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Growth, Constraints and Sustainability of Custard Apple (*Annona squamosa*) Cultivation: A Geographical Analysis of Khandala Tahsil, Satara District. (M.S)

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Abstract

Custard Apple (*Annona squamosa*) cultivation has emerged as an important component of dryland horticulture in Khandala Tahsil of Satara District, Maharashtra. Over the past two decades, the area under cultivation has expanded considerably due to favourable agro-climatic conditions, government horticulture promotion schemes, and increasing market demand. Despite this expansion, the sector faces multiple constraints that limit productivity and profitability. The present study examines the growth trend of Custard Apple cultivation from 2000–01 to 2019–20 and identifies the major problems encountered by farmers through primary field surveys and secondary data analysis. The findings indicate that climatic variability, particularly uncertain rainfall and extreme temperature fluctuations, significantly affects flowering and fruit setting. Operational challenges such as labour shortages, high wage rates, irregular electricity supply, and water scarcity further constrain timely farm operations. Additionally, excessive dependence on chemical fertilizers and high costs of pesticides increase production expenses and raise sustainability concerns. The study suggests adoption of integrated nutrient and pest management practices, micro-irrigation systems, and improved institutional support to enhance productivity, ensure environmental sustainability, and strengthen the economic viability of Custard Apple cultivation in the region.

Keywords: Custard Apple Cultivation; Climatic Variability; Dryland Horticulture; Agricultural Sustainability.

Introduction

Horticulture has emerged as a dynamic sub-sector of Indian agriculture, contributing significantly to rural employment, nutritional security, and farm income diversification. In semi-arid regions of Maharashtra, fruit crops have increasingly replaced traditional rain-fed crops due to higher economic returns and government support under horticulture development programmes (**Census of India, 2011**). Custard Apple (*Annona squamosa*), a drought-tolerant and hardy fruit crop, is particularly suitable for dryland agro-climatic conditions and marginal soils. Its adaptability to low rainfall and undulating basaltic terrain makes it an important crop in western Maharashtra.

In Khandala Tahsil of Satara District, horticultural expansion has accelerated during the last two decades, especially under fruit cultivation. The area under Custard Apple has shown noticeable growth due to favourable environmental conditions and increasing market demand. However, productivity remains unstable due to climatic variability, labour shortages, inadequate irrigation facilities, and plant protection issues (**Kumar & Singh, 2020**). Similar studies conducted in other parts of India highlight that temperature fluctuations, rainfall irregularity, and high input costs significantly affect fruit crop sustainability (**Sarkar, Mondal, & Basu, 2018; Reddy et al., 2019**).

However, limited geographical studies have comprehensively examined the combined impact of climatic variability, infrastructural limitations, and management-related constraints on Custard Apple cultivation at the tahsil level in western Maharashtra. Most existing studies focus either on production trends or on isolated constraints, without integrating growth analysis with sustainability concerns. Therefore, the present study attempts to provide a regional-level empirical assessment of growth patterns, structural constraints, and sustainability challenges associated with Custard Apple cultivation in Khandala Tahsil. This geographical investigation aims to bridge the research gap by linking temporal growth trends with field-based evidence on production risks and long-term viability.

Study Area

Khandala Tahsil is located in the northern part of Satara District and lies between 17°55' to 18°05' North latitude and 73°55' to 74°10' East longitude (**Fig.1**). The tahsil represents a transitional zone between the Deccan Plateau and the northern fringes of the Western Ghats. The

region is characterized by undulating topography, Deccan Trap basaltic formations, and a semi-arid to sub-tropical monsoon climate. Seasonal streams and limited irrigation facilities support agriculture, which is the primary occupation of the population. In recent years, horticulture has gained prominence, particularly Custard Apple cultivation, due to favourable agro-climatic conditions and growing market demand.

According to the *Census of India (2011)*, Khandala Tahsil comprises 65 villages, out of which Custard Apple cultivation is practiced in about 30 villages. For the present study, 20 percent of these Custard Apple growing villages were selected for detailed investigation. Accordingly, 6 sample villages were chosen using a stratified random sampling method for village selection and systematic purposive sampling for farmer respondents (**Fig.2**). These sample villages represent the major Custard Apple producing belt of the tahsil and provide a comprehensive understanding of cultivation practices, production trends, and associated problems in the study area.

