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Research paper

Landholdings and Cropping Patterns Practised for Sustainable Agriculture in Vellore District, Tamil Nadu: An Analysis

Arun R [1], Siva Kumar S [2]*

[1] Ph. D (IFT) Research Scholar, Department of Social Sciences, School of Social Sciences and Languages, Vellore Institute of Technology (VIT), Vellore. Pincode:632014
[2] Associate Professor, Department of Social Sciences, School of Social Sciences and Languages, Vellore Institute of Technology (VIT), Vellore. Pincode:632014
**Corresponding author E-mail: siva.kumars@vit.ac.in*

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Abstract

Background: India is essentially an agrarian economy in which agriculture plays an indispensable role in all aspects of life. A wide variety of crops is cultivated across the country, depending on soil characteristics and other influencing factors. The present study focuses on the Vellore District of Tamil Nadu, aiming to understand the prevailing land-use patterns and agricultural practices. The primary objective is to analyse cropping patterns in relation to the size of landholdings among different categories of farmers.
Methods: Primary data were collected from 360 respondents in the study area using a structured questionnaire. A stratified random sampling method was adopted to ensure adequate representation across the region. The collected data were tabulated and analysed using statistical and econometric tools such as percentages, Student's t-test and ANOVA.
Results: Small and marginal farmers constitute the majority of respondents. Most cultivable land is owned by the farmers themselves, with paddy and groundnut being the predominant crops, along with several other varieties.
Conclusion: Analysing cropping patterns in relation to landholding size is crucial for understanding the relationship between crop selection and the fac-tors that influence it. This study examines that relationship within the context of Vellore District. There is significant scope to extend the research by incorporating additional variables and expanding the study area.

Keywords: *Land-Use Pattern; Crop Diversification; Seasonal Cultivation; Irrigation; Sustainable Farming Practices.*

1. Introduction

Cropping pattern refers to the proportion of land area cultivated with various crops at a given time. The principal crops commonly included in cropping patterns are paddy, ragi, jowar, bajra, maize, wheat, pulses, sugarcane, and cotton (Satnami, 2019). Cropping patterns are shaped by both physical and economic factors. Key physical factors include soil characteristics, rainfall intensity, and climatic conditions. Economic factors comprise agricultural commodity prices, farm size, input availability, demand conditions, landholding structures, and government policies related to exports, imports, taxation, and subsidies. Soil type and rainfall play a particularly significant role in determining agricultural productivity and cropping patterns (Erande Manohar Ramnath, 2018). Cropping patterns may also differ widely across circles and regions, influenced by the development of marketing infrastructure and changing population demand trends (Shafi, 2000). India is one of the world's leading agrarian nations, with 54.6% of its population engaged in agriculture (Census, 2011). The types of crops cultivated vary significantly across states and agro-climatic regions. Approximately 70% of the total cultivated land in India is used for food crops, while the remaining 30% is allocated to oilseeds, cotton, and other fiber and fodder crops (T. R. Magar, 2021).
Vellore District in Tamil Nadu holds significant historical importance in India's freedom movement. It is the seventh-largest district in the state, with a total population of 3,936,331. The district covers a geographical area of 5,920.18 sq. km, of which 1.74 lakh hectares constitute the net cultivated area. Agriculture occupies nearly 60% of the district's land area and remains the predominant form of land use. Major crops include paddy, groundnut, sugarcane, and millets (vellore.nic.in). The cropping pattern in Vellore reflects a mixed system: irrigated pockets along the Palar River basin and canal-fed regions grow paddy, sugarcane, and vegetables, while extensive dryland areas support groundnut, millets, and pulses.
The study area has undergone notable changes in climatic conditions, population growth, urbanization, and land fragmentation. In this context, it becomes essential to examine the relationship between landholding size and cropping patterns in the region. Understanding cropping patterns is crucial not only for assessing local agricultural practices but also for addressing broader issues such as food security, economic stability, environmental sustainability, and climate change adaptation.

