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Dryland Farmers on Climate Resilient Practices – An Adoption Study at an Industrialized Taluk of Tamil Nadu

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To study the adoption of climate resilient practices by the farmers in the dryland region.
Study Design: Cross-sectional survey design was used for the present descriptive study.
Place and Duration of Study: The study was conducted in Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (Prayagraj) during the year of 2018 and for the period of 6 months.
Methodology: The study used direct interview method with the subjects using a structured and pre-tested interview schedule for primary data collection in the sampled area which is an industrialized taluk of Tamil Nadu. The selection of area was purposeful, whereas, selection of villages was random and 15 respondents form each village was convenient. The collected data was tabulated and interpreted using descriptive statistics and correlation analysis.
Results: The results of the study suggest that there is a poor adoption level of climate resilient practices existing among the dryland farmers. While, some of the practices like incorporation of residues in to soil instead of burning, brown and green manuring, conservation tillage, temperature tolerant varieties, farm machinery custom hiring centre, location specific intercropping systems, crop rotation, usage of better planting materials, prophylaxis, custom hiring centre and weather based insurance were adopted to some extent. Though there was no specific intervention to sensitize on

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these practices, adoption of above mentioned practices were found which could be due to the passive adaptation by the farmers of the locality over years. And the results of correlation analysis revealed that there is a significant relationship between adoption of climate resilient practices and variables like the respondents' education, exposure to mass media exposure, contacts with extension agents, innovativeness level, risk orientation and scientific orientation at 0.01% level of significance.

Conclusion: The results of the study will definitely help in evaluating government projects (as baseline) like National Initiative on Climate Resilient Agriculture, and strengthening programme planning and implementation in climate change.

Keywords: Adoption; climate change; climate resilient practices; effects, dryland.

1. INTRODUCTION

Changing climate seeks immediate action from people of the planet. Most of the countries have agreed the existence of climate change and made imperative changes in their governance viz, establishing separate ministry and department for undertaking research, educating people on its potential harms and making policies to reduce the green house gases emission to curb climate change. The effect of climate change does not restrict to environmental and economical, but influences social wellbeing too [1]. United Nation Convention to Combat Desertification (UNCCD) estimates the economic impact of drought is annually more than 80 million dollars. Droughts have cause loss of food grains that could be used to feed around 81 million of world population every day [2].

India, being a developing country, is one among the top countries that releases more carbon to the atmosphere, ranks fourth place in 2018 [3]. In order to reduce the emission of green house gases, the government of India has initiated various programmes, schemes and projects to promote clean renewable energy sources and to make country resilient to climate change. One among such projects in agriculture sector which is implemented by Indian Council of Agricultural Research (ICAR) is National Initiative on Climate Resilient Agriculture (NICRA). NICRA was launched in February 2011 to promote research, to demonstrate technologies and to build capacity of the farmers with reference to climate resilience. NICRA has listed many climate resilient practices which could help farmer to become resilient to changing climatic scenario [4]. The climate resilient practices listed by the NICRA for dryland agriculture are classified under four main categories: Natural Resource Management, Crop Production, Livestock and Institutional Interventions. The category natural resource management contained practices like, *In situ* moisture conservation practice, biomass mulching, incorporation of residues in to soil instead of burning, brown and green manuring, rain water harvesting and supplement irrigation recycling, proper drainage, conservation tillage, artificial groundwater storage and water saving irrigation methods. Climate resilient crop production practices consisted of drought/ temperature tolerant varieties, water saving paddy cultivation practices, community nurseries in multiple dates, farm machinery custom hiring centers, location specific intercropping systems and crop rotation. Resilient livestock management practices included uses of community lands for fodder production, improved planting material, improved fodder storage, fodder enrichment, prophylaxis and heat stress reducing shelters for livestock. And, institutional interventions for climate resilience included constitution of seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing group, weather index based insurance and climate advisory. These practices are found to be effective in solving farmers farming problem as well as providing adequate economic benefits [5,6].

Dryland areas are found to be more vulnerable to climate change compared to other region [7]. It is essential to study the extent of existing climate resilient practices in dryland region. The present study was selected to find the level of adoption of climate resilient practices by the farmers of dryland region - where the intervention for any climate resilient practices have not provisionally undertaken - and to identify any passive adaptation strategies followed by the dryland farmers.

