

Irrigation Intensity and Cropping Intensity in Rayalaseema Region: A District-level Correlation Analysis using Karl Pearson's Method

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Received: 31 July 2026; Revised accepted: 03 Sept 2026

Abstract

Irrigation refers to the artificial feeding of the soil or plants during dry spells. It is a vital input of modern agriculture for crop production and has a strong impact on crop diversification. Its urgency needs emphasis for having stable and successful agriculture in areas like drought-prone regions, where rainfall is seasonally distributed and unreliable. So, in this paper, an attempt has been made to analyze the irrigation intensity, cropping intensity, and the relationship between irrigation intensity and cropping intensity in the Rayalaseema Region at the mandal level for the year 2023-24. Karl Pearson's product-moment correlation coefficient method has been adopted to compute the relationship between irrigation intensity and cropping intensity. The mandal-level irrigation and cropping pattern data have been collected from the Chief Planning Office (CPO) of Kurnool district and the Economic and Statistical Departments of the respective districts for the year 2023-24. The analysis of Karl Pearson's Correlation Coefficient across the eight districts of Rayalaseema Region reveals that the relationship between irrigation intensity and cropping intensity is predominantly weak, with correlation values confined within the range of -0.3674 to $+0.3326$.

Key words: Irrigation, Cropping pattern, Irrigation intensity, Cropping intensity, Karl Pearson's product-moment correlation coefficient

Irrigation refers to the artificial provision of water to plants. It is a critical non-physical input in modern agriculture, as crop production in any area largely depends on the availability of irrigation facilities. In the Rayalaseema Region, inadequate and irregular rainfall adversely affects agricultural productivity. Due to spatial variation in rainfall distribution and monsoon uncertainty, agriculture in this region has become highly dependent on artificial water supply. Consequently, irrigation significantly influences agricultural production [1]. Irrigation intensity serves as a key parameter for assessing agricultural patterns and the level of regional development. Irrigation is a prerequisite for agricultural development and is essential for both crop production and diversification. Modern agricultural practices require increased irrigation due to the expanded use of advanced inputs and the application of chemicals for soil conservation [2]. The importance of irrigation has grown with the adoption of recent agricultural technologies. Most irrigation facilities, including wells and tube wells, are artificial sources. While increased irrigation intensity enhances agricultural production, it also leads to the overexploitation of groundwater resources.

Previous studies have established irrigation as an important determinant of agricultural intensification and cropping intensity, although the magnitude and direction of this relationship vary considerably across regions. Abhilash *et al.* [3], Gohar and Cashman [4] reported that irrigation

significantly influenced cropland use and cropping patterns, while Goswami and Sen [5] highlighted its role in improving land-use efficiency and area allocation among different farm-size groups. Rout [6] emphasized that assured and timely irrigation reduces dependence on monsoon rainfall, improves input-use efficiency and enhances agricultural production and employment. Positive associations between irrigation and cropping intensity were also reported by Bairagi [7], Ahlawat [8], Ganguly [9], Deshmukh [10], Sujatha [11] and Mondal [12], although substantial spatial disparities were observed. Conversely, Jasim [13] and Dey [14] reported weak or negative relationships in parts of Tamil Nadu and West Bengal, indicating that cropping intensity is influenced not only by irrigation but also by crop diversification, land-use changes, soil and climatic conditions, technological adoption and socio-economic factors. Similarly, Pagar [15] observed considerable tahsil-level variation in Nashik District, with better-irrigated areas generally recording higher cropping intensity. Recent studies have further highlighted the growing pressure on groundwater resources due to increasing irrigation demand and recommended crop diversification, rainwater harvesting, groundwater recharge and water-conserving technologies for sustainable agricultural development [16-17]. Ali [18] also reported a predominantly negative relationship between irrigation and cropping intensity in Dakshin Dinajpur, attributing the variation to changing land use, rising input costs,

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Citation: Appanna B, Chendrayudu N. 2026. Irrigation intensity and cropping intensity in Rayalaseema region: A district-level correlation analysis using Karl Pearson's Method. *Res. Jr. Agril. Sci.* 17(5): 560-570.

declining soil fertility and farmers' preference for single commercial crops. Collectively, these studies indicate that while irrigation is a critical prerequisite for agricultural intensification, its influence on cropping intensity is highly context-specific and is governed by a combination of physical, technological, economic and socio-cultural factors.

MATERIALS AND METHODS

Royalaseema is a geographic region in the Indian state of Andhra Pradesh. It comprises four southern districts of the State, from before the district's reorganization in 2022, namely Kurnool, Anantapur, YSR and Chittoor. Four new districts were created from these, namely Sri Sathya Sai, Nandyal, Anamaya and Tirupati. Royalaseema region is a landlocked region with an expanse of 67,526 km², accounting for 42% of the total

geographical area of Andhra Pradesh. The region lies between 12°30' to 16°15' N and 76°55' to 79°55' E. It is situated in the south and southeastern part of the Deccan Plateau. The region is bordered by Tamil Nadu to the south Karnataka to the west, and other parts of Andhra Pradesh to the north and east. The altitude varies from 300 to 700m above MSL. Geologically, the Royalaseema region in Andhra Pradesh is a diverse and ancient landmass primarily composed of hard rock formations, spanning ages from the Archean to the Recent, with a significant presence of Precambrian rocks. The average annual rainfall is 672 mm. The Royalaseema region is characterized by a hot, semi-arid climate with high temperature variations across different seasons, often exceeding the average. To examine the relationship between irrigation intensity and cropping intensity at the mandal level across eight districts of the Royalaseema Region using Karl Pearson's Correlation Coefficient.

