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Extent of adoption of improved citrus production technologies in Nagpur mandarin belts of Vidarbha region of Maharashtra

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Abstract

Nagpur mandarin (*Citrus reticulata* Blanco) is an input intensive perennial fruit crop which is shallow rooted and demands proper care and management throughout its life cycle of 20-25 years sometimes even more. Hence adoption of scientific production techniques is essential to obtain a bumper yield of good quality fruits which can fetch remunerative market price. In this direction, ICAR-Central Citrus Research Institute, Nagpur has developed package of practices right from disease free planting material production technology and nursery management techniques to post harvest handling of fruits. The authors of this study attempt to measure the extent of adoption of these technologies amongst farmers of different yield categories in the citrus growing districts of Nagpur, Amravati and Wardha of Vidarbha region of Maharashtra. The Technology Adoption Index (TAI) was developed for assessing the extent of adoption of improved technologies of ICAR-CCRI. It was found that overall farmers lagged in adoption of post harvest handling of fruits (TAI=12.99). There was found to be very less difference among different categories of farmers with respect to nutrient management and hence this technology showed good extent of adoption (TAI=19.88). Disease management (TAI=14.15) and insect pest management (TAI=16.75) practices were adopted by all categories of farmers but to a slight less extent by medium yielders and extremely low adoption of disease and insect management practices by low yielders. Orchard management (TAI=14.92) were adopted to a moderate extent by all categories of farmers. The findings of the study provide a feedback to researchers for reorienting their research to develop farmer-friendly technologies to address the challenges of citrus farming existing in the region.

Keywords: Citrus, technology, package of practices, technology adoption index, ICAR-CCRI, Vidarbha

Introduction

Technology intensification in agriculture has transformed Indian farming scenario largely over the past decade. Scientific farming has enhanced agricultural productivity in manifolds which seemed impossible through traditional farming. In a country of teeming millions, it is essential for our country to be self sufficient in food grains, horticulture and animal husbandry sector to suffice the needs of growing population. Therefore, adoption of technological innovations by farmers is a crucial factor to keep up with the growing demands of food and this has proven to be true in several countries of the world (Huang and Wang, 2024; Lim, 2022; Ruzzante, *et al*., 2021; Rakholia, *et al*., 2024) [5, 9, 15, 14]. India has achieved self sufficiency in food grains and is also nutritionally secure through her booming horticulture sector. India ranks second in fruits and vegetable production in the world after China (Economic Times, 2023) [3]. The country's advantage lies in being a low-cost producer of fruits and vegetables because of a combination of factors such as favourable agro-climatic conditions, availability of labour and low input costs. As a result, fruits and vegetables account for almost 90% of the total horticulture production in the country (Economic Times, 2023) [3]. Amongst this, citrus is a widely cultivated fruit crop which has presence in almost all states of India. Starting from mandarins, sweet oranges, limes and lemons to grapefruits and pummelos; citrus species present a nutritious and refreshing fruit platter to Indians throughout the year through its wide biodiversity. Citrus cultivation in India spans across 11.00 lakh hectares, making it the third most cultivated fruit after mango and banana. The annual production of citrus is 14.65 million tons (MoAg&FW, GoI, 2023) [13].

In India, Indian Council of Agricultural Research-Central Citrus Research Institute (ICAR-CCRI), Nagpur is the premiere institute conducting research on citrus fruit crop. The institute develops technologies for overall improvement of productivity and profitability of citrus farmers across India and provide sustainable solutions to the problems of citrus growers through extension and farm advisory services (ICAR- Central Citrus Research Institute, 2021). The institute was established in 1985 and since then it has been

engaged in development of improved production technologies of citrus ranging from disease free planting material production technology and nursery management techniques to post harvest handling of fruits. ICAR-CCRI technologies have transformed the citrus production scenario by benefitting farmers of all scale (Bhattacharyya *et al*., 2023) [1]. But as we know, some technologies get adopted at fast pace by farmers and stakeholders while others take time to reach the critical mass due to perceived attributes of technology (Mariano, *et al*., 2012; Ferrari, *et al*., 2022; Iversen, 2019) [11, 4, 7]. The extent of adoption if assessed can serve as direct feedback from land to lab for researchers to modify their technology or reorient their future research towards developing a more farmer friendly technology.

Hence, a study was formulated at ICAR-CCRI to determine the extent of adoption of improved production and post harvest technologies of the institute amongst different categories of farmers of citrus growing districts of Maharashtra through development of Technology Adoption Index (TAI).