1.1 Theoretical Framework

Though the designed study is descriptive, an attempt has been made to explain the cause-effect relationship under the theory of diffusion of innovation by Edwards Rogers [8]. Twelve

independent variables viz, respondent's age, education level, annual income, family type, farming experience, land holding (in acres), exposure to mass media, contacts with extension agents, social participation, innovativeness, risk orientation and scientific orientation were selected. These variables were chosen based on reviewing the existing literature and consulting experts in the domain of climate change research; after considering its feasibility in conducting research and availability of related information with the respondents. And the following hypothesis was assumed:

H_0: The selected independent variables have no relationship with the extent of adoption of climate resilient practices by the dryland famers.

2. RESEARCH METHODOLOGY

2.1 Research Design and Locale of Study

A descriptive cross-sectional study was planned and designed at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), for that, Tamil Nadu was chosen purposefully as it is one of the driest states of the India [9]. Virudhunagar district was selected purposefully as it is one of the districts that comes under Tamil Nadu uplands and leeward flanks of south Sahyadris, hot, dry semi-arid eco-sub region (8.1) of ICAR. And the selected district receives scanty annual rainfall of 829mm [10].

There are 8 taluks in the district, out of those Sivakasi taluk was selected purposefully because the taluk is heavily industrialized. Sivakasi is the nation's fireworks capital which contains 90 percent of firework industries in India, [11] and the place where around 460 fireworks are operational and provides employment to thousands of the local workforce. This region of the district alone submits around a thousand crore of annual revenue [12]. The employment provided by the Sivakasi is the livelihood for many, including farmers of this taluk, because agriculture in the taluk is being affected because of very adverse climatic fluctuations [13].

2.2 Sampling Design

Non-parametric sampling was used in the present research. The selected taluk contains 41 revenue villages as reported in the census of India, [14] out of which around 20 per cent of villages (8 villages) were selected randomly for the present study (Fig.1). About 120 farmers were selected conveniently from the selected villages at 15 respondents per village. Dryland farmers were operationally defined as one whose primary business is farming and resides in the dryland region.

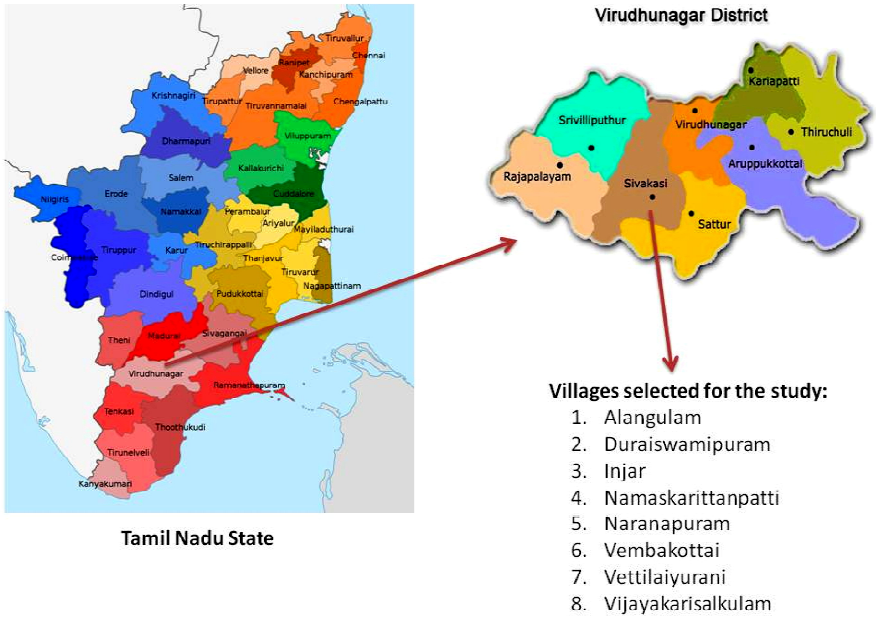

Fig. 1. Locale of study

2.3 Data Collection Methods and Analysis

Direct interview method was used for data collection, using structured and pre-tested interview schedule. The interview schedule carried items related to listed climate resilient practices of NICRA, and scores were assigned on three point continuum as '3' for fully adopted, '2' for partially adopted and '1' for not adopted. The collected data was tabulated and analyzed by applying descriptive statistics, Z-test and correlation analysis. SPSS 21 was used for correlation analysis. The categorization of adoption score in Table 3 was done using range method.