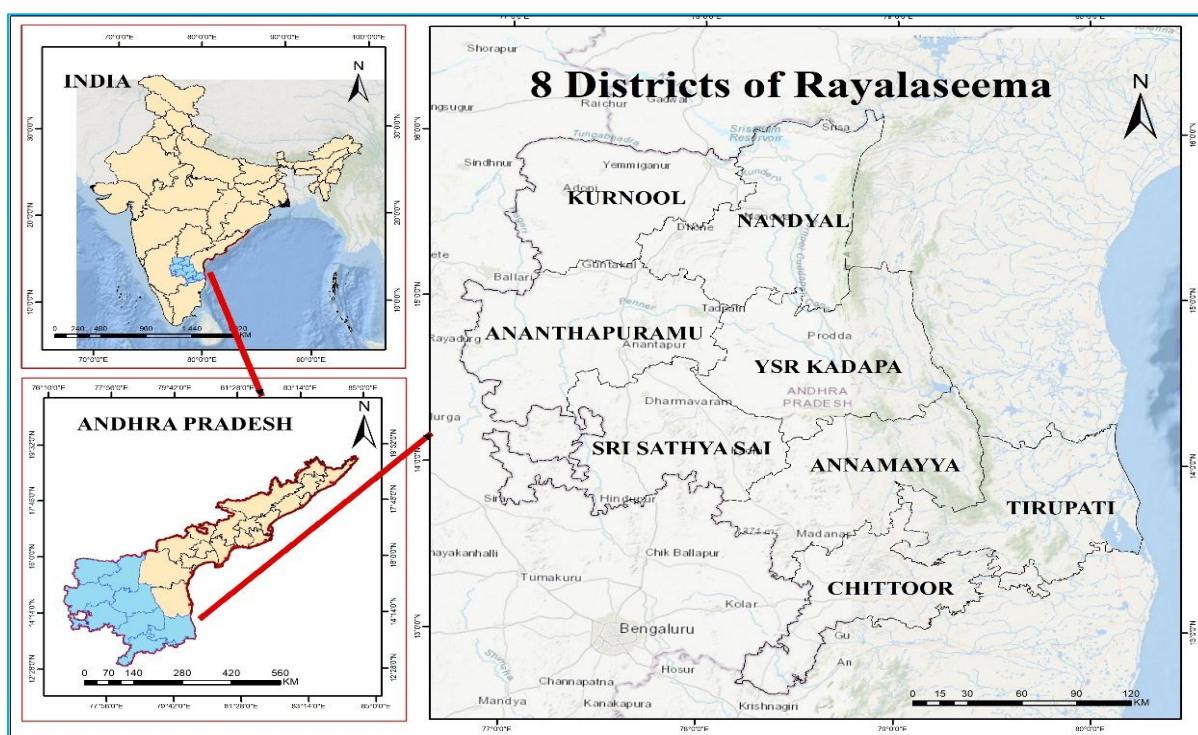


Fig 1 Location map of the study area

The study is based on secondary data collected from the Chief Planning Office (CPO) and the Economic and Statistical Departments of the respective districts. Here, the mandal level has been taken as a unit for analysis. Karl Pearson's product-moment correlation coefficient method has been applied for analyzing the relationship between cropping intensity and irrigation intensity. The given equations are used to get cropping intensity and irrigation intensity.

$$1). \text{ Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100$$

$$2). \text{ Irrigation intensity} = \frac{\text{Net irrigated area}}{\text{Net Sown area}} \times 100$$

3). The Karl Pearson's Correlation Coefficient is computed using the following formula:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \cdot \sum(y_i - \bar{y})^2}}$$

Where;

r = Karl Pearson's Correlation Coefficient

x_i = Individual value of the independent variable (X)

y_i = Individual value of the dependent variable (Y)

$\bar{x}$ = Arithmetic mean of variable X

$\bar{y}$ = Arithmetic mean of variable Y

$\sum(x_i - \bar{x})(y_i - \bar{y})$ = Sum of the products of deviations of X and Y from their respective means

$\sum(x_i - \bar{x})^2$ = Sum of squared deviations of X from its mean

$\sum(y_i - \bar{y})^2$ = Sum of squared deviations of Y from its mean

n = Number of observations

RESULTS AND DISCUSSION

Irrigation intensity

Irrigation intensity is controlled by various factors such as the source of irrigation, types of crops grown, cropping season, quantity and quality of water supply, density of the network of water channels, etc. The benefit of irrigation intensity is reflected in cropping patterns, land productivity, land-use efficiency, and cultivation methods.

Table 1 Distribution of irrigation intensity

Category	No. of Mandals
Very high irrigation intensity (>80 %)	41
High irrigation intensity (60-80 %)	27
Moderate irrigation intensity (40- 60%)	50
Low irrigation intensity (20-40%)	68
Very low irrigation intensity (<20%)	62
Total	248

Data depicted in (Table 1) shows wide variation in irrigation intensity. It varies from a minimum of 0.50 in Kolimigundla mandal to a maximum of 100 in Badvel, Gopavaram, Chennur, Sidhout, and Nandalur. The average irrigation intensity of the Rayalaseema region is 44 %. Forty-one mandals belong to the very high (> 80) category of irrigation intensity. High level (60 %-80%) of intensity prevails in twenty-seven Mandals. Moderate irrigation intensity is found in 50 mandals of the Rayalaseema Region. Sixty-eight mandals are observed in low irrigation intensity ((20-40%) and the remaining sixty-two mandals are observed in very low irrigation intensity (<20%).

Cropping intensity

Intensity of cropping, extent of maturity, and increasing the yield from the existing cultivated area are problems of paramount importance in the agricultural economy of a region. They require serious attention by the planners. Underutilization

of land is not a problem in a region, since most of the topographically accessible area for cultivation is already under the plow. Still, the problems of underuse of net sown area, underproductivity, and the risk of crop failures are taxing the rural population.

Table 2 Distribution of cropping intensity

Category	No. of Mandals
Very high cropping intensity (>80 %)	3
High cropping intensity (60-80 %)	4
Moderate cropping intensity (40- 60%)	12
Low cropping intensity (20-40%)	53
Very low cropping intensity (<20%)	176
Total	248

Data presented in (Table 2) shows wide variation in cropping intensity. It varies from a minimum of 0.00 in Srisailam mandal to a maximum of 164.94 in Nagari mandal. The average irrigation intensity of the Rayalaseema Region is 110%. Three mandals belong to the Very high (> 152) category of irrigation intensity. High level (139-152%) of intensity prevails in four Mandals. Moderate irrigation intensity (126-139%) is found in the twelve mandals of the Rayalaseema Region. Fifty-three mandals were observed in Low Irrigation Intensity (113-126%), and the remaining one hundred seventy-six mandals were observed in Very low Irrigation Intensity (<113%).

Table 3 Statistical relationship of irrigation intensity and cropping intensity in Kurnool district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	C. Belagal	43.53	122.60	22.76	14.04	517.94	197.00	319.43
2.	Gudur	10.29	105.74	-10.48	-2.82	109.86	7.98	29.60
3.	Kallur	10.99	119.76	-9.78	11.20	95.68	125.34	-109.51
4.	Kurnool	17.03	114.74	-3.74	6.18	14.00	38.14	-23.11
5.	Orvakal	13.20	108.56	-7.57	0.00	57.33	0.00	0.03
6.	Kodumur	20.80	126.89	0.03	18.33	0.00	335.83	0.52
7.	Veldurthy	18.23	103.75	-2.54	-4.81	6.46	23.18	12.24
8.	Mantralayam	20.19	104.97	-0.58	-3.59	0.34	12.92	2.09
9.	Kosigi	24.51	108.98	3.74	0.42	13.98	0.17	1.55
10.	Kowthalam	22.06	105.89	1.29	-2.67	1.66	7.15	-3.45
11.	PeddaKadubur	44.27	113.40	23.50	4.84	552.17	23.38	113.63
12.	Yemmiganur	34.78	103.53	14.01	-5.03	196.24	25.35	-70.52
13.	Nandavaram	21.60	104.54	0.83	-4.02	0.69	16.20	-3.33
14.	Gonegandla	36.35	115.72	15.58	7.16	242.69	51.20	111.47
15.	Adoni	12.97	103.68	-7.80	-4.88	60.86	23.86	38.11
16.	Holagunda	39.69	110.14	18.92	1.58	357.91	2.48	29.81
17.	Halaharvi	32.08	100.04	11.31	-8.52	127.88	72.67	-96.40
18.	Alur	14.62	102.80	-6.15	-5.76	37.84	33.23	35.46
19.	Aspari	6.74	100.00	-14.03	-8.56	196.89	73.35	120.17
20.	Devanakonda	19.42	114.77	-1.35	6.21	1.83	38.51	-8.39
21.	Krishnagiri	14.04	105.51	-6.73	-3.05	45.31	9.33	20.56
22.	Pattikonda	10.87	105.96	-9.90	-2.60	98.04	6.78	25.79
23.	Chippagiri	18.99	100.00	-1.78	-8.56	3.17	73.35	15.26
24.	Maddikera	2.60	101.74	-18.17	-6.82	330.21	46.57	124.01
25.	Tuggali	9.44	110.40	-11.33	1.84	128.41	3.37	-20.80