2. Review of Literature

Landholding and cropping patterns in the Vellore district are dominated by small and marginal farmers, characterized by substantial land fragmentation and mixed farming systems. Irrigated pockets predominantly cultivate paddy, while rainfed areas typically support crops such as groundnut, millets, and pulses. Irrigation availability significantly influences both crop choice and cropping intensity, with canal-fed and groundwater-supported lands achieving higher cropping intensity than exclusively rainfed tracts (Bhalla & Singh, 2009).

In sub-Saharan Africa, small and fragmented farms are common, resulting in diversified, low-input cropping systems that prioritize food security over market-oriented production (Jayne et al., 2016). In Southeast Asia particularly the Philippines and Vietnam, small holdings are intensively cultivated with rice and high-value crops when irrigation is reliable, a pattern similar to irrigated regions in Vellore (Timmer, 2014). In contrast, Latin America exhibits more unequal land distribution, where large commercial farms coexist with small subsistence plots, creating complex combinations of monocropping and polyculture within the same districts or provinces (Kay, 2016).

Developed nations generally feature larger farm sizes and market-driven cropping patterns. In the USA and Australia, mechanization and capital-intensive farming enable extensive monocultures of wheat, maize, and cotton, while irrigation infrastructure and policy incentives influence spatial cropping arrangements (Lobell et al., 2009). Even regions with fragmented land ownership such as parts of southern Europe display similarities to Vellore's smallholder systems, with mixed cropping and dependence on traditional farming practices (García-Llorente et al., 2012).

Empirical studies demonstrate that land fragmentation in southern India reduces agricultural productivity by increasing transaction costs and limiting mechanization, aligning with Vellore’s challenges of small, scattered plots that hinder sustainable intensification (Jha et al., 2005). Research employing diversification indices highlights trends toward high-value crops in Indian states, driven by market forces and resource constraints. These methodologies provide useful frameworks for evaluating Vellore’s diversification prospects in dryland and semi-irrigated settings (Kumar & Gupta, 2015).

Studies on integrated farming systems (IFS) emphasize their value in enhancing soil health, nutrient cycling, and economic resilience for smallholders, offering direct relevance to Vellore’s fragmented landholdings (Meena et.al., 2024). Practical IFS adoption models, such as cooperative initiatives and government support schemes, present scalable approaches for strengthening sustainable agriculture in regions like Vellore (Centre for Science and Environment & CEEW, 2023).

Remote sensing research mapping spatiotemporal changes in cropping patterns across Tamil Nadu provides methodological tools and state-level benchmarks applicable to analyzing cropping trends in Vellore (Pazhanivelan et al., 2025). Data from the Tamil Nadu Tenth Agriculture Census (2015–16) offer comparative insights into size-class distributions, supporting assessments of technology adoption, access to finance, and crop selection in the district. At the state level, the Season & Crop Report (2021–22) serves as a comparator, showing that Vellore is less rice-intensive than Tamil Nadu’s delta districts and more dependent on rainfed oilseeds and pulses than coastal or riverine zones. Such comparisons help assess transitions toward water-efficient crops and broader sustainability goals.

District-level aquifer and groundwater assessments by the CGWB highlight limited storage, seasonal water stress, and the need for both demand-side interventions (micro-irrigation, crop choice) and supply-side measures (recharge structures, tank rehabilitation). These hydrological constraints directly influence sustainable cropping decisions. Sustainable intensification defined as increasing agricultural output from the same area while minimizing environmental impacts is supported by global examples demonstrating feasible transitions (Pretty & Bharucha, 2015).

Research on micro-irrigation adoption outlines its costs, constraints, suppliers, and expected benefits, suggesting that water scarcity and inefficient water use drive demand for such technologies. Widespread adoption could lead to changes in cropping patterns, particularly landholding toward crops that benefit from improved water control (Surya & Anbarasan, 2025).

Studies on disruptions such as pandemic-induced lockdowns show significant impacts on agricultural production and harvest processes, with small farmers being particularly vulnerable. These disruptions underscore the importance of resilience when evaluating changes in cropping patterns or land-use practices (Senthilvelan & Sugantha, 2023). Urbanization also contributes to shifts in cropping patterns due to improved market access and infrastructure, leading to higher cultivation of profitable market-oriented crops and long-term diversification away from traditional staples (Gayathri & Devi, 2024).

