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An economic analysis of impact of climate change in irrigation ecosystem of Tiruchirappalli district of Tamil Nadu, India

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Abstract
Climate change refers to long-term changes in the weather pattern and temperature trend. Due to drastic climate change and global warming, the availability of fresh water for irrigation became a major concern. Hence the present study was conducted to study the impact of climate change in canal, ground water and both canal and ground water irrigation ecosystems of Tiruchirappalli district of Tamil Nadu, India. For the present study, three blocks were purposively selected from the Tiruchirappalli district. 150 sample farmers were selected from 15 villages. Percentage analysis showed that there was an increase in irrigation intensity in all three-irrigation ecosystems and there was an increased number of irrigation for Sesame and Groundnut in the study area. All three irrigation ecosystems showed a decline in water availability. The irrigated area of major crops in the Tiruchirappalli district declined significantly along with an increase in the area of specific crops namely Sugarcane, Green Gram and Sorghum. The Ricardian model was employed to quantify the impact of climate change on the net income of farmers in all the three irrigation ecosystems. The Ricardian model revealed that both the Kharif season rainfall and the Rabi season rainfall had a positive impact on the net income of farmers in all three-irrigation ecosystems while the Kharif season maximum temperature had a detrimental effect on the net income in both canal and groundwater irrigation ecosystem. Tobit model was used to analyse the factors influencing the adoption of climate-smart technologies in the irrigation ecosystem. Tobit model results revealed that farm size, education and extension contact were the factors influencing the adoption of climate-smart technologies in all the three-irrigation ecosystems. The major constraint in all the three irrigation ecosystems was the labour shortage to adopt climate-smart technologies followed by the consequent yield reduction. Government should plan for climate strategies to enhance the beneficial effects and to mitigate the harmful effects of climate change in the district.

Keywords: Canal irrigation ecosystem, ground water irrigation ecosystem, canal and ground water irrigation ecosystem, Ricardian model, Tobit model and climate- smart technologies

Introduction
Climate change refers to long-term changes in the weather pattern and temperature trend. Climate change influenced the crop productivity and irrigation, with extreme changes in the weather causing floods and droughts. Irrigated area in the world was 241.5 million hectares, which were 20.33 per cent of the arable lands, and land under permanent area during 2009 and the percentage of area irrigated reduced drastically to 15.32 per cent in the year 2019. (Dhilip Kumar Majundar 2010). In India, it is anticipated that the irrigated rice yield will decrease by 10 per cent in 2050 and the yield of rain fed rice would decrease by 7 per cent in 2050. Wheat yields are also anticipated to fall by 6 to 25 per cent in 2100, as well as the reduction in maize yields by 18 to 23 per cent in 2100.
Tamil Nadu's average maximum and lowest temperatures would rise by 33°C and 4.50°C, respectively, during this century. On the other side, Tamil Nadu's average rainfall would decrease by 12 per cent within this century. Due to rise in both maximum and minimum temperature by 3 to 5 degrees Celsius and with low rainfall, the yield in major rice-growing districts like Tiruchirappalli and Thanjavur, there would be a reduction in yield. It would be up to 10 to 15 per cent in the year 2020 reduction in the yield followed by 30 to 35 per cent reduction in the yield in the year 2050 and 80 to 85 per cent reduction in the yield during the year 2050. (V. Geethalashmi, Dheebakaran *et al*., 2018). In this context, the present study aims to study the impact of climate change in canal, ground water and both canal and ground water irrigation ecosystems of Tiruchirappalli district of Tamil Nadu, India.

Design of the study

Selection of the study area

Tiruchirappalli district in Tamil Nadu was selected for the study. Three irrigation ecosystems namely canal irrigation ecosystem, groundwater irrigation ecosystem and both canal and groundwater irrigation ecosystem were selected. One block was purposively selected for each irrigation ecosystem. In each block, five villages were selected. From each village, ten farmers were selected randomly and the total sample size was one hundred and fifty farmers. Hence multi stage random sampling was adopted for the study.