Material and Methods

Locale of Study

Nagpur, Amravati and Wardha districts which are the popular Nagpur mandarin (*Citrus reticulata* Blanco) belts of Vidarbha region of Maharashtra were purposively selected for the study. Mandarin is the most popular citrus cultivar amongst all commercial cultivars of India. And these districts account for most of Nagpur mandarin production in the country by virtue of which Nagpur mandarin even received the GI tag in 2014. The Amravati and Nagpur districts of Maharashtra contribute about 80 per cent of the total area under mandarin orchards in Maharashtra state sharing 48.88 per cent and 31.45 per cent, respectively (Wankhede *et al*., 2017) [18].

Sampling Plan and Data Collection

A sample of 30 citrus growers (Nagpur mandarin growers was purposively selected) having high yield (8-10 ton/ha), medium yield (6-8 tons/ha) and low yield (less than 6 tons/ha) were selected as respondents for the study through stratified random sampling method from each of the 3 districts thus making a total sample size of 270 farmers (n=270). The research design followed was *ex post facto*. Semi structured interview schedule was developed and data was collected through personal interview method.

Measuring Extent of Adoption of Technologies through Construction of Technology Adoption Index (TAI)

Composite indices, which combine multiple indicators into a single metric, are used in social science to simplify and analyze complex social and economic phenomena. As adoption of scientific package of practices of citrus includes a basket of technologies, hence authors constructed the Technology Adoption Index (TAI) by assigning weightages through expert consultation to each technology which in turn have a list of package of practices (PoPs) under them (Jara-Rojas, 2020; Mailumo & Onuwa, 2022) [8, 10]. Starting from rootstock and site selection to nursery management to post harvest handling of citrus, the recommended technologies of ICAR-CCRI were at first identified and incorporated in the interview schedule in the form of questions. The package of practices which had a binomial answer that is either the farmer practises or not were given a score of 1 (practises) and 0 (does not practice). While certain technologies like fertilizer application, insecticide doses etc. cannot have an absolute answer. For example, farmers may apply recommended fertilizers but not exactly recommended doses. Hence, such items were scored in a 3 point continuum like 3= Adopted accurately, 2= Adopted to some extent, 1= Adopted to least extent. Therefore for each technology (y) comprising of certain package of practices (x), maximum possible scores which a farmer could obtain were calculated. Thereafter, the technologies with PoPs identified were sent to experts for allotting weightages out of 100 according to their contribution towards citrus cultivation. Later the weightages were adjusted within 0 and 1 range during index development.

Results and Discussion

Technology Adoption Index

The recommended technologies of ICAR-CCRI for scientific citrus farming (*Citrus reticulata* Blanco) were identified, PoPs enlisted, maximum possible scores worked out and weightages allotted by experts. Being a shallow rooted, input intensive crop; irrigation, nutrient management and post harvest management (Table 1) received 25 and 20 weightage respectively out of 100 (w=0.25 and w=0.20 out of 1) followed by orchard management (w=0.15). Disease and insect pest management received 10 out of 100 (w=0.1).

Table 1: ICAR-CCRI technologies identified for study

Technology	Package of Practices	Maximum Possible Score	Weightages after expert consultation (out of 100)
Orchard Management (OM)	Pre planting treatment of the budlings Practice of raised bed planting	3	15
Irrigation Management (IM)	Method of irrigation followed	2	25
Nutrient Management (NM)	Extent of following the CCRI fertilizer schedule 1.78kg urea+1.26 kg SSP+0.18 kg MOP per plant per year in mandarin and 25kg FYM/tree before monsoon for a well grown tree of 6-7 years	3	20
Disease Management (DM)	Major diseases and their management practices: *Phytophthora*, Canker, Greening	3	10
Insect Pest Management (IPM)	Major insects and their management practices: Citrus psylla, Blackfly, Leaf Miner, Thrips, Mites, Fruit sucking moth, Bark eating caterpillar, Fruit fly, Mealy bug, Mites	10	10
Post Harvest Management (PHM)	Mode of plucking fruits Storage methods	6	20
Total score that can be obtained on full adoption of package of practices		27	100

The Technology Adoption Index (TAI) was developed to measure the extent of adoption of the cluster of technologies recommended by CCRI using the following formula:

Technology Adoption Index of a farmer (TAI) = (OMw+IMw+NMw+DMw+IPMw +PHMw) / N × 100

where, OMw = Weighted orchard establishment score (weightage given by experts=0.15), IMw = Weighted Irrigation Management score (weightage given by experts=0.25), NMw = Weighted Nutrient Management score (weightage given by experts=0.20), DMw = Weighted Disease Management score (weightage given by experts=0.10), IPMw = Weighted Insect Pest Management score (weightage given by experts=0.14), PHMw = Weighted Post Harvest Management score (weightage given by experts=0.20), N=Maximum obtainable score.