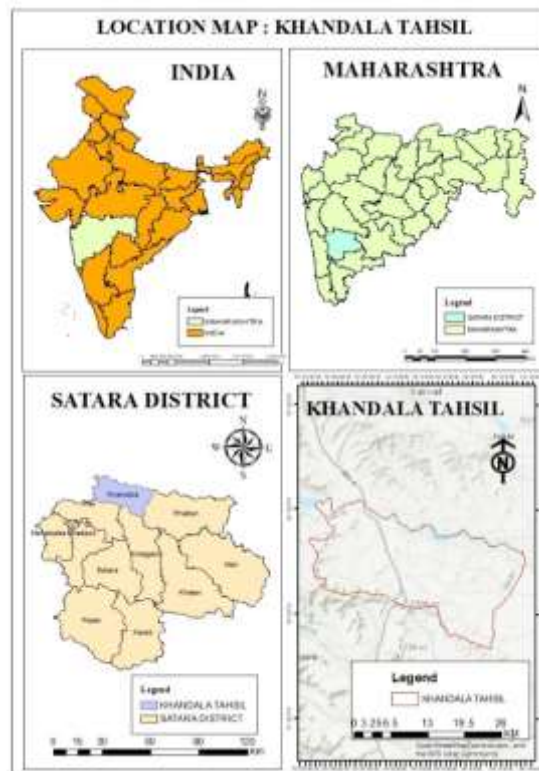


Fig.1



Fig. 2

Methodology

The present study is based on both primary and secondary sources of data. A systematic research design was adopted to examine the growth, problems, and prospects of Custard Apple cultivation in Khandala Tahsil.

1. Data Collection

Primary Data:

Primary data were collected through a structured questionnaire survey conducted among Custard Apple cultivators. A total of **70 farmers** were selected from 6 sample villages representing the major Custard Apple producing belt of the tahsil. The questionnaire included questions related to cultivation practices, irrigation, labour availability, fertilizer use, plant protection, and marketing constraints. Personal interviews and field observations were also conducted to validate responses.

Secondary Data:

Secondary data were obtained from the Tahsil Office, Khandala (2000–01 to 2019–20), Census of India (2011), research journals, books, and government reports related to horticulture development and climate variability.

2. Sampling Technique

A **stratified random sampling method** was used for selecting villages where Custard Apple cultivation is concentrated. Out of 30 Custard Apple growing villages, 6 villages (20%) were selected for detailed study.

Within the selected villages, a **systematic purposive sampling method** was adopted to select respondent farmers actively engaged in Custard Apple cultivation.

3. Data Analysis

The collected data were classified, tabulated, and analysed using the **percentage method and comparative statistical analysis**. Growth trends in the area under cultivation were examined using tabular presentation and volume of change calculations. The identified problems were analysed based on respondent percentages to determine the intensity and significance of constraints affecting Custard Apple cultivation.

Objectives

1. To identify major problems faced by Custard Apple cultivators in Khandala tahsil.
2. To suggest sustainable strategies to improve Custard Apple productivity and farmer income.

Statement of the Problem

Despite the significant expansion of Custard Apple cultivation in Khandala Tahsil of Satara District, the productivity and profitability of the crop remain unstable and below potential levels. Farmers face multiple interrelated challenges, including climatic variability (uncertain rainfall and temperature fluctuations), labour shortages, water scarcity, irregular electricity supply, rising input costs, and inadequate technical knowledge. In addition, excessive dependence on chemical fertilizers and high-cost pesticides raises concerns about soil health, sustainability, and long-term economic viability. These constraints collectively hinder efficient orchard management and reduce farmer income. Therefore, a systematic geographical assessment of the problems affecting Custard Apple cultivation is essential to identify critical gaps and propose sustainable solutions for strengthening horticultural development in the region.

Custard Apple Cultivation In Khandala Tahsil

Custard Apple cultivation in Khandala Tahsil has shown a significant upward trend over the last two decades. The area under cultivation increased from **2.5 hectares in 2000–01 to 206.62 hectares in 2019–20**, (Table 1) indicating rapid horticultural expansion. Although year-to-year fluctuations were observed due to climatic variability and market conditions, the overall growth trend remained positive. The expansion reflects increasing farmer preference for dryland fruit crops, favourable agro-climatic conditions, and support from horticulture development schemes. This steady increase highlights the

growing economic importance of Custard Apple cultivation in the tahsil.

Table 1: Area Under Custard Apple Cultivation in Khandala Tahsil (2000-01 to 2019-20) (Area in Ha.)

