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Crop combination of Srikalahasti Revenue Division, Andhra Pradesh, India using J.C. Weaver's method

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Abstract

Agriculture remains the backbone of the Indian economy, contributing approximately 16-18% of the GDP and the sector employs over 46% of the workforce. Cropping patterns means the proportion of area under various crops at a given point in time. In agricultural geography, researchers utilize crop combination analysis to map the integrated reality of farming practices. This study aims to evaluate the evolving agricultural landscape of the Srikalahasti Revenue Division by analyzing mandal-level data using J.C. weaver's method. Specifically using the year 2023. In the year 2023 the total area under cultivation in Srikalahasti revenue division is 32093 Ha. In the year 2023, Srikalahasti revenue division the highest crop diversification is seen in Narayanavanam mandal where 14 different crops are cultivated whereas the lowest crop diversification is seen in the Srikalahasti mandal where the mandal was only under 5 different crops in 2023. In the year 2023 Kvbpuram, Narayanavanam, Nagalapuram & Pichaturu were under 3rd crop combination and Renigunta, Srikalahasti, Thotambedu & Yerpedu were under monocrop combination.

Keywords: Crop combination, J.C. Weaver's method, minimum deviation method, agricultural geography, Srikalahasti Revenue Division

1. Introduction

Agriculture remains the backbone of the Indian economy, contributing approximately 16-18% of the GDP and the sector employs over 46% of the workforce, providing crucial livelihood security and sustaining rural demand. Agriculture remains the primary economic driver in rural India, shaping not only the livelihood of the population but also the physical landscape. Cropping patterns means the proportion of area under various crops at a given point in time. They continuously adapt to a complex matrix of physical parameters, such as rainfall distribution and soil characteristics, alongside economic pressures like market demand and government policy. Understanding the spatial arrangement of crops is essential for optimizing agricultural resources, managing water allocation, and ensuring regional food security.

In agricultural geography, researchers utilize crop combination analysis to map the integrated reality of farming practices, rather than analyzing crops in isolation. Farmers typically cultivate multiple crops in a given season to maximize yield and mitigate risk. To scientifically delineate these regions, J.C. Weaver (1954) introduced the minimum deviation method. Weaver's technique provides a mathematically rigorous approach by calculating the variance between a theoretical, idealized crop distribution and the actual cultivated land area. By identifying the combination that yields the lowest deviation, the method objectively highlights the dominant crop structures within a specific administrative boundary.

The Srikalahasti Revenue Division of Andhra Pradesh presents a critical area for micro-level agricultural analysis. Comprising distinct administrative division which experiences unique meteorological conditions like rainfall during both southwest monsoon and north east monsoon seasons that directly dictate farming capabilities. The region supports a diverse agricultural profile, typically encompassing cereals, pulses, fruits, fodder crop and oilseeds. However, due to fluctuating rainfall characteristics and shifting socio-economic variables mean that the agricultural focus across these mandals is highly susceptible to change.

While historical cropping patterns for the region have been broadly documented, there is a distinct need to analyze recent temporal shifts at the micro-level. Tracking how agricultural priorities transition over time allows planners to identify emerging vulnerabilities, such as a

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dangerous over-reliance on a single water-intensive crop. Therefore, this study aims to evaluate the evolving agricultural landscape of the Srikalahasti Revenue Division by analyzing mandal-level data of the year 2023.

1.1 The primary objectives of this study are

To calculate and delineate the crop combination regions across the mandals of the Srikalahasti Revenue Division for the years 2023 using J.C. Weaver's minimum deviation method.

1.2 Study area

The study deals with the geographical perspectives of the agriculture in Srikalahasti revenue division. Srikalahasti revenue division is administratively located in Tirupati district, Andhra Pradesh, India. The study region geographically extends 13°61'75" N to 13°88'29" N Latitude and 79°50'20" E to 79°85'25" E Longitude covering 2112 sq.km of area. consist of eight mandalas namely,

- 1) KvbPuram
- 2) Nagalapuram
- 3) Narayanavanam
- 4) Pichaturu
- 5) Renigunta

- 6) Srikalahasti
- 7) Thotambedu, and
- 8) Yerpedu

Climate: The Srikalahasti Revenue Division experiences a Tropical Monsoon with dry summer climate, classified under the 'As' zone according to Koppen's climatic classification. It is a geographically unique region because it is the only region in the world that receives precipitation from both the Southwest Monsoon and the Northeast Monsoons.

Rainfall: Rainfall within the Srikalahasti Revenue Division is highly seasonal and exhibits considerable spatial variability across its mandals. The Average Annual Rainfall of the Srikalahasti revenue division is 992.92 mm.

Temperature profile: The Srikalahasti revenue division exhibits a high thermal range, shifting from scorching summer peaks to highly comfortable, mild winters. The Average Temperature ranging around 29°C to 30.5°C. highest temperatures are recorded during the height of summer in May and June where the temperature ranges between 40°C to 45°C. The lowest temperatures occur during the winter season, from late December through January, where night time temperatures dip to around 10°C in open/rural areas.

