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Knowledge of alphonso mango growers about climate-resilient technologies: A study from South Konkan costal zone of Maharashtra

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Abstract
The present study was undertaken in the South Konkan coastal zone, which comprises two districts: Ratnagiri and Sindhudurg. The research adopted the ex-post facto method of social science. A simple random sampling method was used to select a total of 156 respondents. The data were gathered using a structured interview and analyzed using appropriate statistical techniques. It was discovered that the majority of mango growers were older and had completed secondary school. They earned a moderate annual income and had a small landholding, which included the marginal area under the mango. A sizable majority had self-ownership of mango orchards and possessed 'adequate' resources for mango orchard management. They cultivated mango orchards on rocky soil with a hilly topography. The respondents in the sample had a high level of knowledge. The study recommends that policymakers, academics, extension personnel, and development agencies focus to increase the adoption of climate-resilient technologies. According to mango farmers, skilled workers are required for mango tree canopy management and rejuvenation. Rural youths' capacity in this area may be strengthened by the Agricultural University and KVKs within the jurisdiction.

Keywords: knowledge, climatic vulnerability, climate-resilient technology

Introduction
On every continent on the planet, the consequences of climate change are now visible. Contributing factors such as erratic weather, rising sea levels, and melting glaciers are gradually reshaping societies all over the world. Between 1880 and 2012, global average land and ocean temperatures increased by 0.95 degrees Celsius (Hansen *et al.*, 2010; IPCC, 2013) [1]. Climate change has remained one of the most perplexing socioeconomic and ecological phenomena affecting rural livelihoods. Indian agriculture provides a livelihood for 58.0 percent of the population (Indian Census, 2011) and makes a share of about 20.0 percent of the national GDP (Economic Survey, 2020-21). Agriculture is the primary source of income for the vast majority (70.00%) of rural residents (Indian Census, 2011). Climate change threatens global food security and agricultural livelihoods, but needful responses may be region-specific, and the areas affected by climate impacts may vary significantly (IPCC, 2019). Developing economies, such as India, are more vulnerable to climate change. India is combating climate change through a combination of strategies, policies, partnerships, and investment. Indian farmers have developed their own methods of adapting to changing weather patterns, but these methods have proven inadequate to deal with extreme weather events. The Indian Council of Agriculture Research (ICAR), New Delhi, has launched a nation-wide project to demonstrate climate-resilient technologies called ‘National Innovations in Climate Resilient Agriculture (NICRA)' via 151 Krishi Vigyan Kendra (KVKs)-Farm Science Centers. The NICRA made a visible impact, demonstrated resilient technologies to address district-specific climatic vulnerabilities, and scaled-up proven technologies in a convergence and partnership mode.
Horticulture is a major driver of economic growth in India. Horticulture accounts for 30.00 percent of total agricultural output value. India is the world's leading producer of fruits such as mango, banana, lime, lemon, papaya, and fenugreek (Horticulture Statistics, 2018). Alphonso mangoes, popular in the Konkan region, are known for their exceptional appearance, nutritional value, delectable taste, and exceptional flavor. The mango is considered India's "National Fruit," while the alphonso is dubbed the "King of Mangoes." Alphonso, on the other hand, is extremely vulnerable to climate change. Building resilience to weather extremes is of the utmost importance to mango farmers.

Therefore, farmer must have an appropriate knowledge of climate-resilient technologies. In this in regard, study was conducted with following specific objectives;

Objective

- To study the socio-economic and ecological characteristics of mango growers.
- To know the knowledge of farmers about climate-resilient mango production technologies.

