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CLIMATE VULNERABILITY ASSESSMENT OF SMALL AND LARGE-SCALE PADDY FARMERS IN PALAKKAD DISTRICT, KERALA

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ABSTRACT

Palakkad has a total paddy area of 76503.68 hectare, of which the wet paddy area is 76361.21 hectare and total dry paddy area of 142.47 hectare. Weather, pest, disease, drought, and flood are the common natural or external risks. The external sources of risk cannot be controlled by farmers, which generally come from the natural environment. In this context, the study looks into the production risks pertaining from the external sources among the small and large scale farmers in the Palakkad district, Kerala. A vulnerability index is developed consisting of exposure, sensitivity and adaptive factors to understand the climate induced production risks among the selected sample farmers during 2005 to 2022.The data reveals that the exposure index is low (<= 11.96) for only minority of small farmers and most of themfell in high and very high category (more than 13.46). In the sensitivity category, majority of small and large farmers wereincluded in the high sensitivity index category group (11.45to 13.66).But the severities of these factors effecting them are different. Exposure factors had medium impact on large number of sample farmers, while, sensitivity factors create high impact on large number of farmers. Likewise, adaptive factors had high impact on small and large scale farmers. Even though adaptation practices are implemented in the district,more efforts were needed to implement them in a timely and systematic way.

Keywords: Adaptation, Exposure, Sensitivity, Vulnerability

INTRODUCTION

Paddy is the principal crop extensively cultivated in all the districts of Kerala, having a unique three season pattern viz. Autumn (July- October), Winter (November – February) and Summer (March – June) and it is the staple food for the people in Kerala. Still now in rural areas, agricultural sector absorb more labour and acts as a leading income generating sector. Among the grand total of paddy area (76503.68 hectare.), total wet paddy area in the Palakkad is 76361.21 hectare and total dry paddy area is 142.47 hectare. In 2021-22, rate of growth of agriculture and associated sectors was 4.91 percent. In 2022-23, it declined to 0.87 percent (Agricultural statistics 2022-23). The growth in crop sector was 0.74 percent as compared to 3.67 percent in 2021-22 (Department of Economics and Statistics 2023, GoK).The contribution of the district among the

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total paddy area to the state was 39.09 percent (Agricultural Statistics, 2021-22).Palakkad is the rice bowl of Kerala because it holds foremost position in the rice production as well as its productivity. Compared to all other agricultural crops, the rice crop is more vulnerable due to exogenous and endogenous factors.The vulnerability associated with the agricultural sector is more than that of non-agricultural sector. Agricultural risks or vulnerabilities occur through external and internal factors. Weather, pest, disease, drought, and flood are the natural risks or external risks. Besides nature, risks can also be caused by marketing and other activities known as internal sources. The external sources of risk which are natural and which cannot be controlled by farmers (Riaman *et.al*.,2021). In this context, this study drives to analyze the production and financial risks among the small and large scale paddy farmers from external sources in Palakkad district. Vulnerability is a multidimensional static process affected due to social, political, and economic forces interacting from local to international scales (Bohle, *et al*., 1994).

MATERIAL AND METHODS

In this study, a vulnerability index was developed comprising exposure, sensitivity and adaptive factors to understand the production risks among the selected sample farmers because of climate variability.The study aims to examine the relation between the production and climatic factors among the small and large scale farmers and also the extent of vulnerability of rice production due to external sources. The study also suggests some concrete solutions to reduce the magnitude of vulnerable situations in the Palakkad district, Kerala.

Vulnerability index was constructed by integrating three key components: exposure, sensitivity, and adaptive competences of the farmers**.** These factors reflect different dimensions of susceptibility to climate- induced risks.Correlation analysis was carried out to understand the climate impact on agricultural production. This study also gave the extent and magnitude of its impact. In addition, a t-test was applied to examine the substantial differences in exposure, sensitivity, and adaptive competences that exist between large and small scale farmers. This analysis provided the different experiences and responds of small and large groups. Furthermore, to explore the association of specific sensitivity factors between large and small farmers, a chi-square test was applied. A trend line wasfitted by using data for the period 2005 to 2022 for climate variablesto understand the long –term changes.Together, these analytical approaches provided a comprehensive understanding of vulnerability of climate on production by using exposure, sensitivity and adaptive capacity among small and large scale farmers.