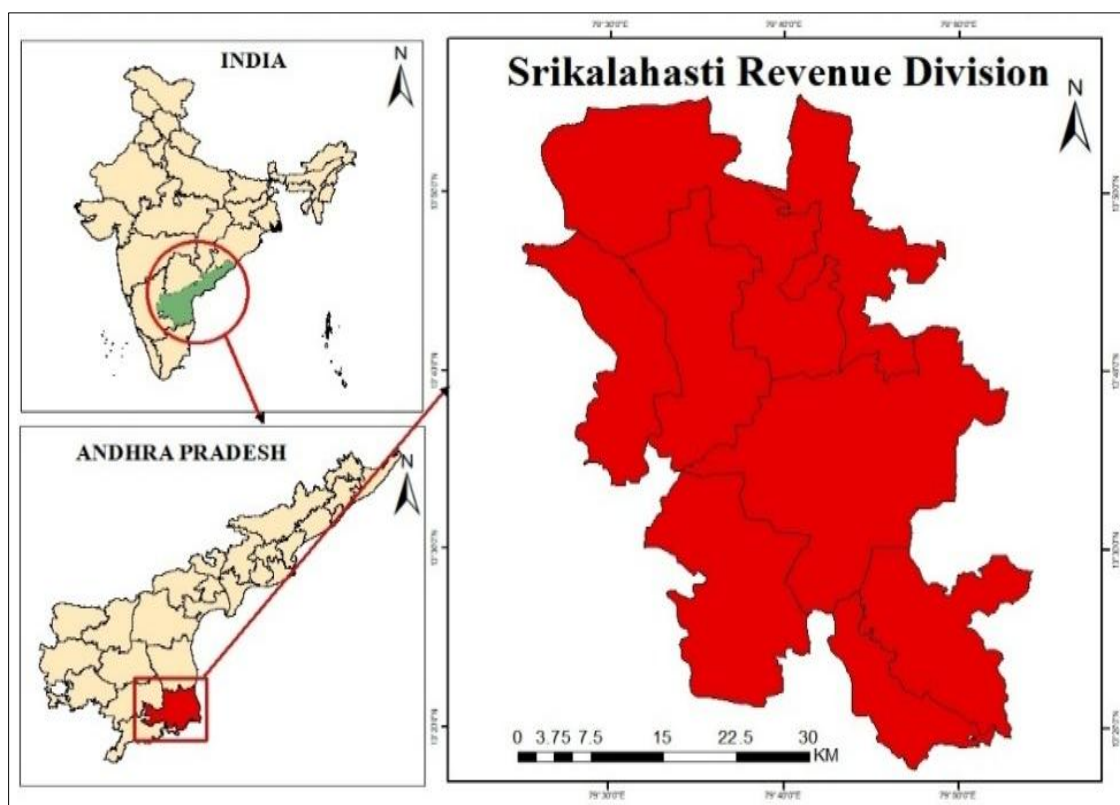


Fig 1: Location map of Srikalahasti Revenue Division, Andhra Pradesh, India

3. Data and Methodology

The present study is entirely based on secondary data sources. The data has been taken from the following secondary sources:

- District Statistical Hand book of Tirupati district 2023
- Agricultural Annual Plan, Office of the Principal Agricultural Officer Tirupati district
- Directorate of Economics and Statistics of Andhra Pradesh

3.1 Weaver's method

J.C. Weaver's Crop (1954) introduced the minimum deviation method. Weaver's technique provides a mathematically rigorous approach by calculating the variance between a theoretical, idealized crop distribution and the actual cultivated land area. By identifying the combination that yields the lowest deviation, the method objectively highlights the dominant crop structures within a specific administrative boundary.

The formula is as following

$$\text{standard deviation} = \sqrt{\frac{d^2}{n}}$$

‘d’= Deviation = difference between the theoretical percentage value and actual percentage value.

‘N’ represents number of crops

$$\sum d^2 = d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2$$

$$\sum d = d_1 + d_2 + \dots + d_n$$

$$d^2 = d \times d$$

d^2 = square of deviation

where;

Percentage of theoretical value = monocrop = %

$$2^{\text{nd}} \text{ crop} = \frac{100}{2} = 50\%$$

$$3^{\text{rd}} \text{ crop} = \frac{100}{3} = 33.33\%$$

$$4^{\text{th}} \text{ crop} = \frac{100}{4} = 25\% \dots \dots \dots \text{so on.}$$

lowest index value $\sum \frac{d^2}{n}$ will be identified as the "Best Crop Combination" for that specific mandal.

3. Result and Discussion

As shown in the table 1, that in the year 2023 the total area under cultivation in Srikalahasti revenue division is 32093 Ha. During 2023 (As shown in the table 1) in the in Srikalahasti revenue division the highest cultivated area is under Srikalahasti mandal with cultivated area of 7000 Ha. During 2023 (As shown in the table 1) in the in Srikalahasti revenue division the lowest cultivated area is under Renigunta mandal with cultivated area of 1206 Ha.