Tools of analysis

Descriptive analysis

The percentage analyses were used to find out the irrigation intensity, the number of irrigation, water availability, irrigated area and adoption of climate-smart technologies for the study.

Ricardian model

To measure the impact of climate change on the value of the cropland, the cross- sectional technique namely the Ricardian model was used. In this model, the net income per hectare was regressed with climate and other exogenous variables. In this model, two season's climatic variables namely the Kharif and rabi were taken and analysed to measure the climatic variable's economic impact in the three different irrigation ecosystems in the Tiruchirappalli district.

Ricardian model employed was,

$V = \beta0 + \beta1 + \beta2 + \beta3 + \beta4 + \beta5 + \beta6 + \beta7 + \beta8 + \beta9 + \beta10 + \beta11 + \beta12 + \beta13 + \beta14 + \beta15 + \beta16 + \beta17 + \beta18 + \mu$

Where,

$\beta1$ = KMAXTEM = Kharif season maximum temperature in degrees Celsius

$\beta2$= KMAXTEM2 = squared Kharif season maximum temperature in degrees Celsius

$\beta3$= KMINTEM = Kharif season minimum temperature in degrees Celsius

$\beta4$= KMINTEM2 = squared Kharif season in minimum temperature

$\beta5$= KRAIN = Kharif season rainfall in mm

$\beta6$= KRAIN2 = Squared Kharif season rainfall in mm

$\beta7$= KRAINDAY = Total rainy days during the Kharif season

$\beta8$= RMAXTEM = Rabi season maximum temperature in degree Celsius

$\beta9$= RMAXTEM2 = Squared Rabi season maximum temperature in degrees Celsius

$\beta10$= RMINTEM = Rabi season minimum temperature in degrees Celsius

$\beta11$= RMINTEM2 = Squared Rabi season minimum temperature in degrees Celsius

$\beta12$= RRAIN = Rabi season rainfall in mm

$\beta13$= RRAIN2 = Squared Rabi season rainfall in mm

$\beta14$= RRAINDAY = Number of rainy days in the Rabi season

$\beta15$= EDU = Education in years

$\beta16$= FARMEXP = Farm experience in years

$\beta17$= FAMSIZE = Family size in numbers

$\beta18$ = EXTN = Extension contacts in number of times

$\beta0$ = intercept

μ= error term

Tobit model

The tobit model is specified as

$Yi = = \beta' Xi + \mu i$, if $\beta' Xi + \mu i > 0$

$= 0, \beta' Xi + \mu i < 0$

i = 1, 2, 3, N

where, Yi is the dependent variable, Xi is the independent variable, N is the number of observations, β is the vector of the unknown parameter, and μi error term which is independently distributed assumed to be zero mean and constant variance. It involves estimation of maximum likelihood, which takes into account positive values of Y and standard normal density function.

The Tobit model employed for the study was

Y1= f (FARM, EDU, EXTN, AGE, EXP, FAM) +μ

Where,

FARM= Farming experience in years

EDU= Education of the respondent in terms of the number of years

EXTN= Frequency of extension contact in number of times per year

AGE= Age of the respondent in years

EXP= Farming experience of the respondent in years

FAM= Family size of the respondent in number

μ= Random error

Results and Discussion

Impact of climate change on water resources

Impact of climate change on irrigation intensity

Irrigation intensity was assessed using the percentage analysis among the sample farmers in the canal, groundwater and both canal and groundwater irrigation between the periods of 2016 and 2020 and the assessed results of irrigation intensity are discussed below in table 1.

