sub>31</sub>	0.013475 X <sub>34</sub>
Cropping intensity (X <sub>13</sub> )	-0.277	-0.058	-0.218	0.019345	0.014604	0.009872

				X <sub>28</sub>	X <sub>82</sub>	X <sub>25</sub>
Selling% (X <sub>14</sub> )	-0.122	-0.053	-0.068	0.018768	0.010222	0.008645
				X <sub>81</sub>	X <sub>31</sub>	X <sub>28</sub>
Debt (X <sub>15</sub> )	-0.176	-0.083	-0.093	0.01632	0.009303	0.009301
				X <sub>82</sub>	X <sub>23</sub>	X <sub>35</sub>
Migration (X <sub>16</sub> )	-0.365	-0.071	-0.293	0.013274	0.010461	0.007291
				X <sub>17</sub>	X <sub>19</sub>	X <sub>23</sub>
Mass media exposure (X <sub>17</sub> )	0.188	-0.070	0.258	<b>0.157307</b>	0.046006	0.031006
				X <sub>9</sub>	X <sub>2</sub>	X <sub>81</sub>
Utilization of personal cosmopolite sources of information (X <sub>18</sub> )	0.003	-0.033	0.036	<b>0.01642</b>	0.015092	0.013099
				X <sub>9</sub>	X <sub>33</sub>	X <sub>82</sub>
Utilization of personal localite sources of information (X <sub>19</sub> )	-0.183	-0.089	-0.093	0.012472	0.011099	0.008334
				X <sub>26</sub>	X <sub>5</sub>	X <sub>16</sub>
Contact with extension personal (X <sub>20</sub> )	0.101	0.008	0.093	<b>0.083665</b>	0.018205	0.018155
				X <sub>9</sub>	X <sub>14</sub>	X <sub>1</sub>
Seed rate% (X <sub>21</sub> )	0.055	0.025	0.030	0.021658	<b>0.014893</b>	0.012699
				X <sub>15</sub>	X <sub>9</sub>	X <sub>1</sub>
Fertilizer% (X <sub>22</sub> )	-0.030	0.058	-0.088	0.008726	0.007971	0.006667
				X <sub>24</sub>	X <sub>28</sub>	X <sub>29</sub>
Pesticide% (X <sub>23</sub> )	-0.097	-0.077	-0.020	0.012696	0.010044	0.006715
				X <sub>28</sub>	X <sub>15</sub>	X <sub>16</sub>
Weed management% (X <sub>24</sub> )	0.105	0.067	0.038	0.013777	0.011666	0.009834
				X <sub>16</sub>	X <sub>2</sub>	X <sub>26</sub>
Water management% (X <sub>25</sub> )	-0.102	0.059	-0.161	0.018149	0.016786	0.008972
				X <sub>23</sub>	X <sub>34</sub>	X <sub>82</sub>
Irrigation index% (X <sub>26</sub> )	0.017	0.074	-0.057	0.035592	0.030976	0.017052
				X <sub>16</sub>	X <sub>81</sub>	X <sub>2</sub>
Sowing time (X <sub>27</sub> )	0.087	0.031	0.056	<b>0.082595</b>	0.017187	0.010126
				X <sub>9</sub>	X <sub>81</sub>	X <sub>13</sub>
Varietal change (X <sub>28</sub> )	-0.160	0.065	-0.225	0.007107	0.006569	0.004503
				X <sub>22</sub>	X <sub>11</sub>	X <sub>82</sub>
Farm power (X <sub>29</sub> )	-0.115	-0.030	-0.085	0.014944	0.014592	0.011066
				X <sub>31</sub>	X <sub>26</sub>	X <sub>1</sub>
Change in rainfall pattern over last 20 years (X <sub>30</sub> )	-0.182	-0.019	-0.164	0.022238	0.016657	0.015059

