

Green Innovation Centre in the  
Agri-Food Sector (GIAE) - India



# STUDY OF TOMATO NURSERY PRODUCTION PRACTICES IN SELECTED DISTRICTS OF MAHARASHTRA AND KARNATAKA

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## EXECUTIVE SUMMARY

A study of tomato nursery practices was undertaken in the project pilot areas of Narayangaon in Maharashtra and Kadur in Karnataka during May 2016. They provide contrasting patterns in how their tomato seedling industries recently developed reflecting different government policies and local circumstances.

Nurseries are key gatekeepers for the tomato industry, providing a growing proportion of the industry's planting materials instead of farmers raising their own seedlings, and helping to promote new varieties. How the seedlings are raised has a crucial influence on the future productive capacity of the commercial tomato crop.

In Narayangaon, expansion of the nursery industry was driven by improvements to water supply and marketing, the use of leased land close to a highway and attracting entrepreneurial investment in nurseries as their sole businesses. This has produced a concentrated group of businesses serving both local and distant farmers. In Kadur the development of nurseries has depended strongly on government subsidies for polyhouse structures. Most nurseries are small and operate as sidelines by existing farmers. Because they are close to many agricultural input suppliers around Bangalore there is more competition, input prices are lower and a wider range of seedling crops and varieties of tomatoes are produced by nurseries.

With strong demand for seedlings from farmers, profit margins are acceptable in both locations, encouraging expansion of the nursery industry. The nursery owners are self-taught and do not believe that they have any major technical problems. However there has been no training provided to nurseries, and many technical problems were observed during the study that affect both the profitability of their businesses and the quality of seedlings provided to farmers. This includes poor water, fertilizer and pesticide management, and the failure of effective control of insect-borne diseases that can later damage field crops.

A targeted training program could have a large impact on helping farmers to demand better quality seedlings, nurserymen to demand better quality inputs and information on varieties, and for nurseries to significantly improve both the quality of the seedlings they supply and the profitability and sustainability of their businesses. This will be important to continue to improve tomato yields and to enable growers to overcome some of the major production threats to their industry posed by virus diseases, a lack of suitable varieties and invasive insect pests.

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## INTRODUCTION

The GIZ Green Innovation Center program for the agriculture and food sectors has selected two areas of India in which to work on improving the value chains for tomatoes. These are around the small town of Narayangaon in Junnar Taluk in Pune district of Maharashtra and in Kadur taluk in Chikkamagaluru district of Karnataka. The study's fieldwork was completed during May 2016. Nurseries are critical to improving the value chain for tomatoes as seedlings are increasingly being used by farmers as the main planting materials for tomatoes, rather than seeds. Nurseries act as key gatekeepers for the promotion of new improved varieties and for preventing early disease infections that can have a profound effect on later yields. Both districts have a relatively recent history of tomato growing and are representative of many other concentrated pockets of tomato production found across Maharashtra, Karnataka and Andhra Pradesh which are the major national suppliers of the crop particularly during the summer and rainy seasons. Understanding the strengths and limitations of the nursery systems in these two areas can provide good insights into improving the management of other tomato nurseries across southern India. They provide a contrast in how the local industries developed, how they deal with inputs and customers and the quality of their management.

Narayangaon is more advanced in terms of nursery management and commercial tomato cultivation practices, and the area of tomatoes grown and the average yields are about three times as high as in Kadur. However a wider range of varieties are provided and seedling costs are lower in Kadur, making them more accessible to a wider range of farmers.

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## METHODOLOGY

A selection of 18 nursery owners in Narayangaon were visited and interviewed and 20 in Kadur. The list of nurseries surveyed is given in Annexure 1. The nurseries in Narayangaon were selected with the help of Mr. Sagar Paymode and his father who lead an informal network of local nurseries. Interviews and site visits were conducted by Dr M. Ravishankar during May 2016, first in Narayangaon and then in Kadur. A snowball sampling method was used in which one nursery interviewed recommended the next. In Kadur Mr. Bharat Dattawade, an employee of the World Vegetable Center who knows the district well and has provided vegetable extension services to local farmers for the past two years assisted in finding and interviewing contacts. Dr Ravishankar conducted all interviews in Hindi in Narayangaon and was assisted by Mr. Dattawade with Kannada translations for about half of the interviews in Kadur.