Table 1: Irrigation intensity under different ecosystem

S. No.	Irrigation ecosystem	Net irrigated area (ha)		Gross irrigated area (ha)		Irrigation intensity (%)	
		2016	2020	2016	2020	2016	2020
1.	Canal Irrigation	4.54	4.06	4.95	4.56	109.03	112.32
2.	Groundwater Irrigation	4.27	3.26	4.42	3.63	103.51	111.35
3.	Canal and groundwater irrigation	3.83	4.25	3.91	4.86	102.09	114.35

It could be inferred from the table that in the canal irrigation ecosystem and the groundwater irrigation ecosystem there was a decline in the net irrigated area and gross irrigated area. On the other hand, in both canal and groundwater irrigation ecosystem, there was an increase in the net irrigated area and gross irrigated area. The irrigation intensity in the canal irrigation ecosystem was 109.03 per cent during the year 2016 and the irrigation intensity during 2020 was 112.33 per cent indicating a rise in the net irrigated area resulting in an increased percentage of irrigation intensity. The irrigation intensity in the groundwater irrigation ecosystem during 2016 was 103.51 per cent and the percentage during 2020 was 111.35 per cent, which revealed that there was an increase in the irrigation intensity.

In both canal and ground water irrigation ecosystem the irrigation intensity was 102.09 per cent during the year 2016 and the percentage of irrigation intensity during 2020 was 114.35 per cent. It could be inferred from the above table that in all the three irrigation ecosystems, the irrigation intensity was marginally increased.

Impact of climate change on the number of irrigation

The impact of climate change on number irrigation was studied among the sample farmers in canal irrigation, groundwater irrigation and both canal and groundwater irrigation ecosystem in Tiruchirappalli district and the results are discussed below in table 2

Table 2: Number of irrigation under different ecosystem

S.No.	Irrigation ecosystems	Crop	Number of irrigation		Change in numbers
			2016	2020	
1.	Canal irrigation	Banana	85	75	-10 (-8.33)
		Black gram	12	10	-2 (-5.00)
2.	Groundwater irrigation	Banana	80	90	10 (8.00)
		Black gram	10	8	-2 (-20.00)
		Groundnut	8	12	4 (50.00)
3.	Canal and groundwater irrigation	Banana	105	90	-15 (-11.53)
		Sugar cane	35	40	5 (-14.28)
		Sesame	10	12	2 (20.00)

It could be observed from the table that in the canal irrigation ecosystem the total number of irrigation of Banana was reduced by 8.33 per cent. In Black gram, there was a decline in the percentage of number of irrigation by 5.00 per cent. In groundwater irrigation ecosystem, the number of irrigation for Banana was increased by 8.00 per cent and in Groundnut, the number of irrigation was increased by 50.00 per cent. In the case of the Black gram, the number of irrigation was reduced by 20.00 per cent. In canal and groundwater irrigation ecosystem, the total number of irrigation in Banana was reduced by 14.28 per cent. In Sesame, the number of irrigation was increased by 20.00 per cent. Thus, it could be concluded from the table that in the canal irrigation ecosystem, there was a reduction in the number of irrigation and in the groundwater irrigation ecosystem, the number of irrigation was increased except for Black gram. In the case of both canal and groundwater irrigation ecosystems, there was decreased number of irrigation except for Sesame and Groundnut**.**

Impact of climate change on water availability

The percentage analysis was used to analyse the impact of climate change on water availability in canal irrigation, groundwater irrigation and both canal and groundwater irrigation in the Tiruchirappalli district and the results are discussed below in table 3

Table 3: Water availability under different ecosystems

S. No	Types of irrigation ecosystem	Water availability (%)	
		2016	2020
1.	Canal irrigation ecosystem	94.26	74.68
2.	Groundwater irrigation ecosystem	107.51	85.89
3.	Canal & groundwater irrigation ecosystem	120.75	97.56

It could be inferred that in the canal irrigation ecosystem water availability was 94.26 per cent in the year 2016 and the percentage of water availability was reduced to 74.68 per cent during the year 2020. In the groundwater irrigation ecosystem, the percentage of water availability was 107.51 per cent during the year 2016, which was reduced to 85.98 per cent in the year 2020. In both canal and groundwater irrigation ecosystem, the percentage of water availability was 120.75 per cent in the year 2016 which was reduced to 97.56 per cent during the year 2020. Thus, in all the three irrigation ecosystem ecosystems of the Tiruchirappalli district, there was a decline in water availability. Impact of climate change on irrigated area in the Tiruchirappalli district

