CROP DIVERSIFICATION IN COASTAL ANDHRA PRADESH -A COMPARATIVE STUDY IN AGENCY AND NON-AGENCY AREAS

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ABSTRACT

The evolution of cropping patterns in India reflects the country's agricultural transformation from traditional subsistence farming to a more diversified and market-oriented approach. The shift towards cash crops and horticulture, along with the adoption of modern technologies and government policies, has significantly altered the agricultural landscape. As India continues to face challenges such as climate change, population growth, and land degradation, it will be crucial to further promote crop diversification and sustainable agricultural practices to ensure food security and improve the livelihoods of farmers. The present paper examines cropping patterns at both the national and state levels, with a particular focus on Andhra Pradesh and its Coastal region. It highlights how economic liberalization, climate adaptation, and technological advancements have driven spatial and temporal shifts in cropping patterns. Additionally, the paper analyzes the Compound Annual Growth Rates (CAGR) of major crops to understand productivity trends and regional disparities. It also analyzes agriculture in Coastal Andhra Pradesh, a region marked by high agricultural productivity and diverse cropping systems. Understanding these cropping patterns is essential for developing strategies that enhance agricultural productivity, ensure food security, and promote income stability for farmers.

Keywords: cropping patterns, agricultural transformation, crop diversification, regional disparities, food security

1. INTRODUCTION

India's agricultural landscape has undergone significant transformations over the past several decades, influenced by historical, technological, and policy changes. Initially, agriculture in India was predominantly focused on subsistence farming, where farmers cultivated crops mainly for local consumption. The cropping patterns were highly dependent

on the monsoon season, soil type, and geographical location, which limited agricultural productivity and stability. However, the shift from traditional to more commercial and diversified cropping systems began in the mid-20th century, catalyzed by the Green Revolution in the 1960s.The Green Revolution marked a pivotal moment in the evolution of cropping patterns in India. Prior to this, the agricultural sector faced challenges such as low productivity, food shortages, and famine risks. The introduction of high-yielding varieties (HYVs) of seeds, particularly for rice and wheat, along with the adoption of chemical fertilizers, pesticides, and irrigation techniques, drastically increased crop yields. In the 1960s and 1970s, states like Punjab, Haryana, and Uttar Pradesh saw rapid growth in wheat and rice production. This period led to a shift from traditional farming practices to a more commercialized system of agriculture. The early data from the Green Revolution era indicated significant increases in cereal production. For instance, wheat production surged from around 10 million tons in 1950 to over 60 million tons by the 1980s, reflecting the success of HYVs in improving crop yields. Similarly, rice production grew from approximately 50 million tons in 1950 to over 80 million tons by 1980 (Singh & Sharma, 2000). This period also saw the adoption of mechanization, which further enhanced production capacities but also led to an increase in the reliance on external inputs like fertilizers and pesticides, raising concerns about sustainability.

1.1. Shift to Cash Crops and Horticultural Crops

In 1980s and 1990s, India's agricultural focus began shifting from staple food crops to cash crops and high-value horticultural crops, as liberalization policies opened up the market and provided farmers with more opportunities to diversify. Crops such as cotton, sugarcane, and oilseeds (groundnut, soybeans) started to dominate certain regions, driven by market demand both domestically and internationally. In parallel, the horticultural sector, including fruits and vegetables, saw rapid growth as the demand for fresh produce increased. According to data from the Directorate of Economics and Statistics (2000), the area under horticultural crops increased from around 13 million hectares in 1980 to 22 million hectares by 2000. The growth of horticulture was particularly significant in states like Maharashtra, Andhra Pradesh, and Gujarat, where favorable agro-climatic conditions and better irrigation infrastructure allowed for the expansion of high-value crops like mangoes, grapes, and tomatoes.

The latest trends in cropping patterns reflect the continuing shift towards diversification, with substantial growth in cash crops and horticulture, while traditional cereal crops like wheat and rice remain significant but have shown slower growth rates. According to the Ministry of Agriculture and Farmers' Welfare (2023), India's total area under rice cultivation is around 43 million hectares, while wheat is cultivated on 30 million hectares. The area under pulses, oilseeds, and vegetables has also been steadily increasing, demonstrating a continued shift toward crop diversification. For example, the area under pulses has risen by approximately 22% from 2000 to 2020, reflecting policy incentives such as the National Food Security Act and the promotion of pulses through the Pradhan Mantri Krishi Sinchayee Yojana. There is a substantial growth in cash crops and horticultural crops, with the area under cotton and sugarcane showing the most significant increase over the past two decades. Similarly, horticultural crops have expanded by nearly 50%, signaling the shift towards more profitable and climate-resilient crops. The shift towards high-value crops is also evident in the growing importance of fruits and vegetables, which are more adaptable to changing climatic conditions and offer better economic returns to farmers.

The main aim of the present paper is to examine cropping patterns at both the national and state levels, with a particular focus on Andhra Pradesh and its Coastal region. The study explores cropping patterns in India, providing a comprehensive overview of the distribution and trends of food crops, commercial crops, and horticultural crops across the country. It highlights how economic liberalization, climate adaptation, and technological advancements have driven spatial and temporal shifts in cropping patterns. Additionally, the paper analyzes the Compound Annual Growth Rates (CAGR) of major crops to understand productivity trends and regional disparities. The study also focuses on agriculture in Andhra Pradesh, emphasizing its agro-climatic zones, major crops, and regional variations. The influence of large-scale irrigation projects, such as those on the Godavari and Krishna rivers, is critically analyzed, highlighting their role in shaping cropping patterns and intensities. The state's agricultural economy is characterized by a mix of traditional and modern cropping systems, showcasing the interplay between subsistence farming and high-value crop cultivation.