Table 1: Mandal wise percentage of total cropped area for Srikalahasti revenue division – during 2023

Mandal wise percentage of cropped area to total cropping area of the for Srikalahasti revenue division -2023														
S. No.	Mandal	Percentage of cropped area										Total %	Total cropped area (hectares)	
		Paddy (48.01)	Ground nut (26.08)	Bajra (20.77)	Sugarcane (2.26)	Black gram (1.85)	Sunflower (0.59)	Sesame (0.44)						
1	Kvbpuram	Paddy (48.01) <td>Ground nut (26.08)<td>Bajra (20.77)<td>Sugarcane (2.26)<th>Black gram (1.85)</th><th>Sunflower (0.59)</th><th>Sesame (0.44)</th><th> </th><th> </th><th> </th><th> </th><th>100%</th><td>4597</td></td></td></td>	Ground nut (26.08) <td>Bajra (20.77)<td>Sugarcane (2.26)<th>Black gram (1.85)</th><th>Sunflower (0.59)</th><th>Sesame (0.44)</th><th> </th><th> </th><th> </th><th> </th><th>100%</th><td>4597</td></td></td>	Bajra (20.77) <td>Sugarcane (2.26)<th>Black gram (1.85)</th><th>Sunflower (0.59)</th><th>Sesame (0.44)</th><th> </th><th> </th><th> </th><th> </th><th>100%</th><td>4597</td></td>	Sugarcane (2.26) <th>Black gram (1.85)</th> <th>Sunflower (0.59)</th> <th>Sesame (0.44)</th> <th> </th> <th> </th> <th> </th> <th> </th> <th>100%</th> <td>4597</td>	Black gram (1.85)	Sunflower (0.59)	Sesame (0.44)					100%	4597
2	Nagalapuram	Paddy (64.75) <td>Ground nut (17.41)<td>Sugarcane (12.65)<td>Sesame (3.26)<td>Bajra (1.26)<td>Total fodder crop (0.51)<td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td></td></td></td></td></td>	Ground nut (17.41) <td>Sugarcane (12.65)<td>Sesame (3.26)<td>Bajra (1.26)<td>Total fodder crop (0.51)<td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td></td></td></td></td>	Sugarcane (12.65) <td>Sesame (3.26)<td>Bajra (1.26)<td>Total fodder crop (0.51)<td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td></td></td></td>	Sesame (3.26) <td>Bajra (1.26)<td>Total fodder crop (0.51)<td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td></td></td>	Bajra (1.26) <td>Total fodder crop (0.51)<td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td></td>	Total fodder crop (0.51) <td>Black gram (0.16)<th> </th><th> </th><th> </th><th> </th><th>100%</th><td>2545</td></td>	Black gram (0.16) <th> </th> <th> </th> <th> </th> <th> </th> <th>100%</th> <td>2545</td>					100%	2545
3	Narayanavanam	Sugarcane (41.76) <td>Ground nut (27.69)<td>Paddy (12.99)<td>Sunflower (4.26)<td>Bajra (3.63)<td>Black gram (2.80)<td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td></td></td></td></td></td>	Ground nut (27.69) <td>Paddy (12.99)<td>Sunflower (4.26)<td>Bajra (3.63)<td>Black gram (2.80)<td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td></td></td></td></td>	Paddy (12.99) <td>Sunflower (4.26)<td>Bajra (3.63)<td>Black gram (2.80)<td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td></td></td></td>	Sunflower (4.26) <td>Bajra (3.63)<td>Black gram (2.80)<td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td></td></td>	Bajra (3.63) <td>Black gram (2.80)<td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td></td>	Black gram (2.80) <td>Sesame (2.29)<td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td></td>	Sesame (2.29) <td>Maize (1.40)<td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td></td>	Maize (1.40) <td>Coconut (0.89)<td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td></td>	Coconut (0.89) <td>Chilies (0.76)<td>Fodder crop (0.76)<th> </th><td>1571</td></td></td>	Chilies (0.76) <td>Fodder crop (0.76)<th> </th><td>1571</td></td>	Fodder crop (0.76) <th> </th> <td>1571</td>		1571
4	Pichaturu	Paddy (34.80) <td>Sugarcane (34.59)<td>Ground nut (18.57)<td>Bajra (5.93)<td>Sesame (2.23)<td>Black gram (2.06)<td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td></td></td></td></td></td>	Sugarcane (34.59) <td>Ground nut (18.57)<td>Bajra (5.93)<td>Sesame (2.23)<td>Black gram (2.06)<td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td></td></td></td></td>	Ground nut (18.57) <td>Bajra (5.93)<td>Sesame (2.23)<td>Black gram (2.06)<td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td></td></td></td>	Bajra (5.93) <td>Sesame (2.23)<td>Black gram (2.06)<td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td></td></td>	Sesame (2.23) <td>Black gram (2.06)<td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td></td>	Black gram (2.06) <td>Sunflower (1.26)<td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td></td>	Sunflower (1.26) <td>Fodder crop(0.38)<td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td></td>	Fodder crop(0.38) <td>Green gram (0.14)<td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td></td>	Green gram (0.14) <td>Coconut (0.03)<th> </th><th> </th><td>2865</td></td>	Coconut (0.03) <th> </th> <th> </th> <td>2865</td>			2865