The impact of climate change on the irrigated area of the major crops were studied by comparing the change in the irrigated area between the periods of 2016 and 2020 and the results are furnished in table 4

Table 4: Impact of climate change on the irrigated area in the Tiruchirappalli district

S. No.	Crop	2016-2017	2020-2021	Change in the area (ha)
1.	Paddy	27035.46	21342.51	-5692.95 (-21.05)
2.	Banana	18236.52	15654.34	-2582.18 (-14.15)
3.	Sugarcane	2383.32	3726.61	1343.29 (56.23)
4.	Cotton	11635.54	9263.45	-2372.09 (-20.38)
5.	Black gram	3543.34	3217.56	-325.78 (-9.19)
6.	Green gram	307.72	415.65	107.93 (35.07)
7.	Maize	11010.75	9562.23	-1448.52 (-13.15)
8.	Sorghum	891.02	972.53	81.51 (9.14)
9.	Groundnut	7413.90	5473.25	-1940.65 (-26.17)
10.	Sesame	989.51	856.73	-132.78 (-13.41)

The results revealed that in paddy, there was decrease in the irrigated area by 21.05 per cent and in Banana, the percentage of decline in area was 14.15 per cent. In Sugarcane, there was increase in the irrigated area by 56.23 per cent. In Cotton, there was a decline in the percentage of irrigated area by 20.38 per cent. In the case of Pulses, there was a decline in the irrigated area of Black gram by 9.19 per cent and the percentage in Green Gram was increased by 35.07 per cent. There was a decrease in the percentage of the irrigated area of maize with
13.15 per cent. In Sorghum, the percentage of increase in irrigated area was 9.14. In Groundnut, there was a decrease in the percentage of irrigated area by 26.17 per cent. In Sesame, the decline in the irrigated area was 13.41 per cent. Thus, it could be concluded that the irrigated area of major crops in the Tiruchirappalli district declined significantly along with an increase in the area of specific crops namely Sugarcane, Green Gram and Sorghum.

Impact of climate change on net income of sample farmers
The impact of climate change on the net income of three irrigation ecosystems in the Tiruchirappalli district was measured using the Ricardian model and the results are furnished in table 5

Table 5: Ricardian income function in Tiruchirappalli district

S. No.	Particulars	Canal irrigation ecosystem	Ground water irrigation ecosystem	Canal and ground water ecosystem
1	Intercept	97224.09	54676.29*	45782.54
2	Kharif season maximum temperature	2760.50**	3820.50*	-6532.55*
3	Kharif season minimum temperature	-8300.97	14220.56	-3506.15**
4	Kharif season rainfall	450.52**	685.25**	4120.75*
5	Total rainy days during kharif season	535.61*	-240.25	450.25
6	Squared kharif season maximum temperature	4.15*	10.59**	10.50**
7	Squared Kharif season minimum temperature	720.56	-165.81	9.65
8	Squared kharif season rainfall	-10.25*	-12.65*	-2.56*
9	Rabi season maximum temperature	-160.55*	2765.82	-2530.50
10	Rabi season minimum temperature	-60.25	-280.65	185.22
11	Rabi season rainfall	4322.06*	220.25*	4075.65*
12	Squared season rabi maximum temperature	2.06	5.14	30.65
13	Squared season rabi minimum temperature	2125.68	278.95	-382.56
14	Squared season rabi rainfall	- 4.25	7.85	-12.58
15	Total rainy days during the Rabi season	-5.15	10.50	157.05
16	Education	560.95*	158.65**	180.68**
17	Farm experience	147.83*	80.50**	-415.60
18	Family size	-64.38	320.58*	65.93**
19	Extension contacts	236.89*	220.58*	350.85*