Palakkad district was purposively chosen as it has first position with 76503.68 hectare (39.09 percent of total paddy area in the state) under cultivation of paddy. The study carried out by taking 150 sample farmers constituting of 105 small and 45 large scale farmers. The selection of sample was purely based on simple random sampling method from the total paddy farmers in the district. To study the magnitude of the production risk, vulnerability index was developed consisting of exposure, sensitivity and adaptive factors. The vulnerability of the crop is measured by taking the lower values of the exposure, sensitivity and adaptive factors as the threshold level. It is operationalized as the minimum levelof climatic factors (temperature, rainfall, humidity, precipitation and wind) that create noticeable impact- either positive or negative. There will be a close connection between crop production and uncertainty. Better policy and

Table 2.Correlation Analysis

Variable		Temperature	Wind Speed	Rainfall	Precipitation	Relative Humidity
Production	Pearson Correlation	-0.441*	-0.038	0.439*	0.639**	0.550*
	Sig. (2-tailed)	0.067	0.879	0.068	0.004	0.018

Source: Computed

management decision helps to increase productivity of agriculture (Amer Ait Sidhoum, 2023)

RESULTS AND DISCUSSION

For the study, it was assumed that the internal factors such as labour charges, use of irrigation, fertilisers and pesticides are constant. The climatic factors such as rainfall pattern, temperature, relative humidity, precipitation and wind speed which are external in nature that affect the yield of the seasonal crop of rice . The data was collected from 150 farmers which includes both small (105) and large (45) scale farmers.The small scale farmers are those having below 2 acres of land and large scale farmers are those having above 5 acres of land. Table 1 represents the frequency table of sample farmers.

Source: Primary data

Table 2 represents the correlation between the production of rice and climate variables. To calculate correlation, climate variables such as temperature, rainfall, wind speed, precipitation, and relative humidity were taken. For the correlation analysis, data of 18 years from 2005 to 2022was used. The study found that there was significant negative correlation between the temperature and production. As the temperature was seen increasing, production was continuously declined.Wind speed and production were not significantly correlated. Rainfall and production were positively correlated. Likewise, a positive relation was noted in precipitation and relative humidity.

Table 1. Details of Sample Farmers

Farmers	Frequency	Percent	Cumulative Percent
Small	105	37	70
Large	45	16	100
Total	150	53	

The table 3 represents the impact of exposure factor which is one of the vulnerability factors among the small and large scale farmers. The exposure factor includes variables such as acres of land affected due to flood and drought, number of times affected, impact of pesticides and diseases, problems due to the non-use of climate adaptive seeds etc. The mean value of vulnerability of exposure factor more or less impacted on both small and large scale farmers because both categories have no proper adaptive and mitigation measures to overcome the vulnerability of climate change. The impact of climate change are not evenly distributed., by intensifying the exposure to environmental hazards it reveals the existing inequalities in vulnerability shaped by race ,class, ethnicity and gender (Denton, 2002; Leichenko and Silva, 2014; Shepherd and Binita, 2015). The table 3 also represents the mean difference of the exposure factor among the small and large scale farmers. The exposure factor is high

Table 3. Mean value of sample farmers

INDEX	Farmer	N	Mean	Std. Deviation	Std. Error Mean
ExposureFactor	Small	105	13.2762	1.54107	0.15039
	Large	45	13.8444	1.29607	0.19321

Source:Computed

Table 4. Independent sample t -test

Exposure index		F	Sig.	t-value	df	Sig.(2-tailed)
Exposure	Equal variances assumed	3.199	0.076	-2.166	148	0.032
	Equal variances not assumed			-2.321	98.219	0.022

Source: Computed

for the large scale farmers compared to small. This indicates that large scale farmers having more acres of land are more susceptible to climate variability.

To study the hypothesis of significant difference in the exposure factors among small and large scale farmers, t – test was calculated. The results exhibited that there wasnotable difference exhibited between the exposure index among the small and large scale farmers.

Table 5 represents the value of exposure index among the small and large scale farmers. The intensity of exposure is categorised into four such as low, medium, high and very high. The data reveals that the exposure index is low (<= 11.96) for only 12 small farmers and most of the small farmers lies in high to very high category (more than 13.46). There has been direct link between climate variability and change through flooding, drought, changes in average temperatures and extreme weather events. Apart from the natural resource inputs, climate variability and climate change can affect the production and marketing of agricultural products (Acosta-Moreno and Skea, 1996). By using stochastic specification model under uncertain situation, efficiency and productivity of crops can increase (Chavas, 2008). River based flooding and landslides had direct impact on infrastructure and indirect effects on agricultural activity, human migration and water supply. Even though these impacts were different in rural and urban areas but had very sensitive to climate variability and change (Scott *et al.,* 1996).