Table 4 Statistical relationship of irrigation intensity and cropping intensity in Nandayal district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Nandikotkur	9.40	105.42	-4.09	-8.85	16.75	78.29	36.21
2.	Pagidyala	6.95	126.37	-6.54	12.10	42.80	146.45	-79.17
3.	Jupadu Bunglow	9.97	115.69	-3.52	1.42	12.40	2.02	-5.01
4.	Kothapalle	7.06	122.99	-6.43	8.72	41.37	76.07	-56.10
5.	Srisailam	0.00	0.00	-13.49	-114.27	182.04	13057.24	1541.72
6.	Atmakur	28.40	101.82	14.91	-12.45	222.25	154.96	-185.58
7.	Pamulapadu	20.02	122.53	6.53	8.26	42.61	68.26	53.93
8.	Midthur	11.52	111.49	-1.97	-2.78	3.89	7.72	5.48
9.	Bethamcherla	5.06	104.30	-8.43	-9.97	71.10	99.37	84.05
10.	Panyam	13.46	155.67	-0.03	41.40	0.00	1714.10	-1.33
11.	Gadivemula	3.85	142.56	-9.64	28.29	92.97	800.42	-272.79
12.	Velgode	28.22	123.36	14.73	9.09	216.91	82.66	133.90
13.	Bandi Atmakur	17.65	152.89	4.16	38.62	17.29	1491.64	160.59
14.	Nandyal	21.10	122.73	7.61	8.46	57.88	71.60	64.38
15.	Mahanandi	12.82	140.16	-0.67	25.89	0.45	670.38	-17.40
16.	Sirvel	2.95	149.57	-10.54	35.30	111.14	1246.21	-372.15
17.	Gospadu	36.51	131.21	23.02	16.94	529.83	287.02	389.96
18.	Banaganapalle	16.40	106.56	2.91	-7.71	8.46	59.42	-22.42
19.	Dhone	2.45	105.34	-11.04	-8.93	121.93	79.71	98.59
20.	Peapully	0.00	107.50	-13.49	-6.77	182.04	45.81	91.32
21.	Owk	5.67	116.28	-7.82	2.01	61.18	4.05	-15.74
22.	Koilkuntla	11.33	100.64	-2.16	-13.63	4.67	185.73	29.47
23.	Rudravaram	12.86	122.30	-0.63	8.03	0.40	64.51	-5.08
24.	Allagadda	31.53	109.30	18.04	-4.97	325.37	24.68	-89.62
25.	Dornipadu	30.97	101.08	17.48	-13.19	305.48	173.93	-230.50
26.	Sanjamala	4.28	105.70	-9.21	-8.57	84.86	73.42	78.93
27.	Kolimigundla	0.50	103.07	-12.99	-11.20	168.79	125.40	145.49
28.	Uyyalawada	6.52	101.12	-6.97	-13.15	48.61	172.88	91.67
29.	Chagalamarri	33.82	106.13	20.33	-8.14	413.22	66.23	-165.43

Table 5 Statistical relationship of irrigation intensity and cropping intensity in Ananthapur district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Anantapur	26.63	107.31	-1.87	1.23	3.51	1.51	-2.30
2.	Atmakur	18.97	111.34	-9.53	5.26	90.87	27.64	-50.12
3.	Bukkaraya Samudram	43.42	121.35	14.92	15.27	222.53	233.09	227.75
4.	Garladinne	65.61	104.26	37.11	-1.82	1376.96	3.32	-67.63
5.	Kudair	32.47	106.52	3.97	0.44	15.74	0.19	1.74
6.	Narpala	54.58	104.46	26.08	-1.62	680.03	2.63	-42.31
7.	Peddapappur	44.45	123.52	15.95	17.44	254.32	304.06	278.08
8.	Putlur	30.26	115.57	1.76	9.49	3.09	90.01	16.67
9.	Raptadu	24.42	100.11	-4.08	-5.97	16.67	35.67	24.38
10.	Singanamala	27.41	102.26	-1.09	-3.82	1.19	14.61	4.18
11.	Tadpatri	14.16	100.67	-14.34	-5.41	205.71	29.30	77.63
12.	Yellanur	55.87	114.16	27.37	8.08	748.98	65.24	221.06
13.	Gooty	9.62	101.56	-18.88	-4.52	356.55	20.45	85.40
14.	Guntakal	12.90	100.44	-15.60	-5.64	243.44	31.84	88.04
15.	Pamidi	27.96	103.58	-0.54	-2.50	0.29	6.26	1.36
16.	Peddavadugur	5.78	104.64	-22.72	-1.44	516.32	2.08	32.78
17.	Uravakonda	19.11	103.75	-9.39	-2.33	88.22	5.44	21.91
18.	Vajrakarur	14.76	103.97	-13.74	-2.11	188.86	4.46	29.03
19.	Vidapanakal	44.34	100.00	15.84	-6.08	250.82	37.00	-96.33
20.	Yadiki	15.76	102.19	-12.74	-3.89	162.37	15.15	49.60
21.	Beluguppa	23.78	113.42	-4.72	7.34	22.30	53.84	-34.65
22.	Bommanahal	59.21	100.00	30.71	-6.08	942.95	37.00	-186.78
23.	Brahmasamudram	18.01	102.69	-10.49	-3.39	110.09	11.51	35.60
24.	D. Hirehal	30.94	100.36	2.44	-5.72	5.94	32.75	-13.95
25.	Gummagatta	17.11	102.84	-11.39	-3.24	129.79	10.51	36.94
26.	Kalyandurg	32.78	105.55	4.28	-0.53	18.30	0.28	-2.28
27.	Kambadur	27.72	100.81	-0.78	-5.27	0.61	27.80	4.13
28.	Kanekal	29.46	122.95	0.96	16.87	0.92	284.51	16.15
29.	Kundurpi	22.33	100.00	-6.17	-6.08	38.10	37.00	37.55
30.	Rayadurg	14.13	101.42	-14.37	-4.66	206.57	21.74	67.01
31.	Settur	19.63	106.86	-8.87	0.78	78.72	0.60	-6.90