This paper also analyzes agriculture in Coastal Andhra Pradesh, a region marked by high agricultural productivity and diverse cropping systems through cropping intensity, land

use patterns, and the pivotal role of crop diversification in promoting agricultural sustainability. Using the Simpson Index, it measures the extent of diversification, illustrating farmers' transition from monoculture to more varied and high-value cropping systems. Understanding these cropping patterns is essential for developing strategies that enhance agricultural productivity, ensure food security, and promote income stability for farmers. The paper underscores the importance of crop diversification as a pathway to mitigating risks associated with climate change, market fluctuations, and resource depletion.

1.2. Objectives

1. To examine cropping patterns in India and Andhra Pradesh
2. To assess crop diversification in Coastal Andhra Pradesh by comparing the agency and non-agency areas.
3. To measure the degree of crop diversification by using the method of Simpson index of Diversification.

1.3. Research Methodology

The research methodology is designed to provide a systematic, objective, and comprehensive analysis of crop diversification and its impact on the income and expenditure of small farmers in Coastal Andhra Pradesh. A multi-stage random sampling technique is used to select study areas and participants, ensuring the process is both representative and statistically valid. The methodology is structured as in step I, selection of state is Andhra Pradesh, Costal Andhra in particular stands out for its high agricultural productivity, cultivating a wide range of crops. Step II selection of district, in Andhra Pradesh consisting of 26 Districts among these two districts have been chosen in the Costal Andhra. These districts are Alluri Sitha Rama Raju districts in agency area, and East Godavari districts in non-agency area. In step III selection of mandals, in agency area out of 22 mandals in Alluri Sitha Rama Raju districts two mandals have been chosen which are Chintapalli mandal and Koyyuru mandal. In non-agency area two mandals have been chosen in East Godavari districts out of 64 mandals in the districts Kovvuru and Chagallu mandals have been chosen. Step IV selection of villages, for each selected mandal, specific villages are chosen based on the presence of smallholder farmers and the variety of crops cultivated. A stratified random sampling technique ensures the representation of both high and low-diversity crop areas.

1.4 Sources of Data

The data for this study is obtained from both primary and secondary sources to ensure comprehensive and reliable results.

i) Secondary Data:

Secondary data complements the primary data and is sourced from various government records and reports, including publications from Agricultural Development Agencies and reports from other relevant government departments. Additional secondary data is gathered from agricultural journals, research papers, and books on topics such as crop diversification, agricultural economics, and rural development.

ii) Primary Data:

Primary data has been collected through a farm-level survey conducted among farmers in the selected villages of the study area. In the agency area of Alluri Sitharama Raju district, due to challenges in gathering data from a sufficient number of farmers in each village, 8 villages from each mandal are selected, with 10 farmers chosen from each village. This ensures a total of 80 farmers per mandal are surveyed, representing the tribal areas adequately despite logistical difficulties. In the non-agency area of East Godavari district, 20 farmers are selected from each of the four villages in each mandal, leading to a total of 80 farmers per mandal. This ensures a diverse and representative sample of the farming community in non-agency areas. The sample size is 320 house holds in both agency and non-agency areas.

2. MAJOR AGRICULTURE CROPS IN INDIA

India's agricultural landscape is dominated by a diverse range of crops, which can be broadly categorized into food crops, commercial crops, and horticultural crops. Among these, food crops play a central role in ensuring food security for the nation, with cereals and pulses being the most critical components.

2.1. Food Crops:

Food crops primarily include cereals, pulses, and other staples that form the foundation of the Indian diet and are critical for national food security. These crops are grown extensively across the country and are essential for both subsistence and commercial purposes. The following sections delve into the major food crops grown in India, including their area of cultivation, production, and consumption trends. Rice is the dominant cereal crop, cultivated

over 43 million hectares, with a production of nearly 118 million metric tons in 2023. The average yield is approximately 2748 kg per hectare. Similarly, wheat has shown steady growth, with production increasing by 2.2% annually from 2000 to 2020. The yield of wheat, at 3541 kg per hectare, is higher than that of rice, reflecting the impact of improved seed varieties and irrigation infrastructure in key wheat-producing states like Punjab and Haryana.

i) Cereal Crops : Cereals such as rice, wheat, maize, and barley constitute the backbone of food production in India. Among these, rice and wheat dominate in terms of both area and production. The data on the area, production, and yield of major cereal crops in India indicates that rice is the dominant cereal crop, cultivated over 43 million hectares, with a production of nearly 118 million metric tons in 2023. The average yield is approximately 2748 kg per hectare.

ii) Pulses: Pulses such as lentils, chickpeas, and pigeon peas are another vital component of the food crop category. Pulses are a major source of protein for millions of Indians, especially in vegetarian diets. Pulses have shown steady growth in terms of area and production, with chickpeas being the most widely cultivated pulse, occupying around 10.5 million hectares. The production of chickpeas reached 10.56 million metric tons in 2023, with an average yield of 1005 kg per hectare.

iii) Other Food Staples : Potatoes, grown primarily in states like Uttar Pradesh, West Bengal, and Bihar, continue to be a major staple in the Indian diet. The area under potatoes is around 2 million hectares, with a production of 48 million metric tons in 2023, showing a significant increase in both yield and area cultivated.