In high rainfall regions, the expansion of non-food perennial crops such as rubber and coconut has been accompanied by declines or slower growth in food crop cultivation. Crop diversity indices (Herfindahl, Simpson) indicate moderate improvements over time (Mehazabeen et al., 2025). Studies reveal that while cereals, millets, pulses, spices, and fruits show positive compound annual growth rates, crops like oilseeds, vegetables, and green manure exhibit negative growth trends, indicating moderate but evolving crop diversification (Priyanga et al., 2023).

The introduction of oil palm as a perennial cash crop has been reported to reduce labour requirements and production risks compared to paddy; however, environmental concerns persist despite the crop’s potential for stable income (Nithya Devi, 2024). Meanwhile, precision agriculture has been shown to enhance productivity, reduce input waste, and mitigate environmental impacts, though high costs, knowledge barriers, and inadequate infrastructure limit adoption among small farmers (Piyush Raj et al., 2025). Innovation in agriculture continues to grow, but adoption remains uneven and is more common in areas with strong extension services, better infrastructure, larger landholdings, or cooperative structures (Ram Naresh et al., 2024).

3. Methods

This research study was conducted in the Vellore district of Tamil Nadu, one of the prominent agro-climatic regions in the state. The district comprises different categories of farmers engaged in cultivation, and they grow a variety of crops depending on changing weather and climatic conditions. As the climate in the study area has become increasingly unstable, farmers have gradually altered their cropping strategies in response. The key research problem, therefore, is to understand how different categories of farmers diversify their crop choices under these changing conditions.

Although several studies have examined cropping patterns, no prior research has specifically explored the relationship between landholding size and the cropping patterns adopted by farmers in this region. Identifying this gap, the researcher undertook the present study. The investigation also holds policy relevance, as fluctuating weather and climate conditions significantly influence agricultural decisions in the district.

A primary data collection method was adopted for this study. Data were gathered using a structured questionnaire administered to farmers through a stratified random sampling technique. A total of 360 farmers from eight villages across the district were surveyed, and all relevant information was systematically collected. The data were then organized and classified based on the analytical requirements of the research.

To examine the relationships between variables and to test the study hypotheses, various statistical and econometric tools were employed, including simple percentage analysis, Student's t-test, and ANOVA.
The main objective of the study is to analyze the cropping patterns followed in the study area in relation to the size of landholdings.

4. Result

The analysis section of this research examines the socio-economic profile of the respondents, the categorization of farmers, the mode of landholding, and data related to the different categories of farmers, the types of crops cultivated, and the size of land allocated to each crop.

Table 1: Socio – Economic Profile of the Respondents

Category	Specification	Total	Percentage
Sex	Male	308	85.6
	Female	52	14.4
Age	Up to 25	3	0.83
	26-35	11	3.05
	36-45	74	20.56
	46-55	83	23.06
	Above-55	189	52.5
Marital status	Married	340	94.44
	Un-married	6	1.67
	widow/widower	14	3.89
Literacy Level	Illiterate	27	7.5
	Primary	49	13.61
	Secondary	193	53.61
	Higher secondary	70	19.44
	Graduate	12	3.33
	Post graduate	4	1.11
	Technical education	5	1.30

Source: Primary Data.

Based on Table 1, there are 308 male respondents and 52 female respondents, constituting 85.6% and 14.4%, respectively. With respect to age categories, the largest group of respondents (189) falls within the 55+ age group, while the smallest group (3) belongs to the 25-and-below category, accounting for 52.5% and 0.83%, respectively. Among the respondents, 340 are married, 6 are bachelors, and 14 are either widows or widowers, representing 94.44%, 1.67%, and 3.89%, respectively. Regarding educational qualifications, the highest numbers of respondents (193) have completed secondary schooling, whereas only 4 respondents are postgraduates, constituting 53.61% and 1.11%, respectively.

Table 2: Categories of Farmers

Category	Number of Farmers	Percentage
Small and Marginal	208	57.8
Medium	127	35.8
Large	25	6.4
Total	360	100

Source: Primary Data.