In both locations the nurseries were randomly selected from across the whole geographical area to provide a representative sample. Locations of the nurseries interviewed are shown in Annexure 2. There are about 40-50 nurseries concentrated around Narayangaon, and the Dr Ravishankar sought the advice of Mr. Paymode in selecting 18 of these both personally known and unknown to him. Interviews were done in the main concentration of nurseries along the highway and in surrounding villages. In Kadur, it was necessary to travel up to 35km from the town to find small pockets of nurseries.

The first draft of the interview questions was developed by Mr. Ramesh Subramanian, author of the accompanying report on the Indian tomato processing study following his interviews with processors. Dr Ravishankar then reviewed these questions with a couple of nurserymen in Narayangaon, made modifications and came up with a final structured interview based on about 60 questions. Data were recorded on paper and then transferred to a spreadsheet for analysis in formulating the final report.

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## THE NURSERY SITUATION

### NARAYANGAON IN MAHARASHTRA

There has been rapid recent growth in the local nursery industry around Narayangaon about 80 km north of Pune and it now supplies most tomato farmers in the district. This nursery village is located in Junnar taluk of Pune district, and national highway 50 (NH-50) passes through it. Nurseries first began in the area about 12-15 years ago, and eight years ago there were only about 20-30% of the nurseries that currently exist. The average age of the businesses interviewed was three and a half years, with a couple operating for ten years, but most had opened in the last year or two. Three years ago a lot of nurseries were started in the village along the sides of NH50, and over the last year a lot of new operations have started in neighboring villages away from the highway to cater to local needs. Today 90% of local tomato farmers use the seedlings purchased from the nurseries, and some are transported to farmers as far as 200 km away.

Large scale tomato production in the district started in 1999 with improvements to water supplies and marketing. The availability of water during summer from a few nearby dams made it possible. In 2001, Agriculture Producers Marketing (APMC) started with an open auction system so that farmers obtained fair prices. This encouraged more farmers to cultivate tomato, and that in turn encouraged more entrepreneurs and farmers to start nursery businesses to meet the local demand for seedlings.

In Junnar taluk there are now 30-35 nurseries, and within the area there are about 40-50 nurseries within an area of about 10 km across. Only four or five of these obtained government subsidies to help them start. Most began by using their own capital or loaned money. Most of the structures used for growing seedlings are not permanent and are based on shade net.