Table 6 Statistical relationship of irrigation intensity and cropping intensity in Sathya Sai district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Dharmavaram	22.25	107.70	-5.47	2.61	29.90	6.79	-14.25
2.	Bathalapalle	27.09	102.05	-0.63	-3.04	0.39	9.26	1.91
3.	Tadimarri	42.36	104.69	14.64	-0.40	214.38	0.16	-5.91
4.	Mudigubba	16.90	103.26	-10.82	-1.83	117.03	3.36	19.83
5.	Kanaganapalle	16.78	105.39	-10.94	0.30	119.64	0.09	-3.24
6.	Chennekothapalle	13.27	105.62	-14.45	0.53	208.75	0.28	-7.61
7.	Ramagiri	14.81	100.00	-12.91	-5.09	166.62	25.94	65.75
8.	Talupula	20.85	113.22	-6.87	8.13	47.17	66.04	-55.81
9.	Nambulipulikunta	13.81	115.16	-13.91	10.07	193.44	101.34	-140.01
10.	Gandlapenta	17.33	107.92	-10.39	2.83	107.91	7.99	-29.36
11.	Kadiri	23.27	110.58	-4.45	5.49	19.79	30.10	-24.40
12.	Nallacheruvu	21.74	112.02	-5.98	6.93	35.74	47.98	-41.41
13.	Tanakal	39.89	107.13	12.17	2.04	148.15	4.15	24.79
14.	Amadagur	22.73	103.11	-4.99	-1.98	24.88	3.93	9.89
15.	Obuladevaracheruvu	20.75	113.44	-6.97	8.35	48.55	69.67	-58.16
16.	Gorantla	13.88	100.00	-13.84	-5.09	191.49	25.94	70.48
17.	Nallamada	21.24	106.10	-6.48	1.01	41.97	1.01	-6.52
18.	Bukkapatnam	42.62	110.27	14.90	5.18	222.07	26.80	77.14
19.	Kothacheruvu	44.83	106.82	17.11	1.73	292.82	2.98	29.54
20.	Puttaparthi	26.52	106.41	-1.20	1.32	1.44	1.73	-1.58
21.	Roddam	46.12	100.00	18.40	-5.09	338.63	25.94	-93.73
22.	Madakasira	26.29	100.00	-1.43	-5.09	2.04	25.94	7.27
23.	Amarapuram	31.89	100.00	4.17	-5.09	17.40	25.94	-21.25
24.	Gudibanda	33.27	100.00	5.55	-5.09	30.82	25.94	-28.28
25.	Rolla	27.19	100.00	-0.53	-5.09	0.28	25.94	2.69
26.	Agali	19.41	100.00	-8.31	-5.09	69.02	25.94	42.32
27.	Parigi	33.66	100.00	5.94	-5.09	35.31	25.94	-30.26
28.	Penukonda	62.05	115.91	34.33	10.82	1178.68	117.00	371.35
29.	Somandepalle	34.87	106.19	7.15	1.10	51.15	1.20	7.84
30.	Hindupur	32.99	100.00	5.27	-5.09	27.79	25.94	-26.85
31.	Lepakshi	30.37	100.00	2.65	-5.09	7.03	25.94	-13.51
32.	Chilamathur	25.95	100.00	-1.77	-5.09	3.13	25.94	9.01

Table 7 Statistical relationship of irrigation intensity and cropping intensity in YSR Kadapa

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Atlur	91.76	100.00	31.02	-6.78	962.33	46.00	-210.39
2.	B. Kodur	93.64	100.08	32.90	-6.70	1082.50	44.92	-220.51
3.	B.Mattam	96.24	100.22	35.50	-6.56	1260.35	43.06	-232.97
4.	Badvel	100.00	100.15	39.26	-6.63	1541.46	43.99	-260.39
5.	Gopavaram	100.00	103.20	39.26	-3.58	1541.46	12.83	-140.64
6.	Kalasapadu	75.22	100.00	14.48	-6.78	209.71	46.00	-98.22
7.	Porumamilla	91.41	100.77	30.67	-6.01	940.73	36.15	-184.40
8.	S.Mydukur	96.51	103.43	35.77	-3.35	1279.59	11.24	-119.91
9.	SAKN	69.90	100.00	9.16	-6.78	83.93	46.00	-62.13
10.	Chapad	95.97	106.62	35.23	-0.16	1241.25	0.03	-5.72
11.	Duvvur	92.73	112.76	31.99	5.98	1023.45	35.73	191.24
12.	J.madugu	23.66	110.74	-37.08	3.96	1374.82	15.66	-146.75
13.	Kondapuram	31.79	110.68	-28.95	3.90	838.02	15.19	-112.84
14.	Muddanur	40.40	106.35	-20.34	-0.43	413.66	0.19	8.79
15.	Mylavaram	18.84	103.03	-41.90	-3.75	1755.49	14.08	157.21
16.	Peddammudium	3.88	102.89	-56.86	-3.89	3232.90	15.15	221.31

17.	Proddutur	32.12	104.58	-28.62	-2.20	819.02	4.85	63.02
18.	Rajupalem	5.90	104.54	-54.84	-2.24	3007.27	5.03	122.96
19.	Yerraguntla	14.24	104.01	-46.50	-2.77	2162.12	7.69	128.90
20.	C. K. Dinne	72.50	105.86	11.76	-0.92	138.33	0.85	-10.85
21.	Chennur	100.00	102.16	39.26	-4.62	1541.46	21.36	-181.47
22.	Kadapa	90.69	100.00	29.95	-6.78	897.09	46.00	-203.14
23.	Kamalapuram	13.96	123.38	-46.78	16.60	2188.24	275.49	-776.42
24.	Khajipet	67.50	103.13	6.76	-3.65	45.72	13.34	-24.69
25.	Pendlimarri	54.10	103.06	-6.64	-3.72	44.07	13.85	24.71
26.	Sidhout	100.00	115.20	39.26	8.42	1541.46	70.86	330.49
27.	Vallur	18.67	108.01	-42.07	1.23	1769.77	1.51	-51.65
28.	Vontimitta	99.74	101.18	39.00	-5.60	1521.11	31.38	-218.49
29.	Chakrayapet	78.42	113.67	17.68	6.89	312.63	47.44	121.79
30.	Lingala	76.19	110.15	15.45	3.37	238.75	11.34	52.04
31.	Pulivendula	54.08	123.71	-6.66	16.93	44.34	286.55	-112.72
32.	Simhadripuram	48.74	105.78	-12.00	-1.00	143.97	1.00	12.03
33.	Thondur	31.06	102.01	-29.68	-4.77	880.82	22.77	141.63
34.	V. N. Palli	29.83	102.18	-30.91	-4.60	955.34	21.18	142.25
35.	Vempalli	46.20	127.74	-14.54	20.96	211.37	439.23	-304.70
36.	Vemula	30.70	122.89	-30.04	16.11	902.32	259.46	-483.86