**Significant at 1 per cent level; *Significant at 5 per cent level

It could be concluded from the above table that in canal irrigation ecosystem, rainfall during the Kharif season and rabi season, Kharif season maximum temperature, squared kharif season maximum temperature, total rainy days during the Kharif season, education, farm experience and extension contacts increased the net income of farmers. Rabi season maximum temperature and squared kharif season rainfall had negative impact on net income of farmers. In groundwater irrigation ecosystem, the Kharif season and Rabi season rainfall, Kharif season maximum temperature, squared Kharif season maximum temperature, education, farm experience, family size and extension contacts increased the net income of sample farmers whereas the squared Kharif season rainfall decreased the net income of farmers.
In both canal and groundwater irrigation ecosystem the rainfall during the Kharif and rabi season, Kharif season minimum temperature, squared kharif season maximum temperature, education, farm size and extension contact increased the net income of the sample farmers whereas the Kharif season maximum and minimum temperature and squared Kharif season rainfall decreased the net income of sample farmers. Further, the quantification of the impact of climatic variables on net income of sample farmers is discussed in the following section.

Marginal impact of significant climatic variables over net income of farmers
Marginal impacts of significant climatic variables on net income in three irrigation ecosystems in the Tiruchirappalli district are discussed in the table 6

Table 6: Marginal impact of significant climatic variables over net income of farmers

SI. No	Irrigation ecosystems	Kharif season rainfall	Rabi season rainfall	Kharif maximum temperature
1.	Canal irrigation ecosystem	450.52**	4322.06*	2760.50**
2.	Groundwater irrigation ecosystem	685.25**	220.25*	820.50*
3.	Canal and groundwater irrigation ecosystem	4120.75*	4075.65*	-6532.55*

**Significant at 1 per cent level; *Significant at 5 per cent level

It could be observed from the table that an increase in rainfall during the Kharif season significantly increased the net income of farmers in all three irrigation ecosystem ecosystems. The marginal impact of the Kharif season rainfall was highest in both canal and groundwater irrigation ecosystems with an increase in the net revenue by 4120.75 rupees. The marginal impact of the Rabi season rainfall was much felt in the canal irrigation ecosystem with an increase in net income of 4322.06 rupees. The marginal impact of the Kharif season maximum temperature in both canal and groundwater irrigation ecosystems would reduce the net income by 6532.55 rupees. A similar study by Temesgen Tadesse Deressa *et al*., 2016 [3] reported a reduction in the net revenue by US$ 64.2 due to increase in temperature during June to September.

Increasing the Kharif season maximum temperature in the canal irrigation ecosystem and groundwater irrigation ecosystem would have a positive marginal impact by increasing the net income by 2760.50 rupees and 3820.50 rupees respectively. Thus, the Kharif season rainfall was much felt in both canal and groundwater irrigation ecosystems and the Rabi season rainfall had a much presence in the canal irrigation ecosystem. On the other hand, the highest reduction in net income with maximum temperature was felt in both canal and groundwater irrigation ecosystems.

Adoption of climate-smart technologies

Climate-smart technologies adopted by sample farmers

The impact of climate change on various climate-smart technologies of shifting to tree crops, changing the cropping pattern, adopting mixed farming, increasing the seed rate, increasing the farm yard manure, mulching, different varietal selection, and adjusting plant dates was studied in all three irrigation ecosystem in Tiruchirappalli district and the results were discussed below in the table 7.