2.2. Major Commercial Crops

Commercial crops are an essential component of India's agricultural sector, primarily cultivated for industrial use, export, and as cash crops for farmers. These crops include cotton, sugarcane, oilseeds, and tobacco, which are critical to both the domestic economy and the global trade markets.

i) Cotton: Cotton is one of the most important commercial crops in India, not only due to its role in textile industries but also because it is a significant export commodity. With around 12 million hectares dedicated to cotton farming, India produces approximately 35 million metric tons of cotton annually, yielding about 292 kg per hectare. The growth rate of cotton production has been robust at 3.2% from 2000 to 2020, driven by advancements in cotton cultivation techniques, such as the adoption of Bt cotton, which has led to higher yields.

ii) Sugarcane: Sugarcane is another critical commercial crop, especially for the sugar and ethanol industries. India's sugarcane cultivation spans approximately 5.2 million hectares, with a production of 358 million metric tons, reflecting a yield of 6890 kg per hectare. The growth rate of sugarcane production has been moderate at 1.5% annually.

iii) Groundnut: Groundnut, also known as peanut, is grown primarily for oil extraction and export. India's groundnut production is around 6.6 million metric tons, cultivated over 5 million hectares, yielding 1320 kg per hectare. The growth rate of groundnut production has been 1.5%, which is relatively stable over the past two decades.

iv) Soybean: Soybean cultivation in India has expanded significantly, reaching an area of 12.3 million hectares and producing 13 million metric tons with a yield of 1055 kg per hectare. The growth rate of soybean production has been impressive at 4.5%, as the demand for soybean oil and soy meal has surged, both domestically and internationally.

v) Tobacco: Tobacco is grown primarily for the cigarette, bidi, and smokeless tobacco industries. Although its area of cultivation is small compared to other commercial crops (0.4 million hectares), its production stands at 0.85 million metric tons, with a yield of 2125 kg per hectare.

vi) Oil seeds: Oilseeds, including mustard, groundnut, soybean, and sunflower, are crucial for vegetable oil production in India. The total area dedicated to oilseed cultivation is about 24 million hectares, yielding 32 million metric tons of production. Oilseed crops have shown a moderate growth rate of 2.3% annually.

2.3. Major Horticulture Crops

Horticulture crops, which include fruits, vegetables, and floriculture, have gained significant importance in recent decades due to their potential to diversify farmer incomes and enhance food security. These crops play a crucial role in the agricultural economy by providing high-value products that have growing domestic and international demand. The sector also supports various agro-based industries such as food processing, packaging, and floriculture, creating additional economic opportunities.

Fruits: India is a leading producer of fruits such as mangoes, bananas, apples, oranges, and grapes, which constitute a significant portion of the horticulture sector. With an area of approximately 10.7 million hectares and a production of 97.4 million metric tons, the fruit sector has shown a steady growth rate of 3.5% annually from 2000 to 2020. The increase in

demand for both domestic consumption and exports, especially for tropical fruits like mangoes, is a key driver of this growth.

Vegetables: Vegetable production in India has seen a rapid increase, with 9.1 million hectares under cultivation and a production of 180 million metric tons. The vegetable sector has experienced a growth rate of 4.0% from 2000 to 2020, driven by growing domestic demand for fresh vegetables as well as exports.

Floriculture: Floriculture, though a relatively small segment of the horticulture sector, has witnessed remarkable growth, with an area of 0.25 million hectares producing 1.9 million metric tons of flowers annually. The growth rate in floriculture has been impressive at 5.8%, reflecting the increasing demand for flowers both in domestic markets and for export, particularly for ornamental purposes, festivals, and weddings.

Spices: India is the world leader in the production of various spices, including black pepper, turmeric, cardamom, chili, and ginger. The country has around 3 million hectares devoted to spice cultivation, producing approximately 7 million metric tons annually. The sector has grown at a rate of 3.2%, driven by both domestic demand for spices in cooking and India's growing presence in global spice markets.

3. Cropping pattern in Andhra Pradesh

The agricultural landscape of Andhra Pradesh is diverse, influenced by its agro-climatic zones, regional preferences, and the availability of water. The state's cropping patterns reflect this diversity, with key crops grown in varying regions based on soil type, irrigation availability, and climatic conditions.

i. **Food Crops:** Food crops, including rice, maize, pulses, and groundnuts, are essential for both domestic consumption and food security in Andhra Pradesh. Rice is the most important food crop, especially in the coastal and delta areas, where irrigation is readily available. Maize and pulses are largely grown in the drier, rainfed regions like Rayalaseema.

Table-1
Production of Food Crops in Andhra Pradesh

Crop	Area (in hectares)	Production (in metric tonnes)	Yield (kg/ha)
Rice	3,539,000	12,100,000	3,418
Maize	455,000	1,400,000	3,078
Groundnut	475,000	1,100,000	2,316
Pulses	350,000	600,000	1,714

Source: AP Socio Economic Survey 2022-23

Rice is the most extensively cultivated crop in Andhra Pradesh, covering an area of 3,539,000 hectares, which underscores its importance as the state's staple food. The production volume of rice stands at an impressive 12,100,000 metric tonnes, reflecting its central role in ensuring food security for the population. With a high average yield of 3,418 kg/ha, rice cultivation benefits from well-developed irrigation infrastructure, adoption of high-yield varieties, and supportive government policies. These factors collectively contribute to making rice the backbone of Andhra Pradesh's agricultural economy.Maize, an important cereal crop, is cultivated over 455,000 hectares in the state. It generates a production volume of 1,400,000 metric tonnes, with an average yield of 3,078 kg/ha. Maize cultivation has seen growth in recent years, driven by increasing demand for animal feed and industrial use. The relatively high yield per hectare highlights the adoption of improved farming practices and the use of hybrid seeds.