Table 6 represents the impact of sensitivity factor among the large and small scale farmers. The variables includes for the sensitivity are the decrease in quantity of production, the amount of loss in straw, decrease in amount of harvesting, amount of purchase in rice for consumption quantity of imports etc. In the sensitivity category, majority of small and large scale farmers were in the sensitivity index category group of 11.45 – 13.66 which is included in the high sensitivity index. It indicates that more farmers, irrespective of the category are vulnerable due to climate variability.

Table 7 represents the adaptive measures taken by the selected farmers in the Palakkad district. The data reveals that the small and large scale farmers practised high

Table 5.Farmers Exposure Factor Cross tabulation

Farmers		Exposure (Low, Medium, High and Very High)				
		<= 11.96	11.97-13.45	13.46-14.94	14.95+	Total
Small	Count	12	44	26	23	105
	% within farmers	11.4%	41.9%	24.8%	21.9%	100.0%
	% of Total	8.0%	29.3%	17.3%	15.3%	70.0%
Large	Count	2	15	15	13	45
	% within farmers	4.4%	33.3%	33.3%	28.9%	100.0%
	% of Total	1.3%	10.0%	10.0%	8.7%	30.0%
Total	Count	14	59	41	36	150
	% within farmers	9.3%	39.3%	27.3%	24.0%	100.0%
	% of Total	9.3%	39.3%	27.3%	24.0%	100.0%

Source: Computed

adaptive techniques to overcome the extent of vulnerability. Out of 105 small farmers, 60 farmers use high to very high adaptation measures because their adaptation value is higher than 7.47. Among 45 large scale farmers, 39 farmers lie in the category of High adaptation group, were aware of adaptive measures but not practiced in the agricultural sectors. New methods will be needed to overcome the climate change induced loss in agricultural production to withstand the risks associated with climate variability and avoid the shifting of occupation.

Table 8 reveals the mean values between the exposure, sensitivity and adaption factors among the small and large scale farmers. The result shows that both farmers had similar impacts arises from climate variability. But in case of adaptation, large scale farmers were more adaptive than small

Table 6. Farmers Sensitivity Factor Cross tabulation

Farmers		Sensitivity (Low, Medium, High and Very High)				
		<= 9.22	9.23-11.44	11.45-13.66	13.67+	
Small	Count	24	23	39	19	105
	% within farmers	22.90%	21.90%	37.10%	18.10%	100.00%
	% of Total	16.00%	15.30%	26.00%	12.70%	70.00%
	Count	10	10	20	5	45
Large	% within farmers	22.20%	22.20%	44.40%	11.10%	100.00%
	% of Total	6.70%	6.70%	13.30%	3.30%	30.00%
Total	Count	34	33	59	24	150
	% within farmers	22.70%	22.00%	39.30%	16.00%	100.00%
	% of Total	22.70%	22.00%	39.30%	16.00%	100.00%

Source: Computed

Table 7.Farmers Adaptation Factors Cross tabulation

Farmers		Adaptation (Low, Medium, High and Very High)				
		<= 6.13	6.14 - 7.46	7.47 - 8.79	8.80+	**Total**
Small	Count	33	12	44	16	105
	% within farmers	31.40%	11.40%	41.90%	15.20%	100.00%
	% of Total	22.00%	8.00%	29.30%	10.70%	70.00%
Large	Count	0	6	27	12	45
	% within farmers	0.00%	13.30%	60.00%	26.70%	100.00%
	% of Total	0.00%	4.00%	18.00%	8.00%	30.00%
Total	Count	33	18	71	28	150
	% within farmers	22.00%	12.00%	47.30%	18.70%	100.00%
	% of Total	22.00%	12.00%	47.30%	18.70%	100.00%

Source: Computed

Table 8. Group Statistics

Factors	farmers	N	Mean	Std. Deviation	Std. Error Mean
Exposure	small	105	13.2762	1.54107	0.15039
	Large	45	13.8444	1.29607	0.19321
Sensitivity	small	105	11.4476	2.38578	0.23283
	Large	45	11.4222	1.78998	0.26683
Adaptation	small	105	7.1714	1.45084	0.14159
	Large	45	8.1333	0.62523	0.0932