5	Renigunta	Paddy (92.45) <td>Ground nut (1.99)<td>Sugarcane (1.19)<td>Chilies (1.32)<td>Sesame (1)<td>Bajra (0.58)<td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td></td></td></td></td></td>	Ground nut (1.99) <td>Sugarcane (1.19)<td>Chilies (1.32)<td>Sesame (1)<td>Bajra (0.58)<td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td></td></td></td></td>	Sugarcane (1.19) <td>Chilies (1.32)<td>Sesame (1)<td>Bajra (0.58)<td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td></td></td></td>	Chilies (1.32) <td>Sesame (1)<td>Bajra (0.58)<td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td></td></td>	Sesame (1) <td>Bajra (0.58)<td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td></td>	Bajra (0.58) <td>Fodder crop (0.50)<td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td></td>	Fodder crop (0.50) <td>Coconut (0.17)<td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td></td>	Coconut (0.17) <td>Maize (0.08)<th> </th><th> </th><th> </th><td>1206</td></td>	Maize (0.08) <th> </th> <th> </th> <th> </th> <td>1206</td>				1206
6	Srikalahasti	Paddy (93.60) <td>Ground nut (4.64)<td>Black gram (1.29)<td>Bajra (0.34)<td>Cotton (0.13)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>7000</td></td></td></td></td>	Ground nut (4.64) <td>Black gram (1.29)<td>Bajra (0.34)<td>Cotton (0.13)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>7000</td></td></td></td>	Black gram (1.29) <td>Bajra (0.34)<td>Cotton (0.13)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>7000</td></td></td>	Bajra (0.34) <td>Cotton (0.13)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>7000</td></td>	Cotton (0.13) <th> </th> <th> </th> <th> </th> <th> </th> <th> </th> <th> </th> <th> </th> <td>7000</td>								7000
7	Thotambedu	Paddy (94.27) <td>Ground nut (3.38)<td>Black gram (0.94)<td>Cotton (0.32)<td>Bajra (0.26)<td>Chilies (0.18)<td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td></td></td></td></td></td>	Ground nut (3.38) <td>Black gram (0.94)<td>Cotton (0.32)<td>Bajra (0.26)<td>Chilies (0.18)<td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td></td></td></td></td>	Black gram (0.94) <td>Cotton (0.32)<td>Bajra (0.26)<td>Chilies (0.18)<td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td></td></td></td>	Cotton (0.32) <td>Bajra (0.26)<td>Chilies (0.18)<td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td></td></td>	Bajra (0.26) <td>Chilies (0.18)<td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td></td>	Chilies (0.18) <td>Sunflower (0.17)<td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td></td>	Sunflower (0.17) <td>Maize (0.02)<td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td></td>	Maize (0.02) <td>Sesame (0.02)<th> </th><th> </th><th> </th><td>6567</td></td>	Sesame (0.02) <th> </th> <th> </th> <th> </th> <td>6567</td>				6567
8	Yerpedu	Paddy (87.83) <td>Ground nut (8.12)<td>Sugarcane (1.19)<td>Black gram (1.74)<td>Bajra (0.42)<td>Chilies (0.05)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>5742</td></td></td></td></td></td>	Ground nut (8.12) <td>Sugarcane (1.19)<td>Black gram (1.74)<td>Bajra (0.42)<td>Chilies (0.05)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>5742</td></td></td></td></td>	Sugarcane (1.19) <td>Black gram (1.74)<td>Bajra (0.42)<td>Chilies (0.05)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>5742</td></td></td></td>	Black gram (1.74) <td>Bajra (0.42)<td>Chilies (0.05)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>5742</td></td></td>	Bajra (0.42) <td>Chilies (0.05)<th> </th><th> </th><th> </th><th> </th><th> </th><th> </th><td>5742</td></td>	Chilies (0.05) <th> </th> <th> </th> <th> </th> <th> </th> <th> </th> <th> </th> <td>5742</td>							5742
														32093