Methodology

The current study was conducted in the districts of Ratnagiri and Sindhudurg in the state of Maharashtra. This region contributes the state's maximum (70.00 percent) area covered by mango. Ratnagiri constitutes 60.11 thousand ha area and 190.0 million tonnes production; however, Sindhudurg possessed 23.50 thousand ha area and 70.38 million tonnes productions of mango (Horticultural Statistics at a Glance, 2018). Further, the status of Geographical Indicator (GI) tagged for Alphonso mangos from Ratnagiri and Sindhudurg. This status, awarded by the India Patent Office, allows a geographical region to lay an exclusive claim over a product. Considering these facts, the Ratnagiri and Sindhudurg districts were purposively selected for this study. Lanja and Rajapur tehsils in Ratnagiri district, and Devgad and Vengurle tehsils in Sindhudurg district, were purposefully chosen. A total of 156 respondents were chosen for the study. A researcher used the "ex-post-facto" method of social research. The 'personal interview' method was used to collect field data in an informal setting. The respondents' data were scored, tabulated, and analyzed using appropriate statistical techniques such as frequency, percentage, mean, and standard deviation.

Result and Discussion

The descriptive statistics of socio-economic characteristics of mango growers surveyed in the study area is depicted in Table 1.

Table 1: Descriptive statistics of socio-economic characteristics of the mango growers

Sl. No	Characteristics	Minimum	Maximum	Average	Standard Deviation
1	Age	22.0	77.0	49.97	11.93
2	Education	2.0	16.0	9.82	3.15
3	Annual income (INR)	1,80,500/	65,40,000/	24,82,000	88,412/-
4	Operational landholding	0.80	35.00	4.28	4.91
5	Area under mango	0.50	20.0	3.37	2.64
6	Ownership of mango orchards	2.0	3.0	2.11	0.32
7	Age of orchards	10.0	70.0	38.10	9.95
8	Resource availability	61.11	85.19	70.58	4.29
9	Access to crop insurance	0.00	1.00	0.47	0.20
10	Access to crop loan	0.00	1.00	0.51	0.40
11	Source of inputs	2.00	4.00	2.42	0.64
12	Extension participation	2.00	14.0	3.07	1.10

On average, the age of the sampled mango growers was 49.97 years, indicating ‘older’ people were largely engaged in mango farming (See Table 1). Most of the mango growers were educated from ‘secondary’ to ‘higher-secondary’ level. Interestingly, none of the respondents was found to be illiterate, reflecting that educated persons were mostly engaged in mango farming. Most of the mango growers were educated so they can adopt advanced technologies, ideas and innovations (Abhishek, 2017; Sayali Dabhole, 2017; Dhenge, 2018) [3, 5, 4].

This study also reported, the average annual income of the mango growers was Rs. 1.2 million. It is clear that the financial condition of mango growers was good. A similar observation was reported by Dhenge, (2018) [4] elucidated on average, annual income of mango farmers was Rs. 3.9 million. Further, Table 1 also indicated that most of the mango growers had small (1.01 to 2.00 ha) and semi-medium (2.01 to 4.00 ha) landholding. Generally, sampled mango orchardists had average landholding of more than 4.00 hectare. Most of the mango growers belonged to the marginal and small category of area under mango. Considerable number of the respondents did mango cultivation on medium, semi-medium and large areas. This indicated, the diversified category of the farmers was engaged in mango farming. On average, 3.37-hectare area is found under mango cultivation. Similarly, average area under mango cultivation was 3.90 ha (Sneha Godse, 2010) [6] and more than 5.0 hectares (Joshi, 2012; Kawale, 2011; Pooja Chaudhari, 2014) [12, 13, 15]. However, average operational holding was less (1.81 ha) with 0.49 ha of leased-in land. Most of the sampled farmers planted mango on their own land. Addition to this, some respondents have ‘leased-in’ mango orchards from other farmers. Such resourceful farmers are engaged in mango trading and they are exporting alphonso to East-Asia, Gulf countries, European Union and USA. Therefore, these farmers take ‘lease-in’ mango orchards from other farmers. Minimum age of mango orchards was 10.0 years; the maximum was 70.0 and average age was 38.10 years. It could be said that the majority of mango orchards are in their ‘middle’ years of productive age. Most of the mango growers from the South Konkan region were resourceful. Average number of resources available with mango growers were high (70.58%). They are having affordable and useful farm resources required for management of mango orchards. Nearly half (average=0.47) of the respondents did not have access to crop insurance schemes- *Pradhan Mantri Fasal Bima Yojana* (PMFBY). The reasons might be lack of awareness, lack of faith in insurance companies and delay in claim settlement. The majority of the respondents had borrowed the crop loan from nationalized and cooperative banks. Further, minimum source of input was 2.0; maximum was 4.0 and average was 2.42. Most of the mango growers reported that input dealers were the main source of inputs for them. Mango is a highly input-intensive fruit crop therefore, it requires quality insecticides, pesticides, micro-nutrients, liquid fertilizers and plant regulators for better management. These critical inputs are easily available with input dealers so input dealers consult the mango growers. Similarly, input dealers were the main source of information in India and were also well acknowledged (NSSO, 2005).