Table 2 shows that among the respondents surveyed, 208 are small and marginal farmers, 127 are medium farmers, and 25 are large farmers, accounting for 57.8%, 35.8%, and 6.4%, respectively.

Table 3: Details on Land Holding

Land type	Total land holding (in hectares)	Percentage
Own land	338	82.24
Not owning own land	22	5.35
Land leased in	33	8.03
Land lease out	18	4.38
Total	411	100

Source: Primary Data.

Table 3 shows that, out of the 360 respondents surveyed, 338 respondents own land, while 22 do not own any land. Additionally, 33 respondents have leased land from others for cultivation, and 18 have leased out their own land for agricultural purposes. These figures represent 82.24%, 5.35%, 8.03%, and 4.38%, respectively.

Table 4: Categories of Farmers, Size of Land Holdings (in Hectares), and Type of Crops

Major Crops Cultivated	Small and Marginal Farmers	Medium Farmers	Large Farmers	Total
Paddy	200.05	244	80	520.05
Groundnut	83.64	197.65	72	353.29
Sugarcane	0.5	1	17	18.5
Ragi	5.75	5	-	10.75
Black gram	0.25	3	-	3.25
Pigeon pea	0.25	-	-	0.25
Banana	14.5	162.5	50.5	227.5
Mango	-	3	12	15
Others	27.7	130.6	58.5	216.8
Total	332.64	746.75	290	1369.39

Source: Primary Data.

It is understood that farmers actively engaged in agricultural activities have been categorized into three groups: small and marginal farmers (holding less than 4 hectares), medium farmers (holding up to 10 hectares), and large farmers (holding more than 10 hectares).
Table 4 indicates that the respondents in the study are categorized into three groups: small and marginal farmers, medium farmers, and large farmers. The small and marginal farmers constitute 208 respondents and cultivate a total land area of 332.64 hectares. Among the various crops grown in the study area, paddy occupies the largest share, covering 200.05 hectares. The next major crops are groundnut (83.64 hectares), banana (14.5 hectares), and other crops (27.7 hectares). Paddy alone accounts for 60.14% of the total area cultivated by small and marginal farmers.

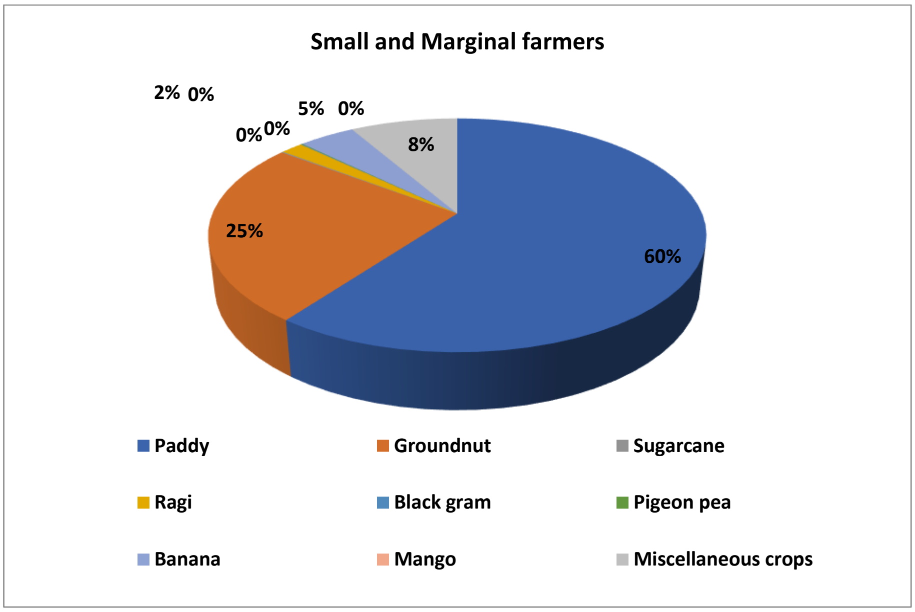

Fig. 4.1: Cropping Pattern Followed by Small and Marginal Farmers.