Source: Computed from the data collected

In the year 2023 (As shown in the table 1) In the Srikalahasti revenue division the highest crop diversification is Narayanavanam mandal, where this mandal is under 14 different crops which are sugarcane (41.76), ground nut (27.69), paddy (12.99), sunflower (4.26), bajra (3.63), black gram (2.80), sesame (2.29), maize (1.40), coconut (0.89), chilies (0.76), fodder crop (0.76), red gram (0.45), green gram (0.19), ragi (0.13), whereas the lowest crop diversification is seen in the Srikalahasti mandal where the mandal was under only 5 different crops in the year 2023 which are paddy

(93.60), groundnut (4.64), black gram (1.29), bajra (0.34), cotton (0.13).

3.1 J.C. Weaver's crop combination analysis

KvbPuram mandal: As shown in the table 2, during 2023 KvbPuram Mandal is identified with a third Crop combination where the index values are: mono Crop is 2702.96 i.e. paddy, two Crop is 288.06 i.e. groundnut, three Crop is 88.61 i.e. bajra, fourth Crop is 266.41 i.e. sugarcane, fifth Crop is 293.2499 i.e. black gram, sixth Crop is 295.5667 i.e. sunflower, and seventh Crop is 285.2885714 i.e. sesame.

Table 2: Crop combination of Kvb puram mandal (Sri kalahasti revenue division) during 2023 using j.c.weaver method

Crop combination KVB Puram mandal (Sri Kalahasti Revenue Division) - 2023																						
Crop combination	Mono crop	2 nd crop		3 rd crop			4 th crop			5 th crop				6 th crop				7 th crop				
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	25	20	20	20	20	16.67	16.67	16.67	16.67	14.28	14.28	14.28	
Actual value %	48.01	48.01	26.08	40.78	26.08	20.77	48.01	26.08	20.77	2.26	48.01	26.08	2.26	1.85	48.01	26.08	2.26	1.85	48.01	26.08	2.26	
d	51.99	1.99	23.92	-7.45	7.25	12.56	-23.01	-1.08	4.23	22.74	-28.01	-6.08	-0.77	17.74	18.15	-31.34	-9.41	14.41	14.82	-33.73	13.84	
d ²	2702.96	3.96	572.17	55.50	52.56	157.75	529.46	1.17	17.89	517.11	784.5601	36.9664	0.5929	314.7076	329.4225	982.1956	88.5481	207.6481	219.6324	1137.713	191.5456	
Σd ²	2702.96	576.13		265.82			1065.63					1466.2495				1773.4006				1997.02		
Σd ² /N	2702.96	288.06		88.61			266.41					293.2499				295.5667667				285.2885714		
Crops	Paddy	Ground nut		Bajra			Sugarcane					Black gram				Sunflower				Sesame		

Source: Computed from the data collected

Because the variance value increases at the fourth crop, the three Crop index value (88.61) is the first local minimum. Thus, it is identified as the best statistical representation, making the best Crop combination in this Mandal PGB (i.e. paddy, groundnut, and bajra) according to Weaver.

Nagalapuram Mandal: As shown in the table3, during 2023 Nagalapuram Mandal is identified with a third Crop combination where the index values are: mono Crop is 1242.56 i.e. paddy, two Crop is 639.84 i.e. groundnut, three

Crop is 556.11 i.e. sugarcane, fourth Crop is 565.71 i.e. sesame, fifth Crop is 538.94 i.e. bajra, sixth Crop is 501.14 i.e. total fodder crop, and seventh Crop is 462.80 i.e. black gram. Since the variance value begins to rise again at the fourth crop, the three Crop index value (556.11) serves as the first local minimum and is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is PGS (i.e. paddy, groundnut, and sugarcane) according to Weaver.

Table 3: Crop combination of Nagalapuram Mandal (Sri Kalahasti Revenue Division) during 2023 using J.C. Weaver method

Crop combination Nagalapuram Mandal (Sri Kalahasti Revenue Division) - 2023																						
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th crop		5 th crop				6 th crop				7 th crop						
Theoretical value%	100	50	50	33.33	33.33	25	25	25	20	20	20	20	16.67	16.67	16.67	16.67	14.28	14.28	14.28	14.28	14.28	
Actual value %	64.75	64.75	17.41	64.75	12.65	64.75	17.41	12.65	64.75	17.41	3.26	1.26	64.75	17.41	3.26	1.26	64.75	17.41	3.26	1.26	0.51	
d	35.25	-14.75	32.59	-31.42	15.92	20.68	-39.75	7.59	12.35	21.74	-44.75	2.59	16.74	18.74	-48.08	-0.74	13.41	15.41	-50.47	-3.13	13.77	
d ²	1242.56	217.56	1062.11	987.22	253.45	427.66	1580.06	57.61	152.52	472.63	2002.56	6.71	280.23	351.19	2311.686	0.5476	179.8281	237.4681	2547.221	9.7969	189.6129	
Σd ²	1242.56	1279.67	1668.33	2262.82	2694.71	3006.8362	3239.6228	462.8032571														
Σd ² /N	1242.56	639.84	556.11	565.71	538.94	501.1393667	462.8032571															
CROP	Paddy	Groundnut	Sugarcane	Sesame	Bajra	Total fodder crop	Blackgram															

Source: Computed from the data collected

Narayanavanam Mandal: As shown in the table 4, during 2023 Narayanavanam Mandal is identified with a third Crop combination where the index values are: mono Crop is 3391.90 i.e. sugarcane, two Crop is 282.82 i.e. groundnut, three Crop is 172.20 i.e. Paddy, fourth Crop is 215.63 i.e. Sunflower, fifth Crop is 219.50 i.e. Bajra, sixth Crop is 213.49 i.e. black gram, seventh Crop is 203.72 i.e. sesame, eighth Crop is 194.41 i.e. maize, ninth Crop is 185.15 i.e. coconut, tenth Crop is 175.77 i.e. chilies & fodder crop,

eleventh Crop is 167.08 i.e. red gram, twelfth Crop is 159.07 i.e. green gram, and thirteenth Crop is 151.53 i.e. ragi. Because the variance value clearly increases at the fourth crop, the three Crop index value (172.20) marks the first local minimum, so it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is SGP (i.e. sugarcane, groundnut, and paddy) according to Weaver.