				X <sub>28</sub>	X <sub>19</sub>	X <sub>34</sub>
Change pattern in temperature(day/night) over last 20 years (X <sub>31</sub> )	0.069	0.113	-0.044	0.00792 X <sub>7</sub>	0.005201 X <sub>24</sub>	0.005188 X <sub>41</sub>
Change pattern in weather disaster over last 20 years (X <sub>32</sub> )	0.124	-0.007	0.131	<b>0.10931</b> X <sub>9</sub>	0.016846 X <sub>34</sub>	0.01222 X <sub>15</sub>
Change in seasonal pattern over last 20 years (X <sub>33</sub> )	-0.156	-0.061	-0.095	0.014101 X <sub>81</sub>	0.011894 X <sub>31</sub>	0.008179 X <sub>18</sub>
Change pattern in insect/ pests & diseases over last 20 years (X <sub>34</sub> )	-0.037	-0.075	0.038	<b>0.02375</b> X <sub>9</sub>	0.009911 X <sub>5</sub>	0.008796 X <sub>82</sub>
Change pattern in weed problem over last 20 years (X <sub>35</sub> )	-0.053	0.039	-0.091	0.0077 X <sub>22</sub>	0.006664 X <sub>1</sub>	0.005849 X <sub>7</sub>

Residual effect: 0.32; Highest Indirect Individual effect: x<sub>9</sub> (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<sub>1</sub>-x<sub>35</sub>)**

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<sub>9</sub>) exerts highest direct effect and the variable, water management % (X<sub>25</sub>) 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<sub>9</sub>) has been found to channelize substantial indirect effect of, as many as, 17 times to define its tremendous impact over 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

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<sub>1</sub>-x<sub>35</sub>)**

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<sub>9</sub>) exerts highest direct effect whereas the variable, primary occupation (X<sub>41</sub>) 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<sub>9</sub>) 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

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368 returns from rice cultivation practiced by SR12  
369 method in the light of climate change. 423

370 These results are in contrast with those 424  
371 of the study conducted by Bello in which farm 425  
372 size have been found to have a significant 426  
373 correlation with adaptation to climate change 427  
374 among rice farmers in Western Zone of Bauchi 428  
375 State, Nigeria. [18] 429

#### 376 4. CONCLUSION 430

377 The study focused on assessing the net return 431  
378 from rice production in light of climate change 432  
379 comparing both the conventional and SR1 433  
380 methods. The results indicated that variables like 434  
381 family size, weed management %, social 435  
382 participation, and migration among others are 436  
383 playing a significant role in receiving net return 437  
384 from producing rice in the context of climate 438  
385 change. It is evident that various mitigating steps 439  
386 have to be taken in order to provide safe and 440  
387 secure livelihood opportunities to farmers 441  
388 including alternative farming practices and crop 442  
389 diversification which will also take care of income 443  
390 perspectives. By increasing cultivar demands for 444  
391 higher growing degree days and improving 445  
392 current rice crop management practices and 446  
393 technologies, it is possible to lessen the negative 447  
394 effects of climate change. As it has become very 448  
395 important on a global level, this research 449  
396 framework has a lot of potential for conducting 450  
397 further studies across agro-climatic zones of 451  
398 Maharashtra as well as across India. 452

#### 400 5. FUTURE RECOMMENDATION 453

401 The present investigation is an endeavor 454  
402 identify the climatic factors associated with the 455  
403 management of rice production. Besides these 456  
404 are other areas left unattended where a lot of 457  
405 scopes of further research can be done jotted 458  
406 down. 459

- 407 (i) More numbers of variables can be 460
- 408 included for greater precision. 461
- 409 (ii) Post harvest technology and value 462
- 410 addition. 463
- 411 (iii) Gender dimension involved in rice 464
- 412 management. 465
- 413 (iv) Cost effectiveness of the production 466
- 414 consumption pattern. 467
- 415 (v) Marketing information, marketing 468
- 416 strategy. 469
- 417 (vi) Export potentiality of the rice grower. 470
- 418 (vii) Advance strategies to combat the 471
- 419 climate change. 472

#### 420 421 COMPETING INTERESTS 473

422 Authors have declared that no competing 474  
423 interests exist. 475

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