Extent of Technology Adoption amongst Different Categories of Citrus growers

Using the TAI the extent of adoption of CCRI technologies was measured amongst farmers of different categories. The average index values of each technology (Table 2) depicted that that overall farmers lagged in adoption of post harvest handling of fruits (TAI=12.99). Almost all of them plucked the fruits by hands and some of them resorted to sorting and grading for selling it to the procurement agencies/wholesale dealers. Few practised waxing and cooling and those who did, they were doing in mandarins meant for export.

Table 2: Technology Adoption Index values of different categories of citrus farmers

Category	Average Adoption Index values					
	Orchard mgmt.	Irrgn mgmt	Nutrient mgmt	Disease mgmt	Insect pest mgmt	PHT mgmt
Farmers with high yield (8-10 tons/ha & more)	17.89	22.77	21.65	18.67	21.82	17.65
Farmers with medium yield (6-8 tons/ha)	14.55	25.43	20.54	12.34	17.67	11.09
Farmers with low yield (<6 tons/ha)	12.34	22.24	17.45	11.45	10.78	10.23
Mean TAI of technologies amongst total respondents	14.92	23.48	19.88	14.15	16.75	12.99

There was found to be very less difference among different categories of farmers with respect to nutrient management and hence this technology showed good extent of adoption (TAI=19.88). Drip irrigation was also adopted by maximum farmers of high yielder category (irrigation management TAI= 23.48) but the farmers with low yield mostly practised flood irrigation. Still irrigation management was the technology which farmers adopted and followed whole heartedly. Since irrigation plays the most important role in citrus, especially, mandarin orchards, as also highlighted by the highest weightage provided to irrigation management techniques, its importance was reflected at farmers' level also through their adoption of drips and following the irrigation schedules. Disease management (TAI=14.15) and insect pest management (TAI=16.75) practices were adopted by all categories of farmers but to a slight less extent by medium yielders and extremely low adoption of disease and insect management practices by low yielders. The farmers reported that they were quite unaware of the symptoms of diseases and their preventive/control measures. Orchard management (TAI=14.92) were adopted to a moderate extent by all categories of farmers.

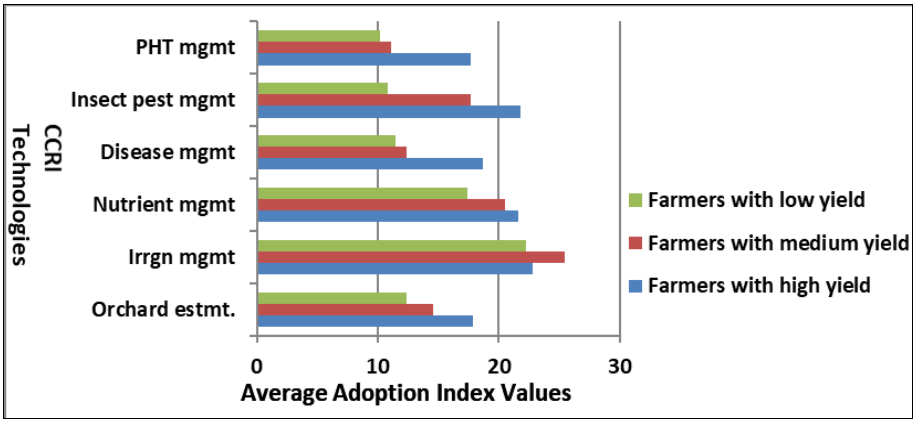

Fig 1: Graphical Representation of Extent of Adoption of ICAR-CCRI Technologies among Different Categories of Farmers

Farmers who had high yield had higher TAI values than those with medium and low yields (Fig. 1) which also hints that greater adoption of technology can lead to improved yields. Similar findings were reported by Timsina *et al.* (2025) [17] amongst citrus cultivators of Nepal, Shende (2016) [16] amongst citrus growers of India, Mazhar *et al.* (2022) [12] amongst citrus farmers of Pakistan and De-Miguel *et al.* (2019) [2] amongst citrus growers of Spain.

Conclusion

The extent of adoption of technology varies with not only perceived attributes of the technology but also with socio-personal and socio-economic characteristics of the farmers. The cafeteria of technologies of ICAR-CCRI has been transferred to farmers and still continue to address the challenges of citrus farming. However, package of practices pertaining to irrigation, nutrient and insect pest management

were found to be adopted to greater extent, probably because of visibly observable consequences of non-adoption. Hence farmers seem to be more careful with the doses of insecticides, pesticides and fertilizer and timely watering of plants. Scientific methods of citrus farming are a necessity in today's scenario of climate change, growing demands of food, scarcity of manpower and natural resources. The findings of the study will further help researchers to reorient their research towards addressing specific challenges in citrus farming. With the clarion call for *Viksit Bharat*, *Viksit Krishi* is the new target for Indian agriculture and horticulture sector has the potential to take it one step further through ensuring nutritional security to our country's population.

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Conflict of Interest
The authors declare no conflict of interests

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