Table 1 also showed that sampled mango farmers had an average extension participation score of 3.07. The minimum score was low (2.0) and maximum score was high (14.0). This indicated, the majority of the respondents had a 'medium' exposure to different extension organizations and frontline extension activities. Past studies also revealed that most of the mango growers had 'medium' extension participation (Mamatha and Hiremath, 2000; Jadav, 2005)

Ecological characteristics of mango orchards

Table 2 indicates that the maximum score of soil type was 3 means mango orchards were established on 'rocky' soil. The rocky soil is suitable for mango plantation in Konkan, gives more physiological stress to plants and hot wind from Arabian seas facilitate early maturity in fruits.

Table 2: Descriptive statistics of ecological characteristics of the mango orchards

Sl. No	Characteristics	Minimum	Maximum	Average	Standard Deviation
1	Soil type	1.00	3.00	1.32	0.68
2	Topography	1.00	2.00	1.32	0.52
3	Distance of orchards from seashore	2.0	45.0	12.22	9.43
4	Planting density	80.0	100.0	96.28	6.14

These early-maturing fruits command a premium on both the domestic and international markets. The average score for topography was 1.32, while the maximum score was 2.0. This indicates that the mango orchards were established on a 'hilly' rather than a flat topography. The hilly topography allows for increased sunlight from the south-west, which promotes reproductive growth and reduces insect pest infestation. The minimum distance between mango orchards and the seashore was 2 kilometers; the maximum distance was 45 kilometers; and the mean distance was 12.22 kilometers. As previously stated, the rocky soil is found in the Konkan's western belt. It is found within a short to medium distance (4-22 kilometers) of coastal areas. This coastal belt is ideal for alphonso cultivation. As a result, the majority of respondents planted mango orchards in the west coastal belt rather than the east. A university of agriculture has recommended a planting density of 100 trees per hectare. According to the recommendation, the average planting density of 96.28 trees per hectare indicates that alphonso mango orchards are well established.

Knowledge of mango farmers about climate-resilient mango production technologies

Table 3 illustrates data regarding knowledge of sample respondents on climate-resilient mango production technologies.

It is evident from Table 3 that cent per cent of the sample respondents possessed knowledge on using recommended dose of paclobutrazol during July-August; providing irrigation (100-200 liter/tree) to reduce dropping of pea size fruits, using university recommended spraying schedule for insect-pest management, paper bagging of fruits from the 'Marble to Egg' stage and rejuvenation of old and senile orchard was also reported by the 100.00 per cent of the mango growers.

Table 3: Distribution of the respondents according to their knowledge on different climate resilient mango production technologies.

Sl. No.	Technologies	Knowledge-Yes	
		Frequency (n=156)	Percentage
1.	Use of recommended dose of Paclobutrazol during July-August	156	100.00
2.	Spraying of Gibberellic Acid (GA) 50 ppm to avoid recurrent flowering	96	61.53
3.	Spraying of Naphthalic Acetic Acid (NAA) 20 ppm to avoid fruit drop	11	07.05
4.	Spraying of Potassium Nitrate (1%) for more fruit retention	81	51.92
5.	Canopy management to facilitate more sunlight and thereby reduce pest infestation	134	85.89
6.	Provide irrigation (100-200 litre/tree) to reduce dropping of pea size fruits	156	100.00
7.	Use of university recommended spraying schedule for insect-pest management	156	100.00
8.	Bagging of fruit from 'Marble to Egg' stage	156	100.00
9.	Rejuvenation of Old and Senile orchard	156	100.00

Additionally, the majority (85.89%) of respondents were familiar with canopy management in mango crops, which allows for more sunlight and thus reduces pest infestation, spraying with Gibberellic Acid (GA) 50 ppm to avoid recurrent flowering (61.54%), and spraying with 1% Potassium Nitrate for increased fruit retention (51.92 per cent). However, only 7.05 percent of respondents were aware of spraying Naphthalic Acetic Acid (NAA) at a concentration of 20 parts per million (ppm) to prevent fruit drop in mango.