Table 4: Crop combination of Narayanavanam mandal (Sri kalahasti revenue division) during 2023 using J.C. Weaver method

Crop combination Narayanavanam Mandal (Sri Kalahasti Revenue Division) - 2023																										
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th crop		5 th crop				6 th crop			7 th crop											
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	25	20	20	20	20	16.67	16.67	16.67	16.67	16.67	14.28	14.28	14.28	14.28	14.28	14.28	14.28
Actual value %	41.76	41.76	27.69	41.76	12.99	41.76	27.69	12.99	4.26	41.76	27.69	12.99	4.26	3.63	41.76	27.69	2.8	3.63	41.76	27.69	12.99	4.26	3.63	2.8	2.29	2.29
d	58.24	8.24	22.31	-8.43	5.64	20.34	-16.76	-2.69	12.01	-21.76	-7.69	7.01	15.74	16.37	-25.09	-11.02	13.87	13.04	-27.48	-13.41	1.29	10.02	10.65	11.48	11.99	11.99
d ²	3391.90	67.90	497.74	71.06	31.81	413.72	280.90	7.24	144.24	473.50	59.14	49.14	247.75	267.98	629.5081	121.4404	192.3769	170.0416	755.1504	179.8281	1.6641	100.4004	113.4225	131.7904	143.7601	
Σd ²	3391.90	565.63		516.59			862.52				1097.50				1280.9175					1426.016						
Σd ² /N	3391.90	282.82		172.20			215.63				219.50				213.48625					203.7165714						
CROP	Sugarcane	Groundnut	Paddy	Sunflower			Bajra				Bajra				Black gram					Sesame						

Source: Computed from the data collected

Pichaturu Mandal: As shown in the table, during 2023 Pichaturu Mandal is identified with a third Crop combination where the index values are: mono Crop is 4251.04 i.e. paddy, two Crop is 234.25 i.e. sugarcane, three Crop is 73.87 i.e. groundnut, fourth Crop is 148.25 i.e. bajra, fifth Crop is 189.54 i.e. sesame, sixth Crop is 198.46 i.e. black gram, seventh Crop is 197.96 i.e. sunflower, eighth Crop is 194.12

i.e. total fodder crop, ninth Crop is 187.58 i.e. green gram, and tenth Crop is 179.87 i.e. coconut. Because the variance value clearly increases at the fourth crop, the three Crop index value (73.87) marks the first local minimum, so it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is PSG (i.e. paddy, sugarcane, and groundnut) according to Weaver.

Table 5: Crop combination of Pichaturu mandal (Sri kalahasti revenue division) during 2023 using j.c.weaver method

Crop combination Pichatur Mandal (Sri Kalahasti Revenue Division) - 2023																					
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th Crop		5 th crop			6 th crop			7 th crop							
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	20	20	20	20	16.67	16.67	14.28	14.28	14.28	14.28	14.28	14.28
Actual value %	34.8	34.8	34.59	34.8	34.59	18.57	34.8	34.59	5.93	34.8	34.59	5.93	2.23	34.8	34.59	34.8	34.59	18.57	5.93	2.23	2.06
d	65.2	15.2	15.41	-1.47	-1.26	14.76	-9.8	-9.59	19.07	-14.8	-14.59	1.43	17.77	-18.13	-17.92	-20.52	-20.31	-4.29	8.35	12.05	13.02
d ²	4251.04	231.04	237.47	2.16	1.59	217.86	96.04	91.97	363.66	219.04	212.87	2.04	315.77	328.6969	321.1264	421.0704	412.4961	18.4041	69.7225	145.2025	169.5204
Σd ²	4251.04	468.51		221.61		593.02				947.69				1190.7466			1385.7444				
Σd ² /N	4251.04	234.25		73.87		148.25				189.54				198.4577667			197.9634857				
Crop	Paddy	Sugarcane	Groundnut			Bajra				Sesame				Black gram			Sunflower				

Source: Computed from the data collected

Renigunta Mandal: Renigunta Mandal: As shown in the table 6, during 2023 Renigunta Mandal is identified with a mono Crop combination where the index values are: mono Crop is 57.15 i.e. Paddy, two Crop is 2053.06 i.e. groundnut, three Crop is 1821.13 i.e. sugarcane, fourth Crop is 1542.76 i.e. chilies, fifth Crop is 1321.75 i.e. sesame, sixth Crop is 1152.37 i.e. bajra, seventh Crop is 1019.24 i.e. total fodder

crop, eighth Crop is 913.52 i.e. coconut, and ninth Crop is 827.23 i.e. maize. Because the variance value increases at the second crop, the mono Crop index value (57.15) marks the first local minimum and the lowest value. Thus, it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is a monoculture of Paddy according to Weaver.