Source: Computed

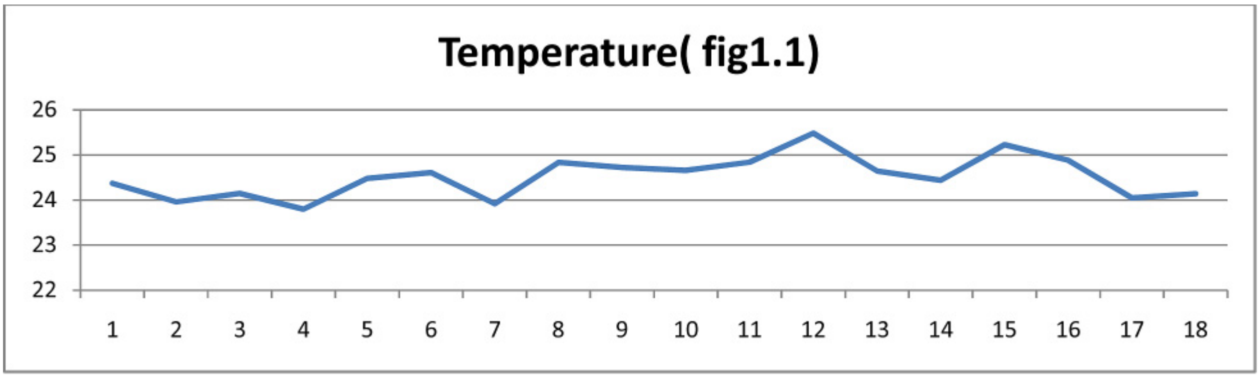
farmers because the mean value (8.1333) of large scale farmers is higher than the small (7.1714).

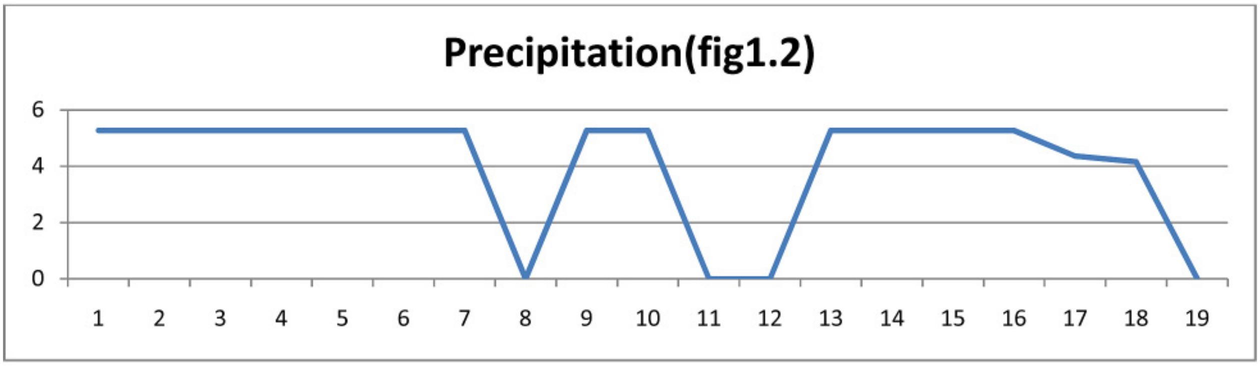
Table 9 represents the outcome of the t-test which shows that there is substantial difference between the exposure and adaptation factors among the small and large scale farmers because the t value is significant at 5 percent. From the analysis, it is clear that all the three indexes such as exposure, sensitivity and adaptation are significant that determine the vulnerability among the small and large scale farmers.