YEARS	KHANDALA TAHSIL	Volume of Change
2000-01	2.5	-
2001-02	13.9	11.6
2002-03	25.7	11.8
2003-04	30.55	4.85
2004-05	73	42.45
2005-06	154.59	81.59
2006-07	125.45	29.14
2007-08	169.55	44.1
2008-09	198.66	29.11
2009-10	153.83	44.83
2010-11	72.75	81.08
2011-12	8.8	63.95
2012-13	78.54	69.74
2013-14	25.05	53.49
2014-15	23.66	1.39
2015-16	29.6	5.94
2016-17	45.15	15.55
2017-18	51.85	6.7
2018-19	138.93	87.08
2019-2020	206.62	67.69

Source: Based on, Tahsil office, Khandala (2000-01 to 2019-20).

Problems of Custard Apple Cultivators

Custard Apple cultivators in Khandala Tahsil of Satara District face several production and management-related challenges that affect yield, quality, and profitability. These problems can be broadly classified into natural, operational, managerial, and financial constraints.

1. Natural Hazards

Custard Apple cultivation in Khandala Tahsil is highly affected by climatic variability. About 58.18% of farmers reported uncertain rainfall as a major constraint affecting flowering and fruit setting (Table 2). A significant 83.63% experienced extreme rise and fall in temperature, which disturbs physiological growth and reduces fruit quality. Nearly 47.27% of respondents indicated Foggy weather as a problem during fruit development, while 43.63% reported heavy rainfall leading to fruit drop and soil erosion. These climatic uncertainties create instability in production and income.

2. Timely Farm Operations

Farm operations are seriously constrained by labour and resource limitations. Around 81.82% of farmers reported non-availability of labourers at critical stages of orchard management. About 62.5% mentioned high labour charges with low efficiency. Water scarcity was experienced by 76.36% of respondents, while 89.09% reported irregular electricity supply affecting irrigation schedules (Table 2). These operational challenges

delay essential agricultural activities and reduce overall productivity.

3. Improper Management

Management-related issues also contribute to lower yields. Only 14.54% of farmers reported over-irrigation as a problem, but a considerable 38.18% indicated lack of technical knowledge regarding scientific orchard practices such as pruning, nutrient management, and pest control (Table 2). This knowledge gap limits the adoption of improved cultivation techniques.

Table 2: Problems of Custard Apple cultivation

Sr. No.	Problems of Custard Apple cultivation	No. of Respondents	%
1.	Natural Hazards		
	i) Uncertain rainfall	32	58.18
	ii) Extreme rise and fall in temperature	46	83.63
	iii) Foggy weather	26	47.27
	iv) Heavy rainfall	24	43.63
2.	Timely farm Operations		
	i) Non-availability of labourers in time	45	81.82
	ii) High charges of labourer with less efficiency	50	62.5
	iii) Shortage of water-supply	42	76.36
	iv) Irregular electricity supply	49	89.09
3.	Improper Management		
	i) Over irrigation	08	14.54
	ii) Lack of Tech knowledge	21	38.18
4.	Use of Fertilizer		
	Organic	4	7.27
	Inorganic	51	92.72
5.	Plant Protection		
	i) High, cost of pesticides	50	90.1
	ii) Inadequacy of finance	36	65.45
	iii) Inferior quality of pesticides	41	74.54

Source: Based on field work.

4. Use of Fertilizers

The pattern of fertilizer use reveals heavy dependence on chemical inputs. Only **7.27%** of cultivators practice organic fertilization, whereas **92.72%** depend on inorganic fertilizers due to easy availability and quicker results (**Table 2**). Excessive use of chemical fertilizers increases production costs and raises concerns about long-term soil health.

5. Plant Protection Issues

Plant protection is one of the most serious concerns. Nearly **90.1%** of farmers reported high cost of pesticides as a major burden. About **65.45%** faced financial constraints in purchasing quality plant protection materials, and **74.54%** complained about inferior or adulterated pesticides available in the market (**Table 2**). These issues weaken pest control measures and increase the risk of yield loss.

Conclusion

The study reveals that Custard Apple cultivation in Khandala Tahsil of Satara District has expanded significantly over the last two decades, indicating its growing economic importance in the regional horticultural economy. However, despite favourable agro-climatic conditions and increasing cultivated area, productivity remains constrained by climatic variability, labour shortages, irregular electricity supply, water scarcity, and high plant protection

costs. The excessive dependence on chemical fertilizers further raises sustainability concerns.

Therefore, strengthening scientific orchard management, promoting integrated nutrient and pest management practices, improving irrigation infrastructure, and enhancing institutional and market support are essential for ensuring long-term sustainability. With systematic planning and policy intervention, Custard Apple cultivation can emerge as a resilient and economically viable dryland horticultural activity in the region.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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