The medium farmers consist of 127 individuals and cultivate a total land area of 746.75 hectares. Among the crops grown by them, paddy occupies the largest share, covering 244 hectares. The next major crops are groundnut (197.65 hectares), banana (162.5 hectares), and other crops (130.6 hectares). Paddy alone accounts for 32.67% of the total area cultivated by medium farmers.

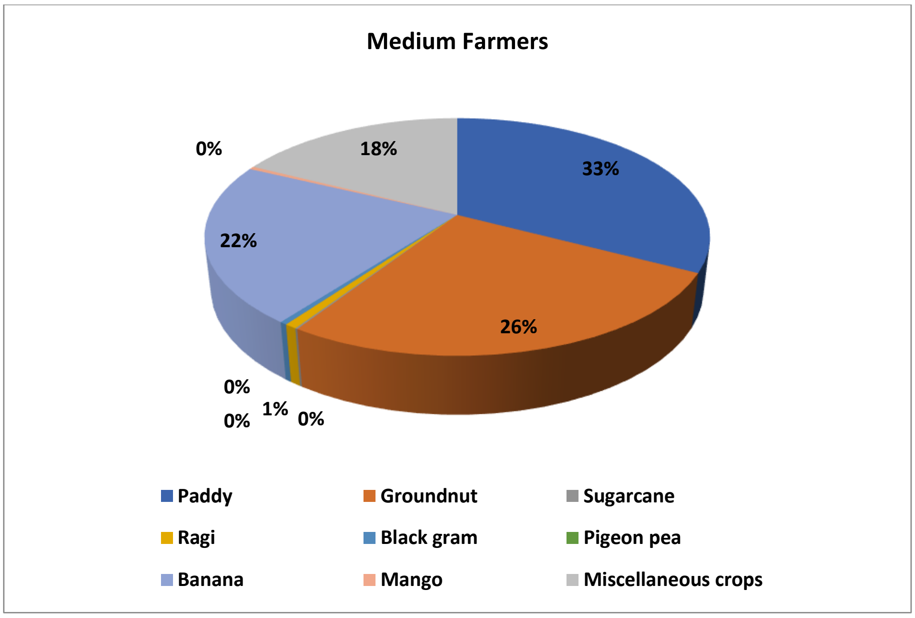

Fig. 4.2: Cropping Pattern Followed by Medium Farmers.

The final category of farmers in the study is large farmers, classified as such due to their comparatively larger landholdings than small and medium farmers. They consist of 290 individuals and cultivate a total land area of 290 hectares. Among the crops grown by this group, paddy occupies the largest portion, covering 80 hectares. The next major crops are groundnut (72 hectares), banana (50.5 hectares), and other crops (58.5 hectares). Paddy alone accounts for 27.59% of the total area cultivated by large farmers.

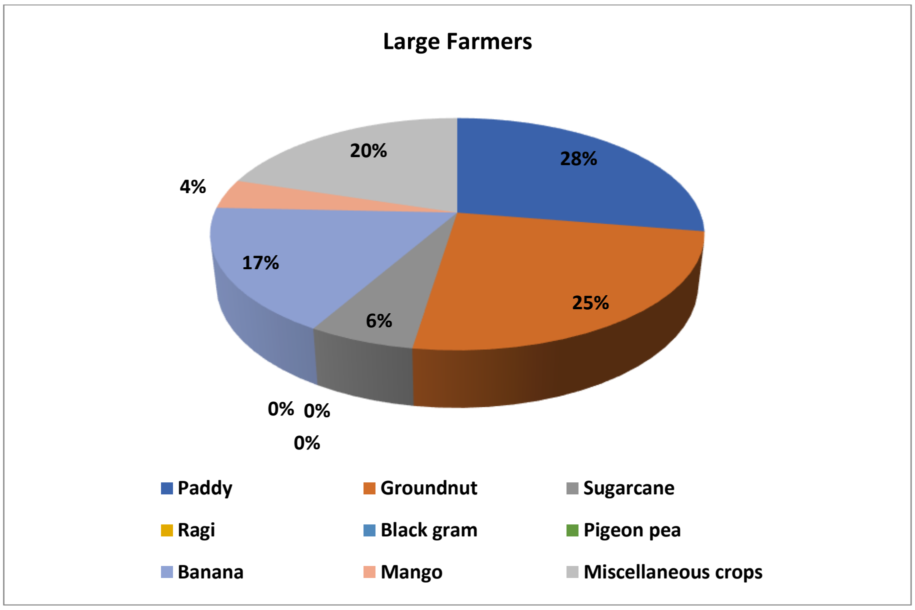

Fig. 4.3: Cropping Pattern Followed by Large Farmers.