3. RESULTS AND DISCUSSION

3.1 Respondents' Distribution Based on Adoption of Climate Resilient Practices

The examination of Table 1 reveals that the majority of farmers have fully adopted the climate resilient practices like location specific intercropping systems (81.67%) and crop rotation (64.17%); whereas, they partially adopted *in situ* moisture conservation (74.17%), conservation tillage (74.17%), biomass mulching (65.83%), incorporation of residues in to soil instead of burning (59.17%), brown and green manuring (51.67%), water saving irrigation methods (55%), temperature tolerant varieties (55.83%), farm machinery custom hiring centers (65%), prophylaxis (44.73%), custom hiring centre (57.5%) and weather based insurance (75.83%). Poor knowledge on rest of the climate resilient practices eventually reduced adoption [15]. Table 2 divulges Z-test value of each climate resilient practices that describes its degree of adoption. Out of 28 climate resilient practices, only 4 found positively significant, that implies high degree of adoption; they were use of farm machinery custom hiring centers, location specific intercropping systems, crop rotation and custom hiring centers. Similarly, adoption of incorporation of residues in to soil instead of burning, brown and green manuring, conservation tillage, temperature tolerant varieties, use of better planting materials, prophylaxis and weather based insurance found no significant at 0.05% level of significance, which donates the adoption score of these above mentioned practices falls near the mean, which explains partial adoption. Climate resilient practices like, rain water harvesting and supplement irrigation recycling, proper drainage, heat stress reducing shelters for livestock, seed and fodder bank found negatively significant; which denotes poor adoption of above mentioned climate resilient practices.

3.2 Extent of Adoption of Climate Resilient Practices

From the Table 3 and Fig. 2, it is evident that the flow of adoption of all climate resilient management practices categories - Natural Resource Management, Crop Production, Livestock Management and Institutional Interventions - is low, followed by medium and high respectively. Conclusively, the results suggest us a very low level of adoption by the dryland farmers with regard to most of the climate resilient practices.

3.3 Relationship of Adoption of Climate Resilient Practices with the Independent Variables

We found that the correlation value (r) of independent variables like, respondent's age, their family type and their farming experience are not significant. This indicates there is no relationship between these variables and adoption of climate resilient practices. Meanwhile, other independent variables like the respondent's education, exposure to mass media, contact with the extension agents, innovativeness level, risk orientation and orientation are significantly related with the adoption of climate resilient practices at 0.01% level of significance. The respondent's landholding found negatively correlated at 0.05% level of significance for climate resilient practices like, Natural resource management practices and Crop production practices, whereas, the same landholding variable found no relation with practices like Livestock management practices and Institutional interventions. And Income found no significance; except for Livestock management practices, where it found to be positively correlated at 0.01% level of significance.

Table 1. Distribution of respondents based on the level of adoption of climate resilient practices

S. No.	Items	Level of adoption (n=120)					
		Fully adopted		Partially adopted		Not adopted	
		F	%	F	%	F	%
Natural resource management practices							
1.	*In situ* moisture conservation practices	13	10.83	89	74.17	18	15
2.	Biomass mulching	9	7.5	79	65.83	32	26.67
3.	Incorporation of residues in to soil instead of burning	33	27.5	71	59.17	16	13.33
4.	Brown and green manuring	41	34.17	62	51.67	17	14.17
5.	Rain water harvesting and supplement irrigation recycling	1	0.83	8	6.67	111	92.4
6.	Proper drainage	1	0.83	11	9.17	108	90
7.	Conservation tillage	14	11.67	89	74.17	17	14.16
8.	Artificial ground water storage	0	0	13	10.83	107	89.17
9.	Water saving irrigation methods	5	4.17	46	38.33	69	57.5
Crop production practices							
1.	Drought/ temperature tolerant varieties	29	24.17	67	55.83	25	20.83
2.	Water saving paddy cultivation practices	0	0	4	3.33	116	96.87
3.	Community nurseries in multiple dates	0	0	3	2.5	117	97.5
4.	Farm machinery custom hiring centers	42	35	78	65	0	0
5.	Location specific intercropping systems	98	81.67	22	18.33	0	0
6.	Crop rotation	77	64.17	43	35.83	0	0
Livestock management practices (n=38)							
1.	Use of community lands for fodder production	2	5.26	12	31.57	24	63.15
2.	Use improved planting material	9	23.68	13	34.21	15	39.47
3.	Improved fodder storage methods	6	15.78	7	18.42	25	65.79
4.	Fodder enrichment	3	7.89	5	13.15	30	78.9
5.	Prophylaxis	16	42.10	17	44.73	5	13.15
6.	Heat stress reducing shelters for livestock	1	2.63	5	13.15	32	84.21
Institutional interventions							
1.	Seed bank	0	0	2	1.67	118	98.33
2.	Fodder bank	0	0	9	7.5	111	92.5
3.	Commodity groups	4	3.33	32	26.67	84	70
4.	Custom hiring centre	41	34.17	69	57.5	10	8.33
5.	Collective marketing group	0	0	21	17.5	99	82.5
6.	Weather index based insurance	11	9.16	91	75.83	18	15
7.	Climate advisory	2	1.67	20	16.67	98	81.67