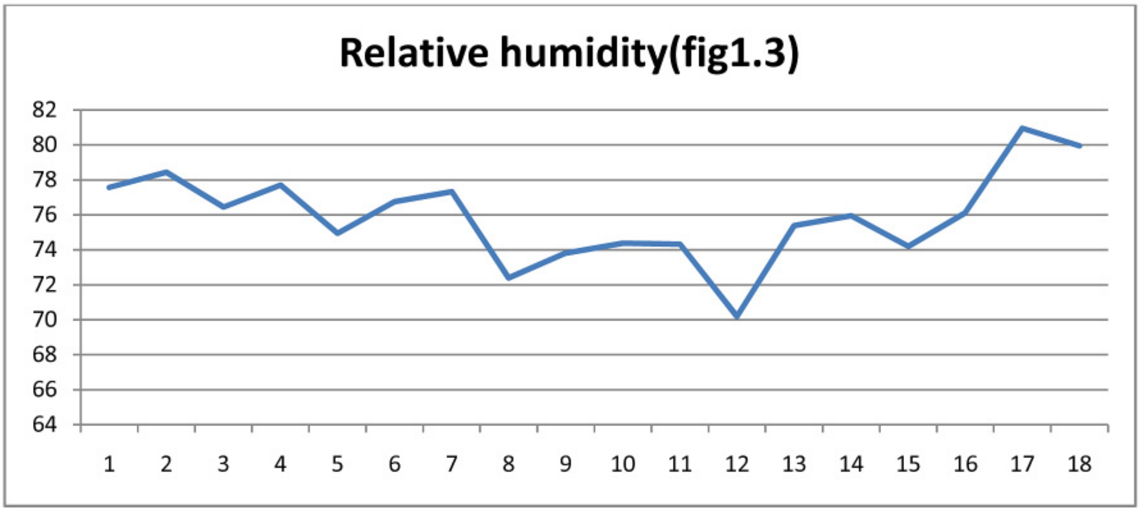
Table 10 represents the value of overall vulnerability between the small and large scale farmers. The mean value of largescale farmers was higher than that of the small because large scale farmers were unable to adjust the climate impact easily because of holding sizable acres of land. Different types of practices can improve mitigation and adaptation methods among farmers (McNeeley *et al.*, 2017)

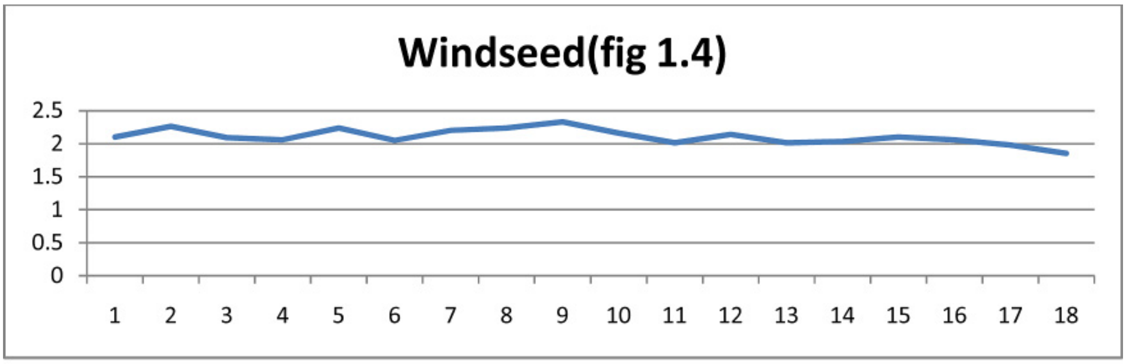
Table 11 represents the findings of the t- test which states that there is notable difference in the overall vulnerability among the small and large scale farmers at 1 percent significant level.

From the following depicted figures, it was noted the temperature (fig1.1) goes on


Temperature(fig1.1)
26
25
24
23
22
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18


Precipitation(fig1.2)
6
4
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19


Relative humidity(fig1.3)
82
80
78
76
74
72
70
68
66
64
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18


Windseed(fig 1.4)
2.5
2
1.5
1
0.5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

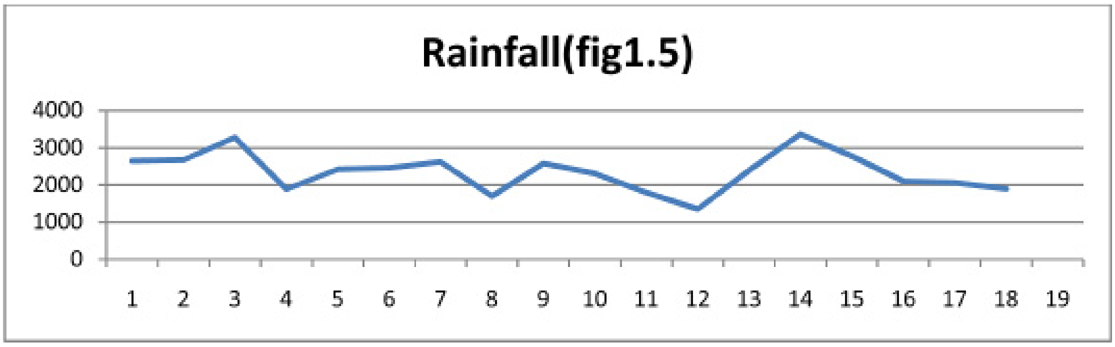


Fig 1.1, 1.2, 1.3, 1.4 &1.5 - Trends of climate variables from 2005 – 2022

Table 9. Test Results Independent Samples Test

Index		F	Sig.	t value	df	Sig. (2-tailed)
Exposure	Equal variances assumed	3.199	0.076	-2.166	148	0.032
	Equal variances not assumed			-2.321	98.219	0.022
Adaptation	Equal variances assumed	46.873	0	-4.274	148	0
	Equal variances not assumed			-5.675	147.982	0