Table 6: Crop combination of Renigunta Mandal (Sri Kalahasti Revenue Division) during 2023 using J.C. Weaver method

Crop combination Renigunta Mandal (Sri Kalahasti Revenue Division) - 2023														
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th crop		5 th crop		6 th crop		7 th crop		
Theoretical value %	100	50	50	33.33	33.33	25	25	20	20	16.67	16.67	14.28	14.28	14.28
Actual value %	92.44	92.44	1.99	92.44	1.91	92.44	1.91	92.44	1.91	92.44	1.91	92.44	1.91	1.33
d	7.56	-42.44	48.01	-59.11	31.42	-67.44	23.01	-72.44	18.01	-75.77	14.68	-78.16	12.29	12.95
d ²	57.15	1801.15	2304.96	3493.99	987.22	4548.15	533.15	5247.55	324.36	5741.093	215.5024	6108.986	151.0441	167.7025
Σd ²	57.15	4106.11	5463.40	6171.03				6608.73		6914.2055		7134.6859		
Σd ² /N	57.15	2053.06	1821.13	1542.76				1321.75		1152.367583		1019.240843		
Crop	Paddy	Groundnut	Sugarcane	Chilies				Sesame		Bajra		Total fodder crop		

Source: Computed from the data collected

Srikalahasti Mandal: As shown in the table7, during 2023 Srikalahasti Mandal is identified with a mono Crop combination where the index values are: mono Crop is 40.96 i.e. paddy, two Crop is 1979.24 i.e. groundnut, three Crop is 1827.38 i.e. black gram, fourth Crop is 1572.69 i.e. bajra, and fifth Crop is 1356.86 i.e. cotton. Because the variance value

increases drastically immediately at the second crop, the mono Crop index value (40.96) marks the first local minimum and the absolute lowest value. Thus, it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is a monoculture of Paddy according to Weaver.

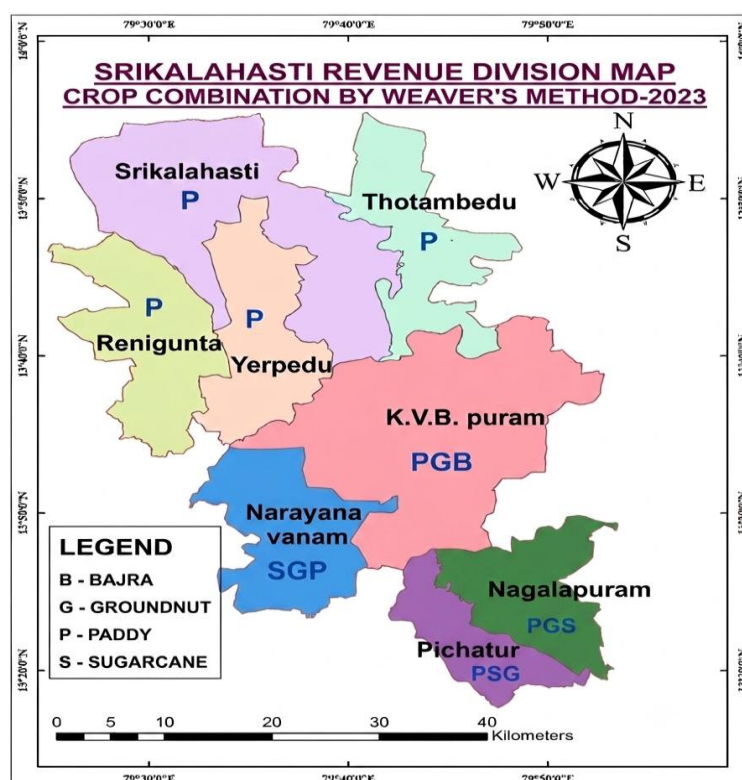


Table 7: Crop combination of Srikalahasti mandal (Sri kalahasti revenue division) during 2023 using J.C. Weaver method

Crop combination Srikalahasti Mandal (Sri Kalahasti Revenue Division) - 2023															
Crop combination	Mono crop	2 nd crop		3 rd crop			4 th crop				5 th crop				
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	25	20	20	20	20	20
Actual value %	93.6	93.6	4.64	93.6	4.64	1.29	93.6	4.64	1.29	0.34	93.6	4.64	1.29	0.34	0.13
d	6.4	-43.6	45.36	-60.27	28.69	32.04	-68.6	20.36	23.71	24.66	-73.6	15.36	18.71	19.66	19.87
d ²	40.96	1900.96	2057.53	3632.47	823.12	1026.56	4705.96	414.53	562.16	608.12	5416.96	235.93	350.06	386.52	394.82
Σd ²	40.96	3958.49		5482.15			6290.77				6784.29				
Σd ² /N	40.96	1979.24		1827.38			1572.69				1356.86				
Crop	Paddy	Groundnut		Black gram			Bajra				Cotton				

Source: Computed from the data collected

Thotambedu Mandal: As shown in the table 8, during 2023 Thotambedu Mandal is identified with a mono Crop combination where the index values are: mono Crop is 27.88 i.e. paddy, two Crop is 2086.65 i.e. groundnut, three Crop is 1904.95 i.e. black gram, fourth Crop is 1629.07 i.e. cotton, fifth Crop is 1399.91 i.e. bajra, sixth Crop is 1220.73 i.e. chilies, seventh Crop is 1079.53 i.e. sunflower, eighth Crop

is 966.83 i.e. maize, and ninth Crop is 874.79 i.e. sesame. Because the variance value increases drastically immediately at the second crop, the mono Crop index value (27.88) marks the first local minimum and the absolute lowest value overall. Thus, it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is a monoculture of Paddy according to Weaver.