It is evident from the above discussion that farmers across all categories cultivate paddy over extensive areas. The total area under paddy cultivation alone amounts to 520.05 hectares out of 1,369.39 hectares, representing 37.98% of the total cultivated land. This indicates that paddy is the most preferred crop and is grown on a large scale in the study area. Consequently, the predominant cropping pattern in the study area is paddy.

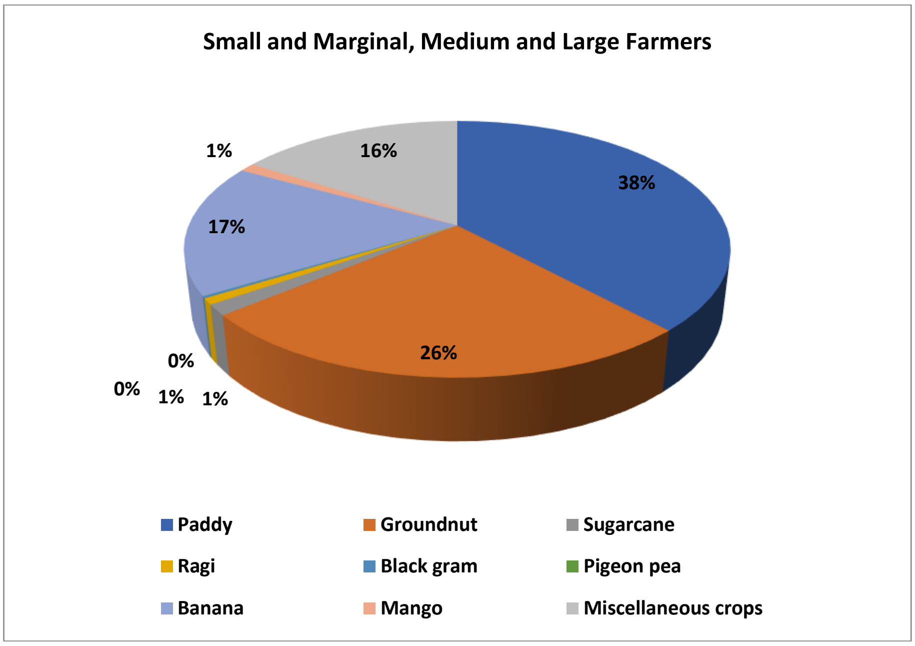

Fig. 4.4: Cropping Pattern Followed by All Categories of Farmers.

H_0: There is no significant relationship between landholding size (farmer category) and cropping patterns.

Table 5: Results of the Student's t-test on Landholding Size and Cropping Patterns

Size of land holding	Total	Crops	Total
Small	208	332.64	
Medium	127	746.75	
Large	25	96.66	
Sum of x	360	1369.39	1729.39
Sum of the squares of x	60018	752384.92	812402.92
N	3	3	
Mean	120	456.46	
Overall mean	288.23		
SS	16818	127308.59	144126.59

Table 6: Results of the ANOVA on Landholding Size and Cropping Patterns

	Sum of squares	Df	Mean of square	F	P
Between the group	60018	1	16890.9974	4.712	0.0957
Within the group	752384.92	4	36031.6475		
Total	812402.92	5			

The researcher applied Student's t-test and ANOVA to analyse the relationship between landholding size and the cropping patterns followed in the study area. The results reveal that the p-value is 0.0957, which is greater than 0.05 at 5% level of significance; therefore, the null hypothesis is rejected. It is proven that there is a statistically significant relationship between the landholding size and the type of crops cultivated, meaning that crop selection is not directly related to the size of landholding among the different categories of farmers; instead, it is decided by the cultivators on various grounds. Farmers in the Vellore district have been cultivating paddy as their choice and the preferred crop over the years, regardless of their category (small, medium, or large). This widespread preference of the cultivators for paddy cultivation explains the reason for the rejection of the null hypothesis.