Groundnut is a key oilseed crop in Andhra Pradesh, cultivated on 475,000 hectares of agricultural land. Its production reaches 1,100,000 metric tonnes, with a yield of 2,316 kg/ha. Groundnut plays a vital role in supporting rural livelihoods and contributing to the edible oil industry. However, the yield is relatively lower compared to cereals, indicating a need for enhanced practices such as soil fertility management and better pest control measures. Pulses, covering an area of 350,000 hectares, contribute 600,000 metric tonnes to the state's agricultural output. The average yield is 1,714 kg/ha, which is relatively low compared to other crops. Pulses are an essential source of protein for the population and help in improving soil fertility through nitrogen fixation. Increasing the productivity of pulses requires focused interventions, such as promoting improved seed varieties and efficient water management.

ii. **Commercial Crops:** Commercial crops such as cotton, sugarcane, and oilseeds are vital for the state's economy, contributing to both domestic consumption and exports. Cotton, particularly, plays a major role in Andhra Pradesh's industrial sector, while sugarcane supports the sugar mill industry.

Table-2
Production of Commercial Crops in Andhra Pradesh

Crop	Area (in hectares)	Production (in metric tonnes)	Yield (kg/ha)
Cotton	700,000	1,400,000	2,000
Sugarcane	350,000	24,000,000	68,571
Groundnut	475,000	1,100,000	2,316
Sunflower	100,000	75,000	750

Source: AP Socio Economic Survey 2022-23

The data on commercial and oilseed crops such as cotton, sugarcane, groundnut, and sunflower highlight the diversity and economic significance of agriculture in Andhra Pradesh. Each crop has distinct contributions to the state's economy, with variations in area cultivated, total production, and yield per hectare. Cotton is a significant cash crop in Andhra Pradesh, cultivated over an area of 700,000 hectares. The production of 1,400,000 metric tonnes underscores its importance in the textile industry and as a source of rural income. The average yield of 2,000 kg/ha reflects the state's efforts to adopt hybrid seeds and improve farming practices. However, there is potential to enhance productivity through better pest control and sustainable farming techniques. Sugarcane stands out as a high-yielding commercial crop in the state, with cultivation spanning 350,000 hectares. The crop achieves an extraordinary production volume of 24,000,000 metric tonnes, with a yield of 68,571 kg/ha, the highest among the crops analyzed. This remarkable productivity is attributed to favorable climatic conditions, efficient irrigation, and advanced farming techniques. Sugarcane is pivotal to the state's economy, supporting sugar production, ethanol production, and allied industries.

Groundnut remains a vital oilseed crop, cultivated on 475,000 hectares and producing 1,100,000 metric tonnes. With a yield of 2,316 kg/ha, groundnut is a critical contributor to the edible oil sector. Its dual role as a cash crop and soil fertility enhancer through nitrogen

fixation makes it indispensable for sustainable agricultural practices. However, there is scope for improvement in yield through better seed varieties and pest management. Sunflower, though cultivated on a smaller area of 100,000 hectares, produces 75,000 metric tonnes of seeds, with a yield of 750 kg/ha, the lowest among the crops studied. The crop's low productivity indicates challenges such as inadequate rainfall, suboptimal farming practices, and limited adoption of high-yield seed varieties. Enhancing sunflower yields requires focused interventions, including research on drought-resistant varieties and better extension services.

iii) **Horticulture Crops:** Horticultural crops, including fruits, vegetables, and floriculture, have seen significant growth in Andhra Pradesh, providing an essential source of income diversification for farmers.

Table-3
Production of Horticulture Crops in Andhra Pradesh

Crop	Area (in hectares)	Production (in metric tonnes)	Yield (kg/ha)
Mango	170,000	3,000,000	17,647
Banana	150,000	3,500,000	23,333
Tomato	75,000	1,500,000	20,000
Chilli	100,000	1,800,000	18,000

Source: AP Socio Economic Survey 2022-23

Horticultural crops such as mango, banana, tomato, and chilli play a vital role in Andhra Pradesh's agricultural economy. These crops contribute significantly to the state's food basket, nutritional security, and income generation for farmers. Analyzing their area, production, and yield offers insights into their economic and agricultural significance.Mango, often referred to as the "king of fruits," is cultivated on 170,000 hectares, producing 3,000,000 metric tonnes with an average yield of 17,647 kg/ha. Andhra Pradesh is a major contributor to India's mango production, supported by favorable agro-climatic conditions and improved farming practices. Mango cultivation provides substantial income to farmers and contributes to exports and the domestic market.Banana occupies 150,000 hectares and generates a production of 3,500,000 metric tonnes, with the highest yield among the crops at 23,333 kg/ha. The remarkable yield is attributed to high-density planting, effective irrigation

systems, and efficient nutrient management. As a year-round crop, bananas serve as a significant source of income and are vital for ensuring food and nutritional security.

Tomato cultivation covers 75,000 hectares, with a production volume of 1,500,000 metric tonnes and an average yield of 20,000 kg/ha. Tomatoes are an essential vegetable crop for both domestic consumption and processing industries. The high yield reflects advancements in hybrid seed varieties, pest management, and efficient cultivation practices.Chilli, a key spice crop, spans 100,000 hectares and produces 1,800,000 metric tonnes, with an average yield of 18,000 kg/ha. Andhra Pradesh is a leader in chilli production, contributing significantly to domestic spice consumption and exports. The crop's high yield underscores the adoption of improved farming techniques and the importance of chillies in the state's agricultural exports.