Table 8 Statistical relationship of irrigation intensity and cropping intensity in Anamaya district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Galiveedu	61.89	118.62	5.69	5.18	32.38	26.85	29.49
2.	Chinnamandem	79.77	110.30	23.57	-3.14	555.58	9.85	-73.97
3.	Sambepalle	55.81	133.05	-0.39	19.61	0.15	384.62	-7.64
4.	Rayachoti	39.52	112.39	-16.68	-1.05	278.20	1.10	17.49
5.	Lakkireddipalle	57.57	104.71	1.37	-8.73	1.88	76.18	-11.96
6.	Ramapuram	74.80	107.84	18.60	-5.60	345.98	31.34	-104.13
7.	Gurramkonda	63.96	112.31	7.76	-1.13	60.23	1.27	-8.76
8.	Kalakada	67.11	102.89	10.91	-10.55	119.04	111.27	-115.09
9.	Kambhamvaripalle	34.83	101.85	-21.37	-11.59	456.65	134.29	247.63
10.	Pileru	39.63	107.54	-16.57	-5.90	274.54	34.79	97.73
11.	Nandalur	100.00	100.00	43.80	-13.44	1918.50	180.59	-588.61
12.	Penagalur	48.64	103.36	-7.56	-10.08	57.14	101.57	76.19
13.	Chitvel	48.28	107.93	-7.92	-5.51	62.72	30.34	43.62
14.	Rajampet	87.02	112.37	30.82	-1.07	949.91	1.14	-32.93
15.	Pullampeta	87.58	103.74	31.38	-9.70	984.75	94.06	-304.34
16.	Obulavaripalle	73.36	105.64	17.16	-7.80	294.49	60.81	-133.82
17.	Kodur	40.21	115.23	-15.99	1.79	255.66	3.21	-28.65
18.	T.Sundupalle	39.19	111.74	-17.01	-1.70	289.32	2.88	28.89
19.	Veeraballe	66.15	105.58	9.95	-7.86	99.02	61.75	-78.20
20.	Mulakalacheruvu	47.72	129.95	-8.48	16.51	71.90	272.64	-140.01
21.	Thamballapalle	40.86	123.64	-15.34	10.20	235.30	104.07	-156.49
22.	Peddmandyam	61.55	124.70	5.35	11.26	28.63	126.83	60.26
23.	Kalikiri	43.73	126.59	-12.47	13.15	155.48	172.97	-163.99
24.	Valmikipuram	49.97	126.54	-6.23	13.10	38.80	171.65	-81.61
25.	Kurabalakota	43.69	116.98	-12.51	3.54	156.48	12.54	-44.30
26.	Pedda Thippasamudram	41.98	120.57	-14.22	7.13	202.19	50.86	-101.41
27.	B Kothakota	49.78	115.02	-6.42	1.58	41.21	2.50	-10.15
28.	Madanapalle	51.67	116.29	-4.53	2.85	20.51	8.13	-12.92
29.	Nimmanapalle	42.70	114.57	-13.50	1.13	182.23	1.28	-15.28
30.	Ramasamudram	47.01	111.21	-9.19	-2.23	84.44	4.97	20.48

Table 9 Statistical relationship of irrigation intensity and cropping intensity in Chittoor district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Chittoor	28.09	105.16	-22.43	-7.88	502.93	62.15	176.79
2.	Gudipala	34.56	114.37	-15.96	1.33	254.60	1.76	-21.17
3.	Gangadharanellore	46.62	110.34	-3.90	-2.70	15.18	7.31	10.53
4.	Penumuru	33.53	108.78	-16.99	-4.26	288.53	18.18	72.42
5.	Srirangarajapuram	60.56	110.51	10.04	-2.53	100.88	6.42	-25.44
6.	Vedurukuppam	56.00	122.06	5.48	9.02	30.07	81.30	49.45
7.	Irala	20.00	103.82	-30.52	-9.22	931.23	85.07	281.46
8.	Puthalapattu	39.74	103.12	-10.78	-9.92	116.12	98.47	106.93
9.	Thavanampalle	46.30	103.91	-4.22	-9.13	17.78	83.42	38.51
10.	Yadamarri	38.33	108.89	-12.19	-4.15	148.50	17.25	50.61
11.	Pulicherla	41.54	104.85	-8.98	-8.19	80.57	67.13	73.54
12.	Rompicherla	14.86	122.11	-35.66	9.07	1271.36	82.21	-323.29
13.	Gudupalle	48.28	103.58	-2.24	-9.46	5.00	89.55	21.16
14.	Kuppam	50.84	109.11	0.32	-3.93	0.10	15.47	-1.27
15.	Ramakuppam	62.19	104.55	11.67	-8.49	136.28	72.13	-99.15
16.	Santhipuram	49.69	105.23	-0.83	-7.81	0.68	61.05	6.45
17.	Karvetinagar	58.47	113.70	7.95	0.66	63.26	0.43	5.22
18.	Palasamudram	59.53	124.32	9.01	11.28	81.25	127.17	101.65
19.	Nagari	91.35	164.94	40.83	51.90	1667.41	2693.28	2119.15
20.	Nindra	98.47	110.29	47.95	-2.75	2299.57	7.58	-132.03
21.	Vijayapuram	78.61	120.96	28.09	7.92	789.27	62.68	222.41
22.	Baireddipalle	36.84	116.82	-13.68	3.78	187.04	14.26	-51.65
23.	Gangavaram	52.58	111.37	2.06	-1.67	4.26	2.80	-3.45
24.	Palamaner	67.57	110.60	17.05	-2.44	290.83	5.97	-41.67
25.	Peddapanjani	58.73	102.33	8.21	-10.71	67.47	114.77	-88.00
26.	Venkatagirikota	71.86	111.92	21.34	-1.12	455.56	1.26	-23.97
27.	Bangarupalem	29.68	127.26	-20.84	14.22	434.14	202.12	-296.22
28.	Chowdepalle	54.76	102.71	4.24	-10.33	18.01	106.78	-43.85
29.	Punganur	44.58	108.25	-5.94	-4.79	35.24	22.98	28.45
30.	Sodam	40.72	123.59	-9.80	10.55	95.96	111.23	-103.32
31.	Somala	51.12	114.89	0.60	1.85	0.36	3.41	1.12

Table 9 Statistical relationship of irrigation intensity and cropping intensity in Chittoor district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Chittoor	28.09	105.16	-22.43	-7.88	502.93	62.15	176.79
2.	Gudipala	34.56	114.37	-15.96	1.33	254.60	1.76	-21.17
3.	Gangadharanellore	46.62	110.34	-3.90	-2.70	15.18	7.31	10.53
4.	Penumuru	33.53	108.78	-16.99	-4.26	288.53	18.18	72.42
5.	Srirangarajapuram	60.56	110.51	10.04	-2.53	100.88	6.42	-25.44
6.	Vedurukuppam	56.00	122.06	5.48	9.02	30.07	81.30	49.45
7.	Irala	20.00	103.82	-30.52	-9.22	931.23	85.07	281.46
8.	Puthalapattu	39.74	103.12	-10.78	-9.92	116.12	98.47	106.93
9.	Thavanampalle	46.30	103.91	-4.22	-9.13	17.78	83.42	38.51
10.	Yadamarri	38.33	108.89	-12.19	-4.15	148.50	17.25	50.61
11.	Pulicherla	41.54	104.85	-8.98	-8.19	80.57	67.13	73.54
12.	Rompicherla	14.86	122.11	-35.66	9.07	1271.36	82.21	-323.29
13.	Gudupalle	48.28	103.58	-2.24	-9.46	5.00	89.55	21.16
14.	Kuppam	50.84	109.11	0.32	-3.93	0.10	15.47	-1.27
15.	Ramakuppam	62.19	104.55	11.67	-8.49	136.28	72.13	-99.15
16.	Santhipuram	49.69	105.23	-0.83	-7.81	0.68	61.05	6.45
17.	Karvetinagar	58.47	113.70	7.95	0.66	63.26	0.43	5.22
18.	Palasamudram	59.53	124.32	9.01	11.28	81.25	127.17	101.65
19.	Nagari	91.35	164.94	40.83	51.90	1667.41	2693.28	2119.15
20.	Nindra	98.47	110.29	47.95	-2.75	2299.57	7.58	-132.03
21.	Vijayapuram	78.61	120.96	28.09	7.92	789.27	62.68	222.41
22.	Baireddipalle	36.84	116.82	-13.68	3.78	187.04	14.26	-51.65
23.	Gangavaram	52.58	111.37	2.06	-1.67	4.26	2.80	-3.45
24.	Palamaner	67.57	110.60	17.05	-2.44	290.83	5.97	-41.67
25.	Peddapanjani	58.73	102.33	8.21	-10.71	67.47	114.77	-88.00
26.	Venkatagirikota	71.86	111.92	21.34	-1.12	455.56	1.26	-23.97