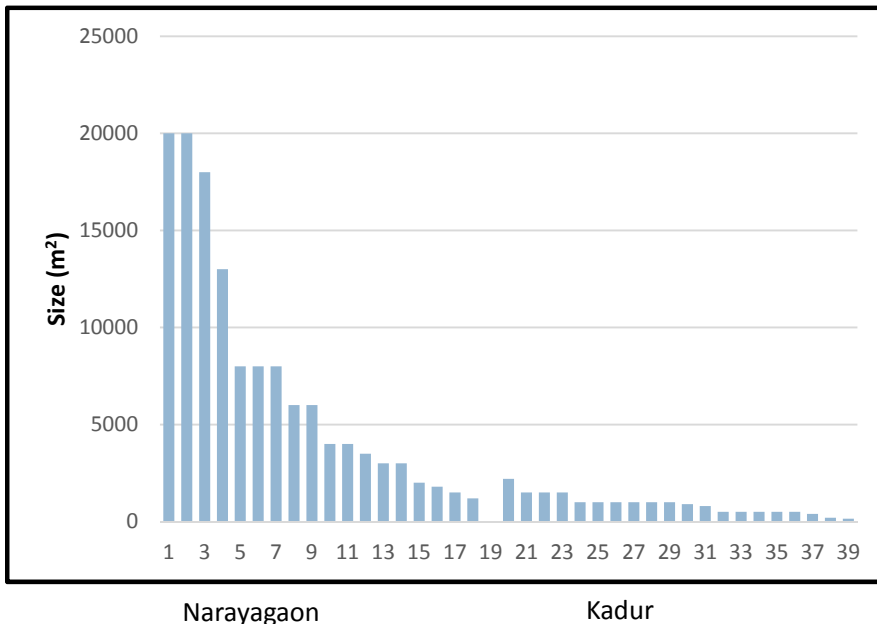
### KADUR IN KARNATAKA

Kadur block is in Chickmagalur district about 240 km west of Bengaluru. The districts around Bengaluru are famous for tomato production, so most of the tomato production input companies are located in this area and the price of inputs is lower than in many other regions. Most of the nurseries were established on the farmers' own land using government subsidies to build protective structures for the production of seedlings of various crops like tomato, chili, cabbage and capsicum. The average period of operation of the nurseries interviewed was four and a half years; a third had been operating for seven to ten years, and a third for a year or less. Tomato seedling production really began to take off in about 2009 and the nurseries involved are spread out over a large area, with pockets of nurseries up to 40 km from Kadur. Government subsidies for the production of polyhouses for seedling production have been instrumental to the growth of the local seedling industry. Farmers receive 50% subsidy for drip irrigation and polyhouses structures (both general category and SC, ST).

### NURSERY AREAS AND OWNERSHIP PATTERNS

The average nursery size in Narayangaon at 7300 m<sup>2</sup> (0.73 ha) and this is about eight times larger than the average in Kadur which is 880 m<sup>2</sup> (0.09ha). As Figure 1 below shows, in both locations there is a wide variation in the size of the nurseries.

**FIGURE 1: RELATIVE NURSERY SIZES AT THE TWO LOCATIONS**



In Narayangaon most of the nursery entrepreneurs started their nurseries with a small area, and added to it year by year as their confidence and experience grew and their incomes increased. About 40% of the current nurseries started in 2014, and expanded in 2015 and 2016. More than 50% of farmers run their business on leased land that is close to the highway, visible and easily approachable.

The situation is different in Kadur where the areas of the nurseries are much smaller compared to Narayangaon. A third had been running their businesses for seven to ten years, and a third for under a year. There had been less dynamic growth than in Narayangaon and 85% owned their own land rather than leasing. All but one interviewed had relied on State government subsidies for polyhouses to begin their operations, and so the size of the nurseries are small, but there are a lot of them. There are more than 150 nurseries in the surrounding area. However there has been little growth in their size over recent years. For all of those interviewed, the nursery was their secondary business after farming.

**PHOTO 1: POLYHOUSE STRUCTURES WITH SHADE NET ON SIDES**



## **STRUCTURES AND INVESTMENTS NEEDED**

In Narayangaon, most of the nurseries are polyhouses followed by shade nets. In Kadur the structures used are determined by subsidies. Old nurseries use a poly roof and sides supported by stone pillars or sides with shade nets. More recent subsidies are only for permanent structures made with GI pipes and all recent nurseries are of this types.

In Narayangaon it cost about INR 50,000 to build a 200 m<sup>2</sup> nursery and the annual investment in a nursery ranged from INR250,000 - 400,000. Most farmers started with areas from 500 – 1000 m<sup>2</sup> using simple shade nets and expanded gradually as profits and opportunities improved. Only a few nurseries started with a single big investment and area. For about two-thirds of growers, the nursery is their primary business and a third are doing other business including farming.

In Kadur the necessary capital investment to start a nursery averages INR 605,000 with a range of about INR 400,000 – 800,000 with subsidies. The cost of building a nursery is higher than in Narayangaon because farmers are relying on government subsidies to cover most of their costs, but subsidies are only available for polyhouses (50% of total cost), not for shade netting houses. Over 90% of those with nurseries are farmers and none rely on their nursery as their sole business. Most of the capital invested is their own, but is supported by subsidies.

Importantly, the emphasis amongst nurseries in both areas is to use shadenets and polyhouses as a means of shading, temperature and humidity control rather than to keep out insects. The resultant impact is a heavy use of pesticides as a control strategy to prevent insect damage.