4. **Simpson Index of Diversification**

The Simpson Index of Diversification (SID) is a popular method for measuring biodiversity and, by extension, crop diversification. This index helps quantify the degree of diversification within a region by evaluating the relative abundance and variety of crops grown. In this section, the Simpson Index is applied to assess the level of crop diversification in Coastal Andhra Pradesh, comparing the agency and non-agency areas to understand the impact of socio-economic and ecological factors on cropping patterns.

Methodology:

The Simpson Index is calculated using the following formula:

The formula for the Simpson Index is:

$$D = 1 - \sum_{=1} (p^2)$$

Where:

- DDD is the Simpson Index of Diversification.
- pi is the proportion of each crop in the total area cultivated in the region.

Note: The sum runs over all crops in the region.

- The index ranges from 0 to 1, where:
- A value of **0** indicates no diversity (i.e., only one crop is cultivated).

- A value closer to **1** indicates higher diversity (i.e., a greater number of different crops are grown in roughly equal proportions).

4.1 Application in Coastal Andhra Pradesh:

For Coastal Andhra Pradesh, the Simpson Index is applied to two distinct agricultural regions: agency areas (less developed regions, often facing challenges such as limited irrigation and lower access to markets and non-agency areas (regions with higher government support, typically better irrigation, and infrastructure).

The data for this analysis is collected from government reports, agricultural surveys, and field surveys conducted in the region. The data includes the areas cultivated for various crops, such as rice, maize, and horticultural crops, among others. The cultivation area for each crop is converted into a proportion of the total cultivated area in each region to calculate the Simpson Index.

These regions, characterized by lower access to infrastructure and irrigation, often have a more monoculture-based cropping system, with rice, cashew, millets being the dominant crop in many areas. In these regions, the Simpson Index is generally lower, indicating less crop diversification. Farmers in these areas may face challenges such as erratic rainfall, limited access to quality seeds, and poor market linkages, leading them to focus on fewer, more reliable crops. These areas have access to better infrastructure, including irrigation facilities, subsidies, and technical support. The cultivation of high-value crops such as paddy, sugarcane and horticultural crops (vegetables and bananas) is more common. The non-agency areas tend to show a higher Simpson Index, indicating greater crop diversification. The availability of irrigation and government support reduces the risk of crop failure and encourages farmers to diversify their cropping systems, contributing to a higher level of agricultural biodiversity.

4.2 Simpson Index of Diversification in Coastal Andhra Pradesh: A Comparative Analysis

To measure crop diversification in Coastal Andhra Pradesh, the Simpson Index of Diversification (SID) can be applied to assess the variety and distribution of crops in both agency and non-agency areas. This index helps gauge the level of crop concentration and diversification, with values ranging from 0 (no diversity) to 1 (high diversity). The index considers both the number of different crops grown and their relative abundance.

The following table illustrates the application of the Simpson Index for crop diversification in agency and non-agency areas of Coastal Andhra Pradesh over the years.

Table-4
Simpson Index for crop diversification

Year	Agency Area SID	Non-Agency Area SID
2016	0.79	0.85
2017	0.82	0.88
2018	0.80	0.87
2019	0.81	0.86
2020	0.83	0.89

Source: Department of Agriculture, Andhra Pradesh (2022)

In agency areas, the diversification index is slightly lower, ranging from 0.79 to 0.83. These areas tend to rely more on traditional farming methods and are often constrained by limited access to irrigation, technical support, and market infrastructure. This results in a relatively narrower range of crops, which can lead to a lower index value. The Simpson Index for non-agency areas has been consistently high, ranging from 0.85 to 0.89 over the five-year period. This indicates a relatively high level of crop diversification, meaning that the region has a balanced mix of crops grown. Factors such as improved irrigation, government support programs like the YSR Rythu Bharosa, and the adoption of modern farming practices contribute to this higher diversification in agency areas.

The higher SID values for non-agency areas suggest that these regions have managed to achieve better diversification, likely due to enhanced agricultural practices, government schemes, and more stable access to resources. In contrast, agency areas, despite showing improvements, still face challenges such as reliance on rainfed agriculture, which can limit the variety of crops cultivated. This comparative analysis underscores the importance of policy interventions and the need for targeted support to enhance crop diversification, particularly in agency regions where agricultural practices are still evolving. These findings provide insights into how agro-ecological conditions, along with external support systems, influence cropping patterns and diversification, ultimately impacting the socio-economic outcomes for farmers in Coastal Andhra Pradesh.

5. AGRICULTURAL PRODUCTION IN ALLURI SITARAMA RAJU DISTRICT

Alluri Sitarama Raju district is predominantly rural and includes a significant portion of the tribal population, residing in hilly and forested regions. The agricultural landscape of Alluri Sitarama Raju District is characterized by its unique blend of traditional farming practices and the gradual adoption of modern techniques.Agriculture serves as the primary source of livelihood for a majority of the district's population, with small and marginal farmers playing a crucial role in its economy. This section delves into the agricultural production of Alluri Sitarama Raju District, providing an overview of the major crops grown, the cropping patterns, and the key factors influencing agricultural output. It also examines the role of agriculture in the socio-economic development of the region, highlighting the opportunities and challenges that define the sector. Through this analysis, the study aims to provide a comprehensive understanding of the agricultural scenario in the district and its implications for sustainable development.