5. Discussion

This state-wide, satellite-based study (Sentinel-1A SAR and MODIS) includes data from Vellore's agro-climatic zone. Between 2019 and 2023, approximately 51% of agricultural land was used for single cropping, 31% for double cropping, and 17% for triple cropping, reflecting the cropping intensity patterns in Vellore (Pazhanivelan et al., 2025). The cropping structure in Vellore has shifted due to urbanization, with a transition from rice to horticultural crops and floriculture (Rajendran & Selvakumar, 2015).

Comparisons with states such as Punjab and Haryana highlight substantial differences. In these regions, large landholdings, near-universal irrigation, and assured procurement policies have supported a high-intensity rice–wheat system (Bhalla & Singh, 2009). In Bangladesh, smallholder farmers achieve very high cropping intensity through sustainable irrigation in double and triple cropping systems (rice–pulses–rice), often exceeding 200% cropping intensity (Ali et al., 2019; Schreefel et al., 2020).

Based on these findings, it is important to understand the current agricultural practices in the study area. Paddy cultivation remains dominant; however, other crops can be considered depending on seasonal and weather conditions. The net sown area in Vellore is decreasing, while fallow land is expanding, highlighting the need for improved land-use practices (Department of Economics and Statistics, Tamil Nadu, 2020).

The quality of seeds provided by government agencies is sometimes inadequate or fails to perform as expected. Therefore, quality seeds should undergo proper laboratory testing before distribution. Adequate financial support must also be made available, as farmers face significant challenges in accessing funds. The use of chemical fertilizers is more common among medium and large farmers, while some small and marginal farmers have begun adopting organic practices using cow dung and dried leaves. These sustainable practices should be encouraged throughout the study area to protect both farmer and consumer health.

Only a few farmers have adopted modern technologies, such as drones, in their agricultural operations. Greater dissemination and adoption of such technologies are needed to improve crop production and productivity. Efficiency studies indicate that optimal resource use, particularly in dryland agriculture, can significantly increase yields without expanding land area (Balasubramanian & Selvaraj, 2011). Sustainable intensification is defined as producing higher output from the same area while minimizing environmental impact has been successfully implemented in several global examples (Pretty & Bharucha, 2015).

6. Policy Implications

Adopting sustainable practices, including organic farming, integrated nutrient management, and watershed development, enhances productivity and soil health. Micro-irrigation is currently used for groundnut cultivation, and its application could be extended to paddy fields to ensure uniform irrigation and strengthen crop output.

7. Conclusion

The study on cropping patterns in the Vellore district of Tamil Nadu provides valuable insights into the agricultural landscape, including crop distribution, fluctuations in cultivation trends, and the factors influencing farmers' decisions. The findings demonstrate that climatic conditions, soil types, water availability, and market demand play crucial roles in shaping cropping patterns. Traditional crops, such as paddy and groundnut, remain dominant; however, there is a noticeable shift toward commercial and horticultural crops due to economic viability and government incentives.

The study also highlights how irrigation facilities, unpredictable rainfall, and technological developments influence crop diversification. Furthermore, it underscores the importance of sustainable farming practices, effective water resource management, and targeted policy interventions to enhance farmer productivity and profitability. Promoting crop diversification and adopting innovative farming practices can help improve the overall agricultural situation in the Vellore district.

Several areas remain open for further research. The current study can be expanded to other regions with different agro-climatic and socio-economic conditions to better understand cropping patterns and their significance for the national economy.

While secondary data sources and previous research have documented the types of crops cultivated in the study area, the present study extends this knowledge by examining cropping patterns in relation to farmer categories. Accordingly, the research focuses on the types of crops cultivated by small, medium, and large farmers, providing a more detailed understanding of agricultural practices across different landholding groups.

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This article is the outcome of collaborative academic work between the research scholar and the supervisor. Arun R - Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing-original draft preparation; Siva Kumar S – writing-review and editing, supervision.

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Data Availability Statement

The dataset generated and analyzed during the current study is available from the corresponding author upon reasonable request.

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