Table 7: Adoption of climate-smart technologies in Tiruchirappalli district

S. No.	Climate-smart technologies	Canal irrigation ecosystem	Groundwater irrigation ecosystem	Canal and groundwater irrigation ecosystem
1.	Tree crop	8 (16.00)	10 (20.00)	11 (22.00)
2.	Crop pattern	23 (46.00)	16 (32.00)	26 (52.00)
3.	Mixed farming	16 (32.00)	17 (34.00)	24 (48.00)
4.	Increased seed rate	24 (48.00)	27 (54.00)	29 (58.00)
5.	Increased farm yard manure	17 (34.00)	21 (42.00)	25 (50.00)
6.	Mulching	10 (20.00)	7 (14.00)	18 (36.00)
7.	Variety selection	27 (54.00)	28 (56.00)	23 (46.00)
8.	Adjusting plant dates	10 (20.00)	15 (30.00)	11 (22.00)
	Total no. of farmers	50	50	50

It could be observed that in the canal irrigation ecosystem the highest proportion of climate-smart technologies was the variety selection with 54.00 per cent followed by increased seed rate with 48.00 per cent.The least percentage of climate-smart technology adopted in canal irrigation ecosystem was shifting to tree crop with 16.00 per cent. In the groundwater irrigation ecosystem, the highest contribution of climate-smart technology was also the variety selection with 56.00 per cent followed by the increased seed rate with 54.00 per cent and the percentage of increased farm yard manure was 42.00 per cent. The least contribution of climate-smart technology in the groundwater irrigation ecosystem was mulching with 14.00 per cent.

In both canal and groundwater irrigation ecosystems, the highest proportion was the increased seed rate with 58.00 per cent followed by changing the cropping pattern with 52.00 per cent. The least percentage in the adoption of climate-smart technologies in both canal and groundwater irrigation ecosystems was the shifting to tree crops and adjusting plant dates with

22.00 per cent. Thus, it could be inferred from the table that farmers adopted varietal selection as the highest climate-smart technology both in the canal irrigation ecosystem and groundwater irrigation ecosystem whereas, in the case of both canal and groundwater irrigation ecosystem, the highest proportion of climate-smart technology adopted was the increased seed rate.

Factors influencing climate-smart technologies adoption

Factors influencing the adoption of climate-smart technologies in all three irrigation ecosystem were analysed using the Tobit model and the results are furnished in table 8

Table 8: Factors influencing the adoption of climate-smart technologies

S.No	Particular	Canal irrigation ecosystem		Groundwater irrigation ecosystem		Canal and groundwater irrigation ecosystem	
		Coefficients	Total elasticity	Coefficients	Total elasticity	Coefficients	Total elasticity
1.	Farm size	0.864**	-0.503	0.539*	0.490	0.4370*	0.8425
2.	Education	0.093*	0.124	0.422*	0.022	0.0568*	0.4320
3.	Extension contacts	0.630*	0.108	0.153*	0.891	0.2670*	0.4232
4.	Age	0.172*	0.146	-0.026*	-1.035	-0.5621*	0.8753
5.	Experience	0.292*	0.140	0.567**	0.315	-0.3496**	0.2542
6.	Family size	0.216NS	0.141	-0.035*	-1.325	5.7113NS	0.5432
7.	Constant	0.665		0.865	2.569	0.8756	0.1762
8.	Sigma	468.35		475.30		402.65	19.8732
9.	Log-likelihood	30.76		32.56		33.25	

*Significant at 1 per cent level; *Significant at 5 per cent level

In canal irrigation ecosystem the farm size, education, extension contacts, age, and farm experience positively influenced the adoption of climate-smart technologies. A similar study by Vijay Laksmi *et al*. (2007) revealed that age and experience had a positive impact and significant influence on the adoption of zero tillage as climate-smart technology. Study by Laxmi *et al*. (2007) found that extension contacts had a positive impact on the adoption of climate-smart technology among the paddy farmers in Indo-Gangetic plains.

In groundwater irrigation ecosystem the farm size, education, extension contacts, age, farm experience had a positive impact on the adoption of climate-smart technologies. On the other hand, the family size and age had a negative impact on the adoption of climate-smart technologies. Similar results reported by Omolehin, R. A. *et al*., (2020) revealed that in the rural area of Nigeria, the age of farmers and farming experience had a negative impact on the adoption of climate-smart technologies.