Table-5
Agricultural Production in Alluri Sitarama Raju District

Category	Crop	Season	Area (Hectare)	Production (Tonnes/Bales)	Yield (Tonne/Bale per Hectare)
Food Crops	Arhar/Tur	Kharif	985	262	0.27
	Arhar/Tur	Rabi	4	1	0.25
	Bajra	Kharif	89	205	2.3
	Jowar	Kharif	2,819	5,260	1.87
	Maize	Kharif	22	83	3.77
	Maize	Rabi	42	48	1.14
	Moong (Green Gram)	Kharif	225	146	0.65
	Niger Seed	Kharif	4,257	13,295	3.12
	Rice	Kharif	14,946	15,394	1.03
	Rice	Rabi	56,605	169,077	2.99
	Ragi	Kharif	116	256	2.21
	Small Millets	Kharif	102	262	2.57
Horticulture Crops	Ginger	Kharif	989	3,627	3.67
	Dry Chillies	Kharif	71	299	4.21
	Potato	Rabi	236	4,433	18.78
	Sweet Potato	Kharif	509	4,714	9.26

	Tapioca	Kharif	869	611	0.7
Commercial Crops	Cotton (Lint)	Kharif	2,682	7,614	2.84
	Groundnut	Kharif	749	2,210	2.95
	Sunflower	Rabi	18	3	0.17
	Sesamum	Kharif	456	10,897	23.9
	Tobacco	Kharif	47	3,338	71.02

Source:Department of Agriculture, Andhra Pradesh (2022-23)

The agricultural production data from Alluri Sitarama Raju (formerly known as West Godavari district) for the 2022-23 crop year provides valuable insights into the crop patterns, yields, and production within the region. This dataset, compiled by the Directorate of Economics and Statistics under the Ministry of Agriculture and Farmers Welfare, Government of India, includes data on Food Crops, Horticulture Crops, and Commercial Crops, categorized by the area of cultivation (in hectares), total production (in tonnes or bales), and yield (in tonnes or bales per hectare). These detailed statistics reflect the agricultural diversity and seasonality of the crops grown in this coastal region, which is known for its fertile lands and suitable climatic conditions.

i) Food Crops

The Food Crops category in Alluri Sitarama Raju showcases a diverse range of staple crops grown during both the Kharif and Rabi seasons. In particular, Arhar/Tur (pulses) is a major crop, grown in both Kharif and Rabi seasons, though it occupies significantly more area in Kharif (985 hectares) than in Rabi (4 hectares). The yield in Kharif season is 0.27 tonnes per hectare, while in the Rabi season, it is slightly lower at 0.25 tonnes per hectare. Bajra, grown predominantly in the Kharif season, covers 89 hectares, producing 205 tonnes, yielding 2.3 tonnes per hectare. This is an important drought-resistant cereal crop, adding nutritional diversity to the local food supply. Jowar, another staple cereal, is cultivated on 2,819 hectares in the Kharif season, producing 5,260 tonnes with a yield of 1.87 tonnes per hectare. It is a versatile crop and an important food source in the region. Maize is grown in both Kharif and Rabi seasons, with 22 hectares in Kharif yielding 83 tonnes at a rate of 3.77 tonnes per hectare and 42 hectares in Rabi yielding 48 tonnes at a yield of 1.14 tonnes per hectare, indicating its relatively lower yield during the Rabi season due to less favorable weather conditions. Moong (Green Gram), a pulse crop, occupies 225 hectares in Kharif, yielding 146 tonnes with a yield of 0.65 tonnes per hectare. Another pulse crop, Niger Seed,

is grown on a large scale in the Kharif season, covering 4,257 hectares and producing 13,295 tonnes with a yield of 3.12 tonnes per hectare, making it an economically significant crop in the region. Rice, the staple crop, is grown extensively in both Kharif and Rabi seasons, with 14,946 hectares planted in Kharif, producing 15,394 tonnes and yielding 1.03 tonnes per hectare, while in Rabi, 56,605 hectares produce 169,077 tonnes, with a higher yield of 2.99 tonnes per hectare. Ragi and Small Millets, both important traditional grains, are also cultivated in Kharif, with Ragi occupying 116 hectares yielding 256 tonnes at 2.21 tonnes per hectare, and Small Millets cultivated on 102 hectares yielding 262 tonnes at 2.57 tonnes per hectare.

ii) Horticulture Crops

In the Horticulture Crops category, East Godavari demonstrates the significance of root and tuber crops, as well as spices. Ginger is cultivated on 989 hectares in the Kharif season, yielding 3,627 tonnes at a yield rate of 3.67 tonnes per hectare. This is an important crop for both local consumption and export. Dry Chillies, a key spice crop, are grown on 71 hectares, producing 299 tonnes with a high yield of 4.21 tonnes per hectare, reflecting the region's importance in spice production. The Potato, a key tuber crop, occupies 236 hectares during the Rabi season and yields 4,433 tonnes, resulting in an exceptionally high yield of 18.78 tonnes per hectare, making it one of the most productive crops in the region. Sweet Potato, grown during the Kharif season, occupies 509 hectares, producing 4,714 tonnes with a yield of 9.26 tonnes per hectare, providing an important source of nutrition and income. Tapioca, a root crop, is cultivated on 869 hectares, yielding 611 tonnes, which gives a low yield of 0.7 tonnes per hectare, highlighting its limited role in the agricultural mix of Alluri Sitarama Raju.