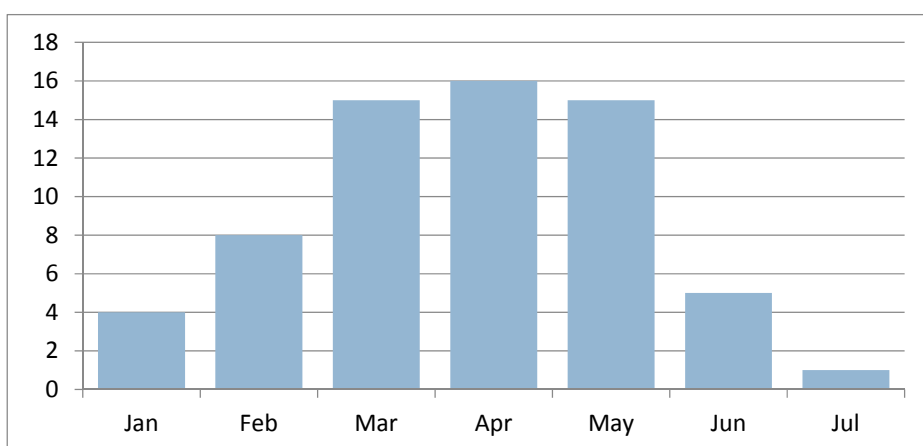


## SEEDLING PRODUCTION SYSTEMS

The peak seedling production season for both locations is in March, April and May when about 80-85% of tomato seedlings are produced, but the overall production season is longer in Narayangaon than in Kadur. In Narayangaon, most fresh tomatoes are sold between June to September when traders come to APMC as there is low production coming from other states and local farmers get premium prices.

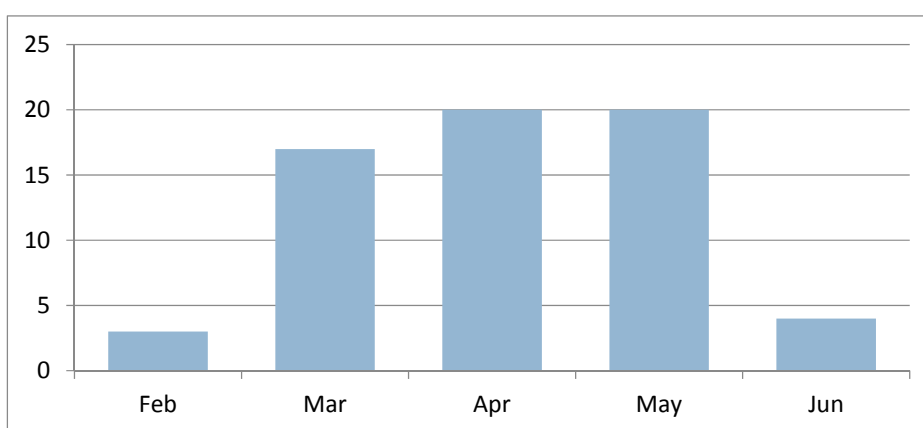
The busiest times for the nurseries is from January until the end of July, with the peak from March to May to supply a range of planting times. They also produce a small quantity of off-season tomato seedlings for planting in November and December. The few crops planted at this time are mainly for local tomato sales. As winter is a peak production time for other states, little is exported and prices depend on local market demands.

FIGURE 2: MAIN SEEDLING PRODUCTION SEASON IN NARAYANGAON



The peak season in Kadur is the same but the overall season is shorter than at Narayangaon, starting in February and finishing in June.

FIGURE 3: MAIN SEEDLING PRODUCTION SEASON IN KADUR



### CROP SEEDLINGS PRODUCED

The nurseries do not just grow tomato seedlings, but this is the main crop in both locations. Tomato accounts for about 70% of all seedlings produced across both locations, but cabbage and cauliflower, chili, eggplant and marigold are also important crops grown.

In Narayangaon, nurseries produce a variety of crops, but in about two-thirds of nurseries the most common crop is tomato. In the remaining third, marigold and cauliflower are the most important crops. In 2015, 34.5 million tomato seedlings were produced by those interviewed. The most popular secondary crop is cauliflower grown by half of the nurseries, followed by tomato and chili.

In Kadur, a wider mix of seedling crops are grown. The most popular seedlings grown are equally shared by tomato and cabbage, and last year tomato accounted for 12.5 million of the 31 million seedlings produced by those interviewed. The second most popular seedling crops are chili and tomato and the third most popular crops are cabbage or chili. With a large number of small nurseries in the region, and being located close to the large vegetable growing areas around Bangalore, there is more competition in the nursery industry in Kadur and they need to diversify the crops they grow in order to survive.