F = Frequency

3.4 Discussion

Low extent of adoption of climate resilient practices viz, Natural Resource Management (78.33%), Crop Production (73.33%), livestock (73.68%) and institutional interventions (80%) has been observed. Out of 28 listed climate resilient practices by NICRA, only 4 sought maximum adoption, 7 sought moderate adoption and around 17 found very minimal adoption. This condition is may be because of low level of knowledge [14] towards certain climate resilient practices. And the high degree of adoption of some climate resilient practices like incorporation

of residues in to soil instead of burning, brown and green manuring, conservation tillage, drought/ temperature tolerant varieties, uses of better planting materials, prophylaxis and weather based insurance are may be due to farmer's passive adaptation towards climate change over the period of time [16]. Correlation value (r) of respondent's age, their family type, their income, their farming experience and their land holding with adoption is not significant. But, in case of livestock management, income found positively correlated at 0.01% significance level; similarly land holding found negatively correlated with practices like natural resource management and crop production. Variables like respondent's education, exposure to mass media, contact with the extension agents [17] [18], innovativeness, risk orientation and scientific orientation are having significant relationship with the adoption of climate resilient practices at 0.01% level of significance.

Table 2. Z - Test for the adoption of climate resilient technologies

S. No.	Items	Mean	S.D.#	Z – Value
Natural resource management practices				
1.	*In situ* moisture conservation practices	1.74	0.80	-3.71*
2.	Biomass mulching	1.81	0.99	-2.11*
3.	Incorporation of residues in to soil instead of burning	2.14	1.24	1.27^{NS}
4.	Brown and green manuring	2.20	1.33	1.67^{NS}
5.	Rain water harvesting and supplement irrigation recycling	1.08	0.30	-30.67*
6.	Proper drainage	1.11	0.37	-29.67*
7.	Conservation tillage	1.98	0.98	-0.22^{NS}
8.	Artificial ground water storage	1.11	0.36	-29.67*
9.	Water saving irrigation methods	1.47	0.85	-6.63*
Crop production practices				
1.	Drought/ temperature tolerant varieties	2.05	1.27	0.42^{NS}
2.	Water saving paddy cultivation practices	1.03	0.17	-48.5*
3.	Community nurseries in multiple dates	1.03	0.17	-48.5*
4.	Farm machinery custom hiring centers	2.35	1.14	3.5*
5.	Location specific intercropping systems	2.82	1.10	8.2*
6.	Crop rotation	2.64	1.28	5.33*
Livestock management practices				
1.	Use of community lands for fodder production	1.42	0.82	-4.46*
2.	Use improved planting material	1.79	1.21	-1.11^{NS}
3.	Improved fodder storage methods	1.50	0.93	-3.33*
4.	Fodder enrichment	1.29	0.65	-6.45*
5.	Prophylaxis	2.29	1.39	1.26^{NS}
6.	Heat stress reducing shelters for livestock	1.18	0.49	-10.25*
Institutional interventions				
1.	Seed bank	1.02	0.14	-98*
2.	Fodder bank	1.08	0.28	-30.67*
3.	Commodity groups	1.33	0.7	-11.17*
4.	Custom hiring centre	2.26	1.27	2.17*
5.	Collective marketing group	1.18	0.47	-20.5*
6.	Weather index based insurance	1.94	0.93	-0.75^{NS}
7.	Climate advisory	1.20	0.52	-16*