In both canal and groundwater irrigation ecosystem the farm size, education, and extension contact had positively influenced the adoption of climate-smart technologies whereas the age and farm experience had negatively influenced the adoption of climate smart technologies in the study area. A similar study by Angles, S *et al*., (2011) [4] studied that age had a negative influence on the adoption of climate-smart technologies to mitigate climate change. Thus, in all the three irrigation ecosystem ecosystems of the Tiruchirappalli district, the climate-smart technologies adoption was influenced by the factors considered for the study.

Constraints in adoption of climate-smart technologies

The constraints in the adoption of climate-smart technologies by the sample farmers in the Tiruchirappalli district were studied and the results are discussed in table 10

Table 9: Constraints in the adoption of climate-smart technologies

S. No.	Constraints	Canal irrigation ecosystem	Groundwater irrigation ecosystem	Canal and Groundwater irrigation ecosystem
1.	Lack of extension information	29 (58.00)	31 (62.00)	27 (54.00)
2.	Yield reduction	32 (64.00)	34 (68.00)	36 (72.00)
3.	Poor irrigation management	28 (56.00)	26 (52.00)	22 (44.00)
4.	Poor crop insurance coverage	22 (44.00)	25 (50.00)	23 (46.00)
5.	Labour shortage	35 (70.00)	38 (76.00)	41 (82.00)

It could be observed from the table that in the canal irrigation ecosystem, the major proportion of constraint was contributed by labour shortage with 70.00 per cent. The percentage contributed by yield reduction was 64.00 per cent. The least proportion in constraint was poor insurance coverage with 44.00 per cent. In the groundwater irrigation ecosystem, the major proportion in constraint was contributed by labour shortage with 76.00 per cent. The percentage contributed by yield reduction was 68.00 per cent. The least proportion in constraint was poor insurance coverage with 50.00 per cent.

In both canal and groundwater irrigation ecosystems, the highest proportion of constraint was the labour shortage with 82.00 per cent. The percentage contributed by yield reduction was 72.00 per cent. The least proportion in constraint was poor irrigation management with 44.00 per cent. It could thus be inferred from the results that the highest proportion of constraint in all the three irrigation ecosystems was the labour shortage to adopt climate-smart technologies followed by the consequent yield reduction.

Summary and Conclusion

The study on water resources revealed that there was a marginal increase in the irrigation intensity in all three irrigation ecosystems. On the other hand, there was a decline in the number of irrigation for crops except sesame and groundnut in the study area. Also, there was a decline in the water availability and in the irrigated area of crops except Sugarcane, Green Gram and Sorghum in all the three irrigation ecosystems of Tiruchirappalli district. Thus there was differential impact on water resources with climate change. The Ricardian model revealed that both the Kharif season rainfall and the Rabi season rainfall had a positive impact on the net income of farmers in all three-irrigation ecosystems while the Kharif season maximum temperature had a detrimental effect on the net income in both canal and groundwater irrigation ecosystem.

The climate-smart technologies of shifting to tree crops, changing the cropping pattern, adopting mixed farming, increasing the seed rate, increasing the farm yard manure, mulching, different varietal selection, and adjusting plant dates were practiced in the study area. Tobit model results on adoption of these technologies revealed that farm size, education and extension contact were the factors influencing the adoption of climate-smart technologies in all the three-irrigation ecosystems. The major constraint in all the three irrigation ecosystems was the labour shortage to adopt climate-smart technologies followed by the consequent yield reduction. Ricardian analyses on three-irrigation ecosystem revealed that climatic variables had significant and differential influence on net income of farmers. In addition, the magnitude of climate change on Kharif rainfall, Rabi rainfall and maximum temperature is influencing the net income of farmers of the district. Hence, the Government should plan for climate strategies to enhance the beneficial effects and to mitigate the harmful effects of climate change in the district.

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