### VARIETIES

In Narayangaon a series of popular varieties have dominated the production of seedlings, but when farmer preferences suddenly change this can be to the nurseries' disadvantage. Two years ago Syngenta's Abhinav variety accounted for 90% of tomato seedlings grown in Narayangaon. It has resistance to tomato leaf curl disease and is oval in shape, firm, and is suitable for transporting over long distances. But when there were production problems with the crop, it quickly fell out of favor, the total area declined and farmers demanded a better variety.

Syngenta recently released the variety 1057 as a replacement and it performed very well in 2015. Farmers were interested in it and most nurseries raised 1057 either booked by farmers or for walk-in sales. But a water shortage caused many farmers to stop growing tomatoes and an alleged Tospo wilt problem with the variety caused farmers to change their minds and ask for other varieties. This caused large scale wastage of 1057 seedlings by nurseries.

Although a complete estimate of seedlings lost by all nurseries could not be obtained, based on the sample surveyed, approximately 3.65 million seedlings were destroyed due to over-production of this variety. This equals a loss to local nurseries of INR 3.65 million. Roughly 34.5 million tomato seedlings were produced from these 16 nurseries in 2015 so this loss due to a change in farmer preferences led to the destruction of about ten percent of annual production.



PHOTO 2: TWO POPULAR TOMATO HYBRIDS GROWN IN NARAYANGAON

In Kadur a wider diversity of varieties is grown. The varieties JKTH-811 was regarded as the top seller by half the nurseries interviewed, and Syngenta 1057 as the top seller by a third of the nurseries. But there were ten varieties mentioned by the nurseries as one of their top three sellers as compared to six in Narayangaon.

### HOW NEW VARIETIES ARE INTRODUCED

New varieties are first introduced through demonstration plots by a seed company or a nursery in farmers' fields. The new variety will then be widely promoted through a field day on site. Local seed retailers sell sample seed packs in the first year at artificially inflated prices (typically INR1400/10 g seed pack with a printed sale price of only INR1000) to give the impression of high local demand, to help to promote the variety.

A general belief has been encouraged that the cost of seeds is directionally proportional to their quality which is in the interests of seed resellers. Farmers are encouraged to believe everyone else is using this variety and this helps to promote adoption. This promotion of a herd mentality can work both ways as farmers can also drop varieties just as quickly based on rumor as they may adopt them. In Kadur there is more competition in the market for inputs including seed, so there are more opportunities to counter rumors and provide alternatives. A wider range of varieties are promoted than in Narayangaon where information passed from farmer to farmer appears to have more impact in the market.

### NURSERY MEDIA USED

The main media used is composted coco peat, and a range of companies supply it. Prakruti provides half the total, Lakshmi Nurshinga, about 40% and others make up the remaining 10%. Bio fertilizers or bio pesticide like Trichoderma are very rarely mixed into the media. About three quarters of the nurseries surveyed in Narayangaon are not using any treatment of their media and about a quarter are using Trichoderma and occasionally fungicides. However, in Kadur, none of the nurseries are using any pretreatment of their planting media.

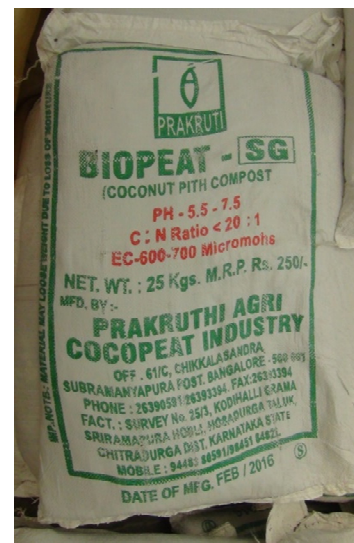


PHOTO 3: MEDIA USED IN NURSERIES

## TRAYS

In Narayangaon, three types of trays are popular; those with 104, 102 and 70 holes. The 104 and 102 hole trays are used for seedling production in the rainy season and the 102 and 70 hole trays during main season. About 65% of farmers prefer to use the 102 hole trays during the main season. Other types are used based on the local demand.

The cost of the trays is shown below.