27.	Bangarupalem	29.68	127.26	-20.84	14.22	434.14	202.12	-296.22
28.	Chowdepalle	54.76	102.71	4.24	-10.33	18.01	106.78	-43.85
29.	Punganur	44.58	108.25	-5.94	-4.79	35.24	22.98	28.45
30.	Sodam	40.72	123.59	-9.80	10.55	95.96	111.23	-103.32
31.	Somala	51.12	114.89	0.60	1.85	0.36	3.41	1.12

Table 10 Statistical relationship of irrigation intensity and cropping intensity in Tirupati district

S. No	Mandal	Irrigation intensity (X) %	Cropping intensity (Y) %	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X})^2$	$(Y - \bar{Y})^2$	$(X - \bar{X})(Y - \bar{Y})$
1.	Chillakur	61.89	100.00	-20.63	-10.71	425.68	114.69	220.96
2.	Chittampur	93.01	105.98	10.49	-4.73	110.00	22.37	-49.60
3.	Gudur	72.66	100.00	-9.86	-10.71	97.26	114.69	105.62
4.	Kota	92.27	102.35	9.75	-8.36	95.02	69.88	-81.49
5.	Vakadu	88.75	106.50	6.23	-4.21	38.79	17.72	-26.22
6.	Balayapalle	98.44	100.00	15.92	-10.71	253.38	114.69	-170.47
7.	Dakkili	99.96	100.00	17.44	-10.71	304.08	114.69	-186.75
8.	Venkatagiri	97.03	108.73	14.51	-1.98	210.48	3.92	-28.72
9.	K.V.B.Puram	53.61	145.88	-28.91	35.17	835.91	1236.97	-1016.85
10.	Nagalapuram	96.06	114.59	13.54	3.88	183.28	15.06	52.54
11.	Narayanavanam	96.28	132.11	13.76	21.40	189.28	457.99	294.43
12.	Pichatur	81.55	130.29	-0.97	19.58	0.94	383.40	-19.03
13.	Renigunta	98.69	103.93	16.17	-6.78	261.40	45.96	-109.61
14.	Srikalahasti	92.45	124.76	9.93	14.05	98.56	197.42	139.49
15.	Thottambedu	94.74	133.58	12.22	22.87	149.28	523.06	279.43
16.	Yerpedu	94.12	114.45	11.60	3.74	134.51	13.99	43.38
17.	Buchinaidu Kandriga	88.04	104.29	5.52	-6.42	30.45	41.21	-35.42
18.	Satyavedu	69.63	114.99	-12.89	4.28	166.21	18.32	-55.19
19.	Varadaiahpalem	90.57	103.18	8.05	-7.53	64.77	56.69	-60.60
20.	Doravarisatram	96.89	108.55	14.37	-2.16	206.44	4.66	-31.03
21.	Naidupet	96.46	103.60	13.94	-7.11	194.27	50.54	-99.09
22.	Ojili	76.44	100.00	-6.08	-10.71	36.99	114.69	65.14
23.	Pellakur	98.33	104.59	15.81	-6.12	249.89	37.45	-96.74
24.	Sullurpeta	96.07	100.00	13.55	-10.71	183.55	114.69	-145.09
25.	Tada	88.03	105.80	5.51	-4.91	30.34	24.10	-27.04
26.	Chandragiri	92.19	118.53	9.67	7.82	93.47	61.16	75.61
27.	Chinnagottigallu	56.05	104.34	-26.47	-6.37	700.77	40.57	168.61
28.	Pakala	32.66	108.63	-49.86	-2.08	2486.22	4.32	103.68
29.	Ramachandra puram	78.44	119.63	-4.08	8.92	16.66	79.58	-36.41
30.	Tirupati (Rural)	70.44	119.59	-12.08	8.88	145.98	78.86	-107.30
31.	Tirupati Urban	95.00	100.00	12.48	-10.71	155.70	114.69	-133.63
32.	Yerravaripalem	20.89	105.17	-61.63	-5.54	3798.51	30.69	341.41
33.	Puttur	97.69	107.97	15.17	-2.74	230.07	7.50	-41.55
34.	Vadamalapeta	50.42	112.11	-32.10	1.40	1030.54	1.96	-44.96

The Karl Pearson's Correlation Coefficient (r) was computed for eight districts of Andhra Pradesh to examine the linear relationship between Irrigation Intensity (X) and Cropping Intensity (Y). The analysis covers eight revenue districts: Kurnool, Nandayal, Anantapur, Sathya Sai, YSR Kadapa, Anamaya, Chittoor, and Tirupati. The computed values of r range from -0.3674 to +0.3326, indicating that the

relationship between irrigation and cropping intensity is neither strong nor uniform across the study region.

Data depicted in (Table 11) presents the computed Karl Pearson's Correlation Coefficient (r), coefficient of determination (R^2), and the nature and strength of correlation for all eight districts

Table 11 Correlation between irrigation intensity and cropping intensity across districts of Andhra Pradesh

S. No.	District	r Value	R^2 Value	Nature	Strength of Correlation
1.	Kurnool	+0.3326	0.1106	Positive	Weak positive
2.	Nandayal	+0.1785	0.0318	Positive	Very weak positive
3.	Anantapur	+0.2686	0.0721	Positive	Weak positive
4.	Sathya Sai	+0.0764	0.0058	Positive	Negligible positive
5.	YSR Kadapa	-0.2793	0.0780	Negative	Weak negative
6.	Anamaya	-0.3674	0.1350	Negative	Weak negative
7.	Chittoor	+0.3150	0.0992	Positive	Weak positive
8.	Tirupati	-0.0942	0.0089	Negative	Very weak negative