The results indicated that mango growers possessed a 'high' level of knowledge regarding the majority of climate-resilient technologies. However, Sayali Thakur (2014) [8] and Aski and Hirevenkanagoudar (2014) [9] reported findings that mango farmers possessed 'medium' knowledge of irrigation, plant protection, and fertilizer application. Similarly, Sowmya Shree (2015) [7] reported that farmers had 'moderate' awareness of the mango plant rejuvenation technique.

Extent of knowledge

The extent of knowledge on climate-resilient technologies facilitates the farmers to cope with vulnerable situation and also mitigate the impact of climate change. In this context, data on knowledge on climate-resilient mango production technologies were collected, analyzed and depicted in Table 4.

Table 4: Distribution of the respondents according to their knowledge on climate resilient mango technologies

Sl. No.	Knowledge (%)	Frequency (N=156)	Percentage	Min.	Max.	Mean	S.D.
1.	Low (<33.33)	0	0	55.56	100.0	78.49	11.95
2.	Medium (33.34 - 66.66)	15	9.62				
3.	High (>66.66)	141	90.38				
Total		156	100				

According to Table 4, 90.38 percent of mango growers had a 'high' level of knowledge about climate-resilient mango production technologies, while only 9.62 percent of respondents had a 'medium' level of knowledge. It was surprising to discover that none of the respondents fell into the 'low' category of knowledge. Additionally, the study reported that the minimum level of knowledge was 55.56 percent, the maximum level was 100.00 percent, and the mean level of knowledge was 78.49 percent. This suggests that the sampled mango growers possessed a wealth of knowledge regarding climate-resilient mango production technologies. These findings are corroborated by Jadhav (2009) [11], Latha (2009) [14], and Borate *et al*. (2010) [10], who discovered that the majority of mango farmers possessed 'extensive knowledge of production technologies. In contrast, Sneha Godse (2010) [6], Kawale *et al*. (2011) [13], Mehta and Madhuri Sonawane (2012), Pawar (2013), and Sowmya Shree (2015) [7] reported that the majority of farmers had 'moderate' knowledge of mango production technology.

Conclusions and implications

The study discovered that the majority of sampled mango growers were elderly, had only a secondary education, and earned a medium annual income. The majority of respondents were classified as having a small landholding. It was discovered that the majority of mango growers had self-owned mango orchards, that mango orchards were in the middle age of orchard category, and higher percentage of respondents had 'adequate' level of resources. Additionally, the majority of respondents had accessed crop insurance and taken out crop loans. It was discovered that a higher percentage of mango growers had a medium level of extension participation and medium levels of access to input sources. In most cases, mango orchards were grown on rocky soil with a hilly topography, at a medium distance from the sea, and with recommended planting densities in mind. Researchers found that the climate-resilient mango growers they surveyed were extremely knowledgeable. Using the recommended dose of paclobutrazol, providing irrigation to reduce fruit drop, using the university-recommended spraying schedule for insect-pest management, paper bagging of fruits from the 'Marble to Egg' stage, and rejuvenation of old and senile orchards were all known to 100 percent of the sampled respondents. The majority of respondents were knowledgeable about canopy management in mango crops, which enables more sunlight and thus reduces pest infestation, gibberellic acid (GA) spraying to avoid recurrent flowering, and potassium nitrate spraying for increased fruit retention.

In a nutshell, the sampled respondents possessed a high level of knowledge. The study recommends that policymakers, academics, extension personnel, and development agencies priorities adoption of climate-resilient technologies. According to mango farmers, skilled workers are required to manage and rejuvenate the mango tree canopy. Rural youths' capacity in this area may be strengthened through collaboration with the Agricultural University and KVKs located within the jurisdiction.

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