*^{NS} = Not Significant *= Significant at 0.05%*
#S.D. = Standard Deviation

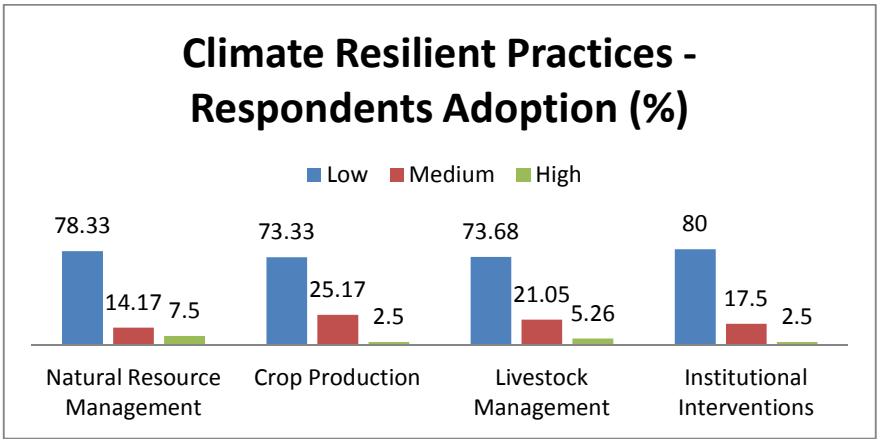

Fig. 2. Respondents' distribution based on the adoption level of climate resilient practices

Table 3. Extent of adoption of climate resilient practices

S. No.	Climate resilient practices	Extent of adoption	Frequency	Percentage
1.	Natural Resource Management Practices (n=120)	Low (11-15)	94	78.33
		Medium (16- 19)	17	14.17
		High (19-23)	9	7.50
		Total	120	100.00
2.	Crop Production Practices (n=120)	Low (9-11)	88	73.33
		Medium (12-13)	29	25.17
		High (14-15)	3	2.50
		Total	120	100.00
3.	Livestock Management Practices (n=38)	Low (8-10.67)	28	73.68
		Medium (10.67-13.33)	8	21.05
		High (13.33-16)	2	5.26
		Total	120	100.00
4.	Institutional Interventions (n=120)	Low (7-9.33)	96	80.00
		Medium (9.33-11.66)	21	17.50
		High (11.66-14)	3	2.50
		Total	120	100.00

Table 4. Relationship of adoption with independent variables

S. No.	Independent variables	Correlation (r) value (-1 to +1)			
		Natural resource management practices	Crop production practices	Livestock management practices	Institutional interventions
1.	Age	-0.089^{NS}	-0.0397^{NS}	-0.0053^{NS}	-0.10864^{NS}
2.	Family type	-0.01466^{NS}	-0.0625^{NS}	-0.0021^{NS}	-0.13951^{NS}
3.	Income	0.094543^{NS}	-0.0136^{NS}	0.3512*	0.068856^{NS}
4.	Education	0.621216*	0.635396*	0.513931*	0.591979*
5.	Farming experience	0.020707^{NS}	-0.0397^{NS}	-0.0732^{NS}	-0.09134^{NS}
6.	Land holding	-0.20848**	-0.2030**	-0.0059^{NS}	-0.13703^{NS}
7.	Mass Media Exposure	0.655268*	0.663245*	0.707951*	0.65187*
8.	Extension contacts	0.719911*	0.633932*	0.55119*	0.58615*
9.	Social participation	0.551224*	0.4304*	0.634859*	0.37808*
10.	Innovativeness	0.754731*	0.64145*	0.728852*	0.548382*
11.	Risk orientation	0.809855*	0.860219*	0.837948*	0.747922*
12.	Scientific orientation	0.543648*	0.624672*	0.696674*	0.588916*

^{NS} = Not Significant ***= Significant at 0.05%* **= Significant at 0.01%*

4. CONCLUSION

The results of the study will act as a control or baseline data, in case of any comparison proposed or made between NICRA project implemented and not implemented area. Overall low level of knowledge and low level of adoption is the ground status of climate resilient practices in dryland region. The results of the study will definitely help in evaluation of the project and to understand the farmer's adaptation behavior to the changing climate, where no specific intervention has made; as well as for better programme planning and implementation in future.

CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. ILO. The Social Dimensions of Climate Change: Discussion Draft, International Labour Organisation; 2011. Available:https://www.iom.int/jahia/webdav/shared/shared/mainsite/activities/env_degradation/cop17/SDCC-Social-dimensions-of-climate-change-Paper.pdf
2. Damania R, Desbureaux S, Hyland M, Islam A, Moore S, Rodella AS, Russ J, Zaveri E. Uncharted waters: The new economics of water scarcity and variability. The World Bank; 2017.
3. Energy G. CO2 status Report. IEA (International Energy Agency): Paris, France; 2019.
4. Venkateswarlu B, Shalander Kumar, Sreenath Dixit, Srinivasa Rao Ch, Kokate KD, Singh AK. Demonstration of climate resilient technologies on farmers' fields action plan for 100 vulnerable districts. Central Research Institute for Dryland Agriculture, Hyderabad. 2012;163.
5. Biswas PK, Ngullie R, Sangtam S, Rongsensusang, Nakro R, Bendanjungla, Kehie R, Jamir S. Adoption of climate resilient agricultural technologies and its impact on aliba village under mokochung district of nagaland. Asian Journal of Environmental Science. 2015;10(1):90-94.
6. Khatri-Chhetri A, Aryal JP, Sapkota TB, Khurana R. Economic benefits of climate-smart agricultural practices to smallholder farmers in the Indo-Gangetic Plains of India. Current Science. 2016;1251-1256.
7. Meze-Hausken E. Migration caused by climate change: how vulnerable are people in dryland areas?. Mitigation and Adaptation Strategies for Global Change. 2000;5:379–406. Available:https://doi.org/10.1023/A:1026570529614
8. Rogers EM. Diffusion of innovations. Simon and Schuster. 2010.
9. Sivagnanam KJ. State Agriculture Profile of Tamil Nadu – 2011. Agro-Economic Research Centre, University of Madras, Chennai, Tamil Nadu, India. 2014;98.
10. CCC, AR, TNSCCC. Climate change projection (rainfall) for virudhunagar. in: district-wise climate change information for the state of Tamil Nadu. centre for climate change and adaptation research (ccc&ar), anna university and Tamil Nadu State Climate Change Cell (TNSCCC), Department of Environment (DoE), Government of Tamil Nadu, Chennai, Tamil Nadu, India; 2015. Available: www.tnsccc.in
11. MSME Development Institute. State Industrial Profile of Tamil Nadu 2014-15. 2015;193.
12. Kumar DT, Palaniappan M, Kannan D, Shankar KM. Analyzing the CSR issues behind the supplier selection process using ISM approach. Resources, Conservation and Recycling. 2014; 92:268–278. Available:https://doi.org/10.1016/j.resconrec.2014.02.005
13. Moulik TK, Purushotham P. The match industry in Sivakasi: A case study of technology, working conditions and self-

employment. Economic and Political Weekly. 1982;M43-53.

14. Census. Census of India. Ministry of Home Affairs. Government of India; 2011.
15. Niranjan DA, Bose DK, Jahanara. Factors influencing level of knowledge of farmers on climate resilient practices in virudhunagar district of Tamil Nadu. International Journal of Research Culture and Society. 2018;2(5):169–172.
16. Tripathi A, Mishra AK. Knowledge and passive adaptation to climate change: An example from Indian farmers. Climate Risk Management. 2017;16:195-207.
17. Bahinipati CS, Venkatachalam L. What drives farmers to adopt farm- level adaptation practices to climate extremes: Empirical evidence from Odisha, India. International Journal of Disaster Risk Reduction. 2015;14:347-356.
18. Acevedo M, Pixley K, Zinyengere N, Meng S, Tufan H, Cichy K, Bizikova L, Isaacs K, Ghezzi-Kopel K, Porciello J. A scoping review of adoption of climate-resilient crops by small-scale producers in low-and middle-income countries. Nature Plants. 2020;6(10): 1231-41.

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