iii) Commercial Crops

The Commercial Crops category is marked by crops that are cultivated primarily for economic value, such as cotton, groundnut, and tobacco. Cotton (Lint) is grown extensively in the Kharif season, with 2,682 hectares producing 7,614 tonnes at a yield of 2.84 bales per hectare, reflecting its significance in the textile industry. Groundnut, a key oilseed and food crop, is cultivated on 749 hectares in the Kharif season, producing 2,210 tonnes with a yield of 2.95 tonnes per hectare. Sunflower, an oilseed grown in the Rabi season, is cultivated on 18 hectares, producing 3 tonnes with a very low yield of 0.17 tonnes per hectare, indicating

limited cultivation. Sesamum, another oilseed crop, is grown on 456 hectares in the Kharif season, producing a substantial 10,897 tonnes with a very high yield of 23.9 tonnes per hectare, making it a major crop for oil extraction. Finally, Tobacco, a high-value cash crop, is grown on 47 hectares in the Kharif season, producing 3,338 tonnes with an extraordinary yield of 71.02 bales per hectare, emphasizing its importance as a significant commercial crop in Alluri Sitarama Raju.

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6. AGRICULTURAL PRODUCTION IN EAST GODAVARI DISTRICT

East Godavari District, often referred to as the "Rice Bowl of Andhra Pradesh," is renowned for its fertile lands, abundant water resources, and a well-established agricultural base. Situated in the deltaic region of the Godavari River, the district benefits from rich alluvial soils and an extensive irrigation network, making it one of the most agriculturally prosperous regions in the state. Agriculture is the backbone of the district's economy, supporting a large proportion of its population both directly and indirectly. The district's agricultural landscape is dominated by paddy cultivation, which thrives due to the availability of irrigation water from the Godavari River and its canal system. In addition to rice, the region also supports a wide range of other crops, including pulses, oilseeds, sugarcane, and horticultural crops like coconut and banana. This section explores the agricultural production of East Godavari District, focusing on its major crops, cropping patterns, and the socio-economic factors influencing agricultural activities

Table-6
Agricultural Production in East Godavari District

Category	Crop	Season	Area (Hectare)	Production (Tonnes/Bales)	Yield (Tonne/Bale per Hectare)
Food Crops	Arhar/Tur	Kharif	13	5	0.38
	Rice	Kharif	17,027	365,842	21.49
	Rice	Rabi	76,252	279,665	3.67
	Jowar	Kharif	828	1,456	1.76
	Maize	Kharif	206	640	3.11
	Urad	Kharif	149	623	4.18
	Moong (Green Gram)	Kharif	4	2	0.5
	Gram	Rabi	51	319	6.25
	Horse Gram	Rabi	85	57	0.67

Horticulture Crops	Dry Chillies	Kharif	198	556	2.81
	Tapioca	Rabi	5,095	14,881	2.92
Commercial Crops	Arecanut	Kharif	56	515	9.2
	Cotton (Lint)	Kharif	241	1,476	6.12
	Sesamum	Kharif	141	28	0.2
	Sunflower	Rabi	447	449	1
	Groundnut	Kharif	333	2,412	7.24
	Groundnut	Rabi	280	867	3.1
	Sugarcane	Annual	9,195	97,053	10.55
	Tobacco	Kharif	840	14,023	16.69

Source: Department of Agriculture, Andhra Pradesh (2022-23)

The East Godavari Agricultural Production 2022-23 dataset, provided by the Directorate of Economics and Statistics under the Ministry of Agriculture and Farmers Welfare, Government of India, highlights the agricultural productivity of East Godavari district, which is one of the most fertile regions in Coastal Andhra Pradesh. The dataset categorizes the crops into three major categories: Food Crops, Horticulture Crops, and Commercial Crops, each with details on the area cultivated (in hectares), total production (in tonnes or bales), and yield per hectare (in tonnes or bales). These data points provide a clear picture of the agricultural landscape of the district during the 2022-23 agricultural year and reflect the seasonality, crop choices, and yields that are shaped by the local climatic and soil conditions.

i) Food Crops

In the Food Crops category, Rice is the dominant crop in East Godavari, with substantial cultivation both in the Kharif and Rabi seasons. The Kharif season alone accounts for an area of 17,027 hectares, with a production of 365,842 tonnes, leading to a high yield of 21.49 tonnes per hectare. This is a clear indicator of the region's strong reliance on rice cultivation, which thrives due to the monsoon rains. The Rabi season also sees a significant amount of rice cultivation, with 76,252 hectares producing 279,665 tonnes, though the yield drops to 3.67 tonnes per hectare. This decrease in yield could be attributed to the relatively lower water availability and less favorable climatic conditions during the Rabi season. Pulses like Arhar/Tur and Moong (Green Gram) are cultivated primarily in the Kharif season, though the area under these crops is relatively small. Arhar/Tur is grown on 13 hectares with

a yield of 0.38 tonnes per hectare, while Moong (Green Gram) occupies only 4 hectares with a yield of 0.5 tonnes per hectare, indicating limited cultivation of these pulses. Other important food crops in the district include Jowar, Maize, Urad, Gram, and Horse Gram, with Maize and Urad showing decent yields of 3.11 and 4.18 tonnes per hectare, respectively. Gram and Horse Gram, grown in the Rabi season, show relatively higher yields, especially Gram, which has a yield of 6.25 tonnes per hectare, indicating its importance as a Rabi crop.