Districts with positive correlation

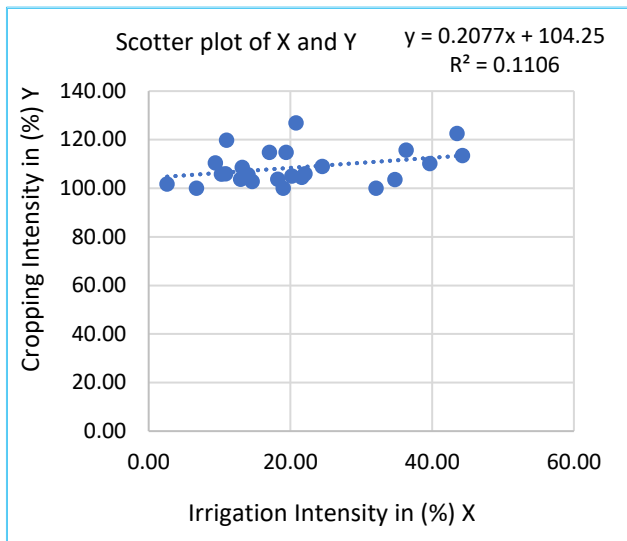


Fig 2 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Kurnool District

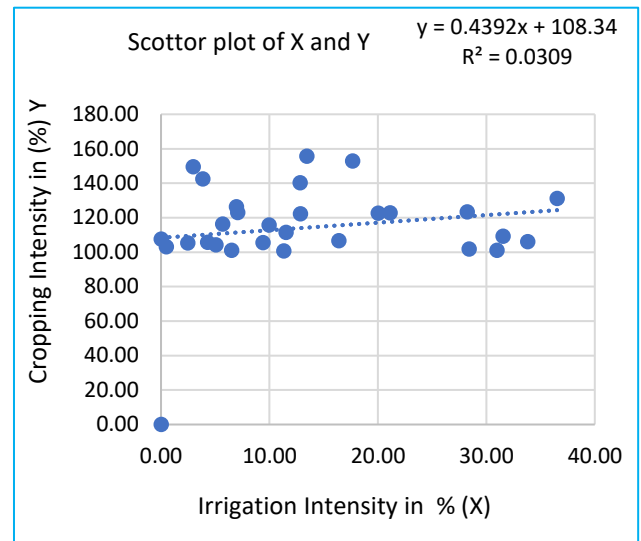


Fig 3 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Nandayal District

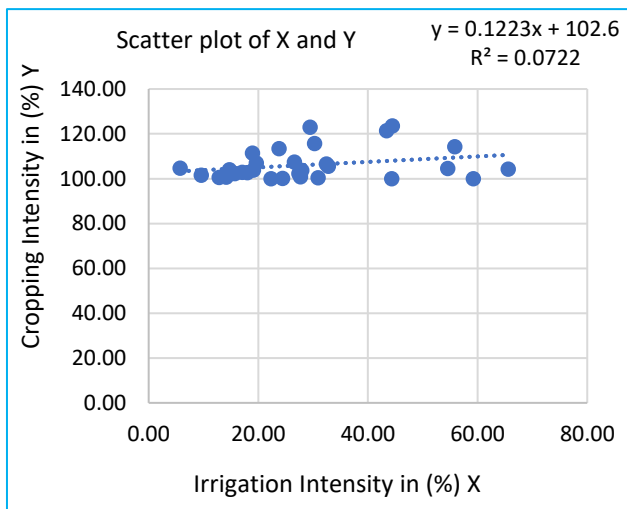


Fig 4 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Anathapur District

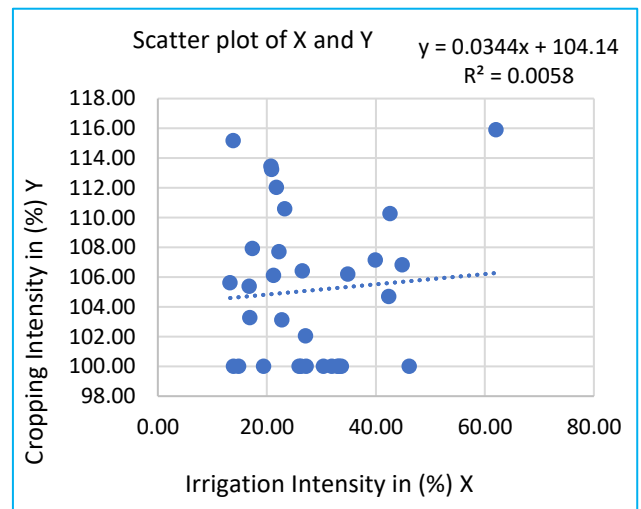


Fig 5 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Sathya Sai District

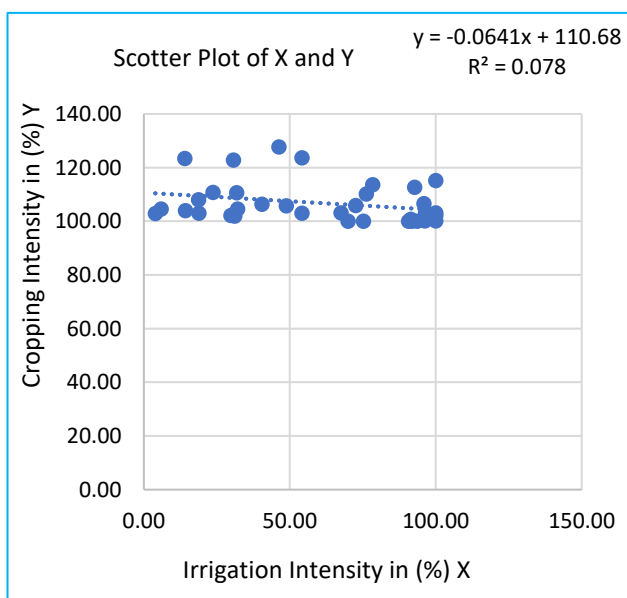


Fig 6 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) YSR Kadapa

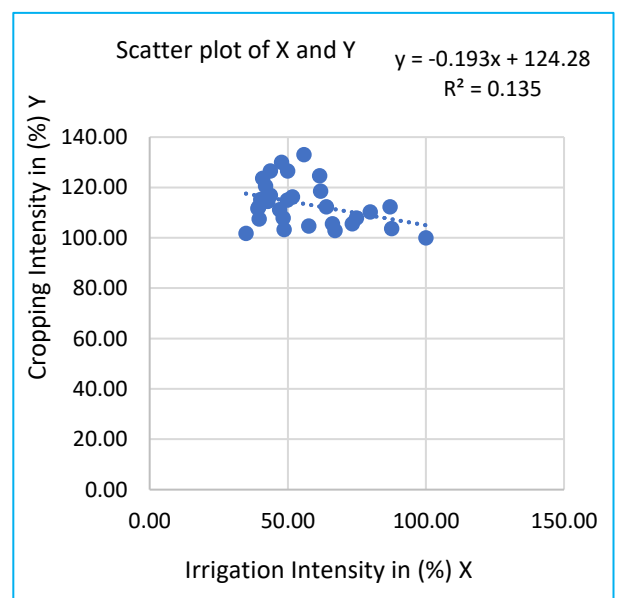


Fig 7 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Anamaya District

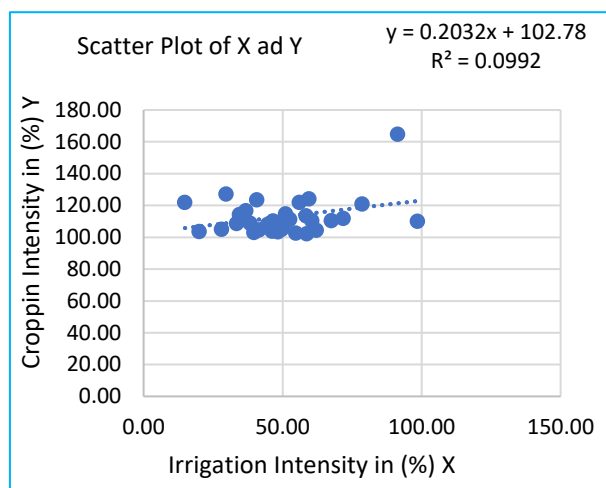


Fig 8 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Chittoor District

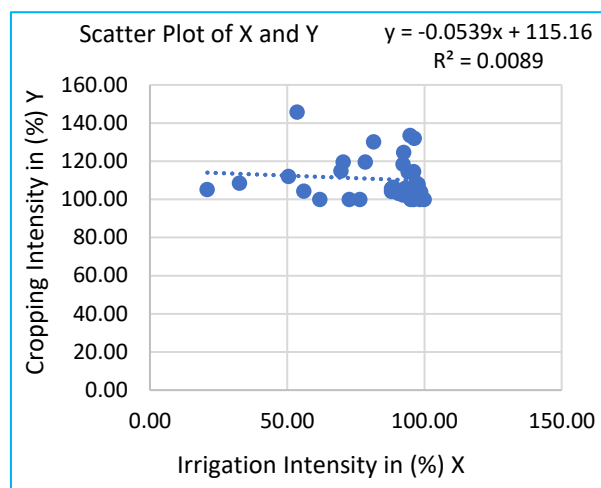


Fig 9 Relationship between Irrigation Intensity (X) and Cropping Intensity (Y) in Tirupati District

Kurnool ($r = +0.3326$): The computed correlation coefficient for Kurnool district is $+0.3326$, indicating a weak positive correlation between irrigation intensity and cropping intensity. The coefficient of determination ($R^2 = 0.1106$) suggests that approximately 11.06% of the variation in cropping intensity is explained by irrigation intensity. The positive direction of the relationship implies that mandals with relatively higher irrigation coverage tend to record marginally higher cropping intensities, though the association is not statistically strong.

Nandayal ($r = +0.1785$): Nandayal district records a correlation coefficient of $+0.1785$, reflecting a very weak positive correlation. With $R^2 = 0.0318$, only 3.18% of the variability in cropping intensity is attributable to irrigation intensity. The weak association suggests that factors other than irrigation such as rainfall dependency, soil type, or cropping pattern diversity play a more dominant role in determining cropping intensity in this district.

Anantapur ($r = +0.2686$): Anantapur district exhibits a weak positive correlation ($r = +0.2686$) and $R^2 = 0.0721$. This indicates that 7.21% of the variation in cropping intensity can be explained by irrigation intensity. Given that Anantapur is one of the most drought-prone districts in Andhra Pradesh, the weak positive relationship is consistent with the limited and uneven spread of irrigation infrastructure across its mandals.

Sathya Sai ($r = +0.0764$): The correlation coefficient for Sathya Sai district is $+0.0764$, denoting a negligible positive correlation. The R^2 value of 0.0058 reveals that merely 0.58% of the variance in cropping intensity is explained by irrigation intensity. This near-zero correlation clearly demonstrates that irrigation intensity has virtually no linear influence on cropping intensity in this district, and that entirely different agronomic or socio-economic determinants govern cropping patterns.

Chittoor ($r = +0.3150$): Chittoor district records $r = +0.3150$, suggesting a weak positive correlation. The $R^2 = 0.0992$ indicates that approximately 9.92% of the variation in cropping intensity is explained by irrigation intensity. The positive trend implies that better-irrigated mandals tend to achieve slightly higher cropping intensities. However, the influence remains weak, possibly due to the district's dependence on tank and well irrigation systems, which are often irregular and rainfall-contingent.

Districts with negative correlation

YSR Kadapa ($r = -0.2793$): YSR Kadapa district shows $r = -0.2793$, indicating a weak negative correlation between