Source: Computed

Table 10. Group Statistics-overall vulnerability

Vulnerability index	Farmers	N	Mean	Std. Deviation	Std. Error Mean
	Small	105	0.5712	0.14787	0.01443
	Large	45	0.6581	0.09041	0.01348

Source: Computed

Table 11. Test Results Independent Samples Test

Vulnerability index	F	Sig.	t value	df	Sig. (2-tailed)
Equal variances assumed	7.924	0.006	-3.659	148	0
Equal variances not assumed			-4.404	130.274	0

Source: Computed

increasing from 2013 onwards and the actual rainfall (fig.1.5) received in the district is showed fluctuating but it goes on declining from year 2000 onwards. These are the important climate variables which affect the production directly. Wind speed (fig.1.4) in the district shows more or less same trend but the relative humidity (fig.1.3) and precipitation (fig. 1.2) also showed very high rate. These would create negative impact the production of rice in the district.

CONCLUSION

The study reveals that the exposure, sensitivity and adaptation factors had a significant impact on farmers. But the severities of these factors on them are different. Exposure factor had medium impact and sensitivity factor created high impact on large number of sample farmers. Likewise, adaptation factor had high impact on small and large farmers. Even though adaptation practices are implemented in the district but it is not in the proper way. Therefore, improved methods like planting of climate resistant varieties, timely application of fertilisers and pesticides, better irrigation facilities and correct meteorological information etc. are needed. These are the important determinants to increase the production of rice and thereby reduce the financial risks associated with it. Better and improved agricultural insurance policies helps to manage the risks associated with the external factors.Proper understanding of the problems will help to reduce the negative impacts through the development of proper adaptive measures. Communication of proper and correct weather forecasts through various channels helps the farmers to mitigate the risks by taking quick and best adaptation measures.

REFERENCES

Agricultural Statistics.2021-22. Directorate of Economics and Statistics, Ministry of Agriculture, Government of Kerala.

Agricultural Statistics.2022-23.Directorate of Economics and Statistics, Ministry of Agriculture, Government of Kerala.

Amer Ait Sidhoum. 2023. Measuring farm productivity under production uncertainty. Agricultural and resource economics, 672-687.

Acosta-Moreno, R. 1997. Interview with S. Agrawala, Bonn, Germany, March 4.

Bohle, H. G., Downing, T. E.and Watts, M. J. 1994. Climate change and social vulnerability:-Toward a sociology and geography of food insecurity. Global Environmental Change, 4(1): 37–48.

Chavas, 2008.Stochastic Specification of Production Functions and Economics Implications.Journal of Econometrics, 7: 67- 86.

Denton, F. 2002. Climate change vulnerability, impacts, and adaptation: Why does gender matter? Gender and Development, 10(2): 10-20.

McNeeley, S. M., Even, T. L., Gioia,J. B. M., Knapp, C. N.and Beeton, T. A. 2017. Expanding vulnerability assessment for public lands: The social complement to ecological approaches. Climate Risk Management,16:106–119.

Riaman, R.; Sukono, S.; Supian, S. and Ismail, N. 2021.Analysing the decision making for agricultural risk assessment:An application of extreme value theory. Decis. Sci. Lett., 10: 351–360.

Riaman, R., Sukono, S., Supian, S. and Ismail, N. 2021.Determining the premium of paddy insurance using the extreme value theory method and the operational value at risk approach.Journal of Physics: Conference Series, *1722*(1) 012059.

Scott, C.A.and M.F. Walter, E.S. 1996. Impacts of historical changes in land use and dairy herds in water quality in the Catskills Mountains. Journal of Environmental Quality, 27:410-1417.

Sumathy, M., Smitha, P. and Manju Varghese. 2025. Climate Vulnerability Assessment among Small and Large Paddy Farmers in Palakkad District, Kerala.
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