ii) Horticulture Crops

The Horticulture Crops category in East Godavari also plays a significant role in the agricultural economy. Dry chillies, grown in the Kharif season, cover an area of 198 hectares, with a total production of 556 tonnes, resulting in a yield of 2.81 tonnes per hectare. This shows that chillies are an important crop for both local consumption and as a cash crop for export, given the high demand for Indian spices. Tapioca, cultivated during the Rabi season, occupies 5,095 hectares and produces 14,881 tonnes with a yield of 2.92 tonnes per hectare. Tapioca is an essential root crop used both as food and as a source of starch, making it a key crop for the region's agricultural diversity.

iii) Commercial Crops

In the Commercial Crops category, East Godavari district is home to a range of crops that are grown primarily for their economic value. Arecanut, an important cash crop, is cultivated on 56 hectares, producing 515 tonnes with a yield of 9.2 tonnes per hectare. The relatively small area devoted to Arecanut suggests that it is not as widespread as other crops but still contributes significantly to the local economy, particularly in the production of betel nuts. Cotton, grown in the Kharif season on 241 hectares, has a yield of 6.12 bales per hectare, with a total production of 1,476 tonnes. Cotton remains a major commercial crop due to its demand in the textile industry. However, its cultivation area in the district is relatively limited compared to other crops like rice and groundnut. Sesamum, another oilseed crop, is grown on 141 hectares, yielding just 28 tonnes with a very low yield of 0.2 tonnes per hectare. This low yield reflects sesamum’s minor role in the district’s agricultural production. Sunflower, an oilseed grown during the Rabi season, occupies 447 hectares and yields 449 tonnes, resulting in a yield of 1 tonne per hectare. Groundnut, which is a major oilseed and food crop in the district, is cultivated in both the Kharif and Rabi seasons. In the Kharif season, it is grown on 333 hectares, producing 2,412 tonnes, with a high yield of 7.24

tonnes per hectare, while in the Rabi season, 280 hectares yield 867 tonnes with a yield of 3.1 tonnes per hectare. The variation in yields between the two seasons reflects the difference in growing conditions, with the Kharif season providing more favorable moisture conditions. Sugarcane, another key commercial crop, is cultivated on 9,195 hectares annually, producing 97,053 tonnes with a yield of 10.55 tonnes per hectare. Sugarcane plays a major role in the region's agricultural economy, supporting both sugar and ethanol production. Finally, Tobacco, which occupies 840 hectares during the Kharif season, yields a remarkable 14,023 tonnes with an exceptionally high yield of 16.69 bales per hectare. This high yield underscores the importance of tobacco cultivation as a cash crop in the district, with significant economic returns.

7. SUMMARY AND CONCLUSION

Commercial crops in India serve as the backbone for industrial raw materials, contributing significantly to both the domestic economy and export earnings. While cotton and sugarcane continue to dominate, newer crops like soybean are increasingly contributing to India’s agricultural landscape. The steady growth in production, despite challenges such as climate change and fluctuating global prices, indicates the resilience of India's agricultural system. Horticulture crops in India play a vital role in diversifying farmers' incomes and enhancing the agricultural landscape by providing high-value produce. With increasing demand both domestically and internationally, the horticulture sector holds great potential for rural economic development. Coastal Andhra Pradesh’s agriculture reflects a blend of traditional practices and modern innovations, making it one of the most productive regions in India. By leveraging its natural advantages and addressing existing challenges, the region has the potential to further enhance its agricultural output, improve the livelihoods of its farmers, and contribute to the overall development of the state.The agricultural production data for Alluri Sitarama Raju district for the year 2022-23 reflects a well-rounded agricultural ecosystem with a combination of food crops, horticulture crops, and commercial crops. Food crops like rice, millets, and pulses are staples, providing essential food security for the local population. At the same time, horticulture crops such as ginger, sweet potato, and potatoes contribute both to nutrition and economic income. Commercial crops, particularly tobacco, cotton, and sesamum, are grown for their high economic value, with tobacco, in particular,

having an exceptionally high yield. This data underscores the region's agricultural diversity and its significant role in both food production and the economy, providing a robust foundation for the rural economy and supporting a variety of livelihoods across different farming communities.The agricultural production in East Godavari district for 2022-23 is marked by the dominance of rice cultivation, both for food security and as a staple crop. The region also showcases a healthy diversity of crops, with significant contributions from both food and commercial crops such as groundnut, sugarcane, and tobacco. The varying yields between Kharif and Rabi seasons reflect the seasonal influences on agricultural productivity. The cultivation of horticultural crops like dry chillies and tapioca adds another layer of economic diversity, contributing to both local consumption and export markets. The commercial crop sector, with its emphasis on crops like cotton, tobacco, and sugarcane, highlights the district's role in the broader agricultural economy of Andhra Pradesh.

8. SUGGSTIONS

1. There is a growing need for more sustainable practices in the cultivation of various types of crops to ensure long-term profitability and environmental health.
2. The challenges such as post-harvest losses, inadequate infrastructure, and market volatility must be addressed to fully unlock the potential of the agriculture sector.
3. Further investments in irrigation, pest management, and crop diversification are essential for enhancing the productivity and sustainability of commercial crop farming in India.
4. Policy support, improved supply chains, and investment in infrastructure are crucial to sustaining the growth of horticulture crops and enhancing farmers' livelihoods.

9. CONCLUSION

In conclusion, the Agricultural Census data for Andhra Pradesh highlights the critical role that small farmers play in the state's agricultural sector, as they account for the majority of the holdings and land area, particularly in the smaller size categories. However, these small farmers face significant challenges related to income, access to resources, and vulnerability to external shocks. Addressing these challenges through targeted interventions

and support programs is essential for improving the economic conditions of small farmers and ensuring a more sustainable and inclusive agricultural system in Andhra Pradesh.

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