Table 8: Crop combination of Thotambedu Mandal (Sri Kalahasti revenue division) during 2023 using J.C. Weaver method

Crop combination Thotambedu Mandal (Sri Kalahasti Revenue Division) - 2023																	
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th crop		5 th crop		6 th crop			7 th crop				
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	20	20	20	14.28	14.28	14.28	14.28	14.28
Actual value %	94.72	94.72	3.38	94.72	3.38	0.94	94.72	0.32	0.94	0.26	0.32	0.32	94.72	0.18	0.26	0.17	0.17
d	5.28	-44.72	46.62	-61.39	32.39	29.95	-69.72	24.68	24.06	19.74	15.73	16.41	-80.44	16.49	14.02	14.11	14.11
d ²	27.88	1999.88	2173.42	3768.73	1049.11	897.00	4860.88	609.10	578.88	389.67	247.432	269.288	6470.59	271.920	196.560	199.092	199.092
Σd ²	27.88	4173.30		5714.85		6516.29		6999.56		7324.3902			7556.7033				
Σd ² /N	27.88	2086.65		1904.95		1629.07		1399.91		1220.7317			1079.529043				
Crop	Paddy	Groundnut		Black gram		Cotton		Bajra		Chilies			Sunflower				

Source: Computed from the data collected

Yerpedu Mandal: As shown in the table 9, during 2023 Yerpedu Mandal is identified with a mono Crop combination where the index values are: mono Crop is 148.11 i.e. paddy, two Crop is 1592.52 i.e. groundnut, three Crop is 1532.26 i.e. Sugarcane, fourth Crop is 1327.37 i.e. black gram, fifth Crop is 1157.65 i.e. bajra, and sixth Crop is 1020.11 i.e. chilies.

Because the variance value increases drastically immediately at the second crop, the mono Crop index value (148.11) marks the first local minimum and the absolute lowest value overall. Thus, it is identified as the best statistical representation. Therefore, the best Crop combination in this Mandal is a monoculture of Paddy according to Weaver.

Table 9: Crop combination of Yerpedu Mandal (Sri Kalahasti revenue division) during 2023 using J.C. Weaver method

Crop combination Yerpedu Mandal (Sri Kalahasti Revenue Division) - 2023														
Crop combination	Mono crop	2 nd crop		3 rd crop		4 th crop		5 th crop		6 th crop				
Theoretical value %	100	50	50	33.33	33.33	33.33	25	25	25	20	20	20	16.67	16.67
Actual value %	87.83	87.83	8.12	87.83	8.12	1.85	87.83	1.85	1.74	8.12	1.85	1.74	0.42	0.02

d	12.17	-37.83	41.88	-54.5	25.21	31.48	-62.83	16.88	23.15	23.26	-67.83	11.88	18.15	18.26	19.58	-71.16	8.55	14.82	14.93	16.25	16.65
d ²	148.11	1431.11	1753.93	2970.25	635.54	990.99	3947.61	284.93	535.92	541.03	4600.91	141.13	329.42	333.43	383.38	5063.746	73.1025	219.6324	222.9049	264.0625	277.2225
Σd^2	148.11	3185.04	4596.78	5309.49	5788.27	6120.6704															
$\Sigma d^2/N$	148.11	1592.52	1532.26	1327.37	1157.65	1020.111733															
CROP	Paddy	Groundnut	Sugarcane	Black gram	Bajra	Chilies															

Source: Computed from the data collected

4. Conclusion

This study applies J.C. Weaver's minimum deviation method to delineate and map the crop combination regions across the eight mandals of the Srikalahasti Revenue Division for the year 2023. The variance analysis provides a clear spatial picture of the integrated farming practices across the division's total cultivated area of 32,093 hectares. The study reveals a distinct spatial divide in cropping strategies within the region. Half of the study area specifically the Renigunta, Srikalahasti, Thotambedu, and Yerpedu mandals exhibits a monocrop agricultural pattern that is dominated by paddy. Whereas, the remaining mandals of KvbPuram, Nagalapuram, Narayanavanam, and Pichatur display a slightly broader three-crop combination. In these areas, farmers have integrated commercial and resilient crops such as groundnut, sugarcane, and bajra alongside paddy to diversify their agricultural pattern in the region and likely mitigate risk.

Furthermore, the analysis highlights a significant inverse relationship between total cultivated area and crop diversification. For instance, while the Srikalahasti mandal accounts for the highest cultivated area at 7,000 hectares, it demonstrates the lowest diversification with only five crops grown. In contrast, Narayanavanam mandal features the highest crop diversification with 14 different crops cultivated, despite managing a much smaller agricultural area. The spatial analysis of crop combinations in the Srikalahasti Revenue Division underscores a heavy regional dependency on paddy cultivation. This monoculture trend poses long-term agricultural risks. By utilizing Weaver's minimum deviation method, this study provides actionable data for regional planners to drive targeted interventions, promoting necessary crop diversification and sustainable resource management to secure the region's farming future.

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