irrigation intensity and cropping intensity. The R^2 value of 0.0780 implies that 7.80% of the variation in cropping intensity is explained by irrigation intensity. The negative relationship may be attributed to highly irrigated mandals in this district focusing on single cash crops or water-intensive mono-cropping systems, which tend to yield lower cropping intensity values compared to diversified rainfed multi-cropping mandals.

Anamaya ($r = -0.3674$): Anamaya district records the strongest negative correlation among all districts, with $r = -0.3674$ and $R^2 = 0.1350$. This weak negative correlation indicates that 13.50% of the variability in cropping intensity is inversely associated with irrigation intensity. Mandals with higher irrigation intensity appear to practice less intensive cropping, possibly because irrigated areas are concentrated in zones where mono-cropping of paddy or sugarcane is dominant, reducing the overall cropping cycles relative to less-irrigated but more diversified agricultural zones.

Tirupati ($r = -0.0942$): Tirupati district records $r = -0.0942$, representing a very weak negative correlation. With $R^2 = 0.0089$, only 0.89% of the variation in cropping intensity is explained by irrigation intensity. The near-zero value of r conclusively indicates that there is practically no linear relationship between irrigation intensity and cropping intensity in Tirupati district. The widespread availability of irrigation across most mandals (with several exceeding 85–98%) may have compressed the variability in irrigation intensity, masking any underlying relationship.

Comparative analysis

Across the eight districts, the correlation coefficients range from -0.3674 (Anamaya) to $+0.3326$ (Kurnool). None of the districts exhibit a strong or moderate correlation ($r \geq 0.5$ or $r \leq -0.5$), confirming that irrigation intensity alone is not a reliable predictor of cropping intensity across these districts.

Three districts Kurnool, Anantapur, and Chittoor share a similar pattern of weak positive correlation, suggesting a moderate tendency for irrigation expansion to support higher cropping frequencies in these districts. Conversely, Sathya Sai and Nandayal show very weak to negligible positive correlations, underscoring the minimal role of irrigation in driving cropping intensity.

Among districts with negative correlations, Anamaya stands out with the highest magnitude ($r = -0.3674$), followed by YSR Kadapa ($r = -0.2793$). Both suggest a structural disconnect between irrigation infrastructure and cropping

intensity, potentially linked to mono-cropping dominance in irrigated areas. Tirupati's near-zero negative value ($r = -0.0942$) points to a saturation effect in irrigation coverage, where the near-universal availability of irrigation has eliminated any meaningful variation that could correlate with cropping intensity [19-20].

CONCLUSION

The analysis of Karl Pearson's Correlation Coefficient across the eight districts of Andhra Pradesh reveals that the relationship between irrigation intensity and cropping intensity is predominantly weak, with correlation values confined within

the range of -0.3674 to $+0.3326$. The study clearly establishes that while irrigation intensity does exert a positive influence in districts like Kurnool, Anantapur, and Chittoor, it does not emerge as a dominant determinant of cropping intensity across the region as a whole. The negative correlations observed in YSR Kadapa, Anamaya, and Tirupati suggest that higher irrigation does not automatically translate into higher cropping intensity- a finding that has important implications for agricultural planning. Policy interventions should therefore focus not only on expanding irrigation coverage, but also on promoting multi-cropping practices, crop diversification, and efficient water use to meaningfully enhance cropping intensity across all districts of the Rayalaseema Region.

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