S. No	Type/Number of holes	Cost (INR.)
1	70 holes	7.50
2	102 holes	7.50
3	104 holes	5

The trays are manufactured locally and old trays are collected from the farmers for Rs.5-6 per kg and recycled. While trays recycled from farms are cleaned, nurseries re-use trays of unsold seedlings without any sterilization treatment. In Kadur, only 98 hole trays are used. These trays are different from those in Narayangaon, being more sturdy and costly at INR 10/tray so nurseries prefer to get their trays back and recycle them.

## FERTILIZERS

In Narayangaon, fertilizers are applied either by spray or drenching. The most common fertilizers used are: 19:19:19 NPK, 00:12:61 NPK,13:45:13 and 00:52:34. Some used to mix in micronutrients.

In Kadur, 19:19:19 NPK and DAP are more common.

## THE PROCESS OF SOWING AND RAISING SEEDLINGS PRIOR TO DISPATCH

Seedlings of tomato are ready to sell in 22-23 days. So including two days of hardening the seedlings are ready to dispatch in 25 days, but if grown in 70 cavity trays they will take 25-30 days. It normally takes three days to germinate in summer and 6-7 days during winter. The seedling trays are gently and loosely filled with the moistened media and pressed with another filled tray to create the space needed for seed sowing. After sowing, the tray is filled with media to lightly cover the seeds. Trays full of sown seed are then stacked one upon another and covered in black polythene for three to four days to increase the temperature to accelerate the germination. The trays are then separated and individually irrigated by showering for 17-18 days depending on the nursery. Finally, the seedlings will be kept outside for 2-3 days for hardening. In total it will take about 25 days for sowing to the final dispatch of seedlings.

PHOTO 4: TOMATO SEED SOWING IN TRAYS



In Narayangaon, there are three different types of practices followed:

1. The seeds are sown and the trays are kept directly on a weed mat.
2. After sowing the seeds, about 10-15 trays are stacked together for 3 days for the seed to germinate. Some cover them with polythene to increase temperatures to improve the germination of the seeds. Once the sprouting of seeds has started, the trays are separated and placed on the weed mat.
3. Seeds are sown densely in the coco peat and the blocks. After 5-7 days at the two cotyledon and one true leaf stage, the seedlings are gently uprooted and root pruning is done. Then the seedlings are transplanted into trays. This treatment saves time, produces healthy seedlings and more trays can be used in a small space.

In Kadur, there is not much diversity in nursery practices. Almost all are the same without any innovation and most follow practice 2 shown above, by stacking trays under polythene once seed is sown, and then separating them and placing them on weed mats once seed have germinated.

In Narayangaon the tomato seedlings are generally kept outside to harden for 2-3 days if grown under shade nets, and 5-7 days if grown under polyhouses before dispatch, whereas in Kadur hardening is the responsibility of the buyer, and seedlings are kept on-farm by the buyer for hardening after delivery from the nursery.

#### **FUNGICIDE AND PESTICIDE USE**

Fungicides are used to control damping off and other leaf diseases. Some have routine application and some as need based application. There is regular use of pesticides without any rotation. The pesticides used are for leafminer and whitefly as they are readily visible. None of the nurseries have tried to control thrips which are present in almost all nurseries. Pesticides are applied by spraying or drenching on a weekly basis. Many nurseries feel that leaf miner is showing pesticide resistance.





**PHOTO 5: WHITE FLY INSIDE NURSERY**



**PHOTO 6: SUCKING PESTS LIKE APHIDS FOUND INSIDE NURSERY ON WEED HOSTS**



**PHOTO 7: LEAF MINER INCIDENCE IN NURSERY**



**PHOTO 8: MEALY BUG INFESTED SEEDLINGS BESIDE NEWLY GERMINATED SEEDLINGS**

### **WATER SOURCES**

In Narayangaon, the main source of water is from wells or bores, but a few nurseries are drawing water from lakes, a river and dams. Only few checked the water quality for physical and chemical parameters (EC, pH, salt etc.), and all watering is done by showering.

In Kadur, most of the water used is from bore wells, and there are lots of problems in producing seedlings as the water contains appreciable amounts of salt.

## TRANSPORT

Transport arrangements for seedlings are very different between the two sites. In Narayangaon, the seedlings in their trays are placed in nursery crates about 25 to 40 cm in height to protect the plants during transport, and shipped in small trucks or other vehicles depending on the size of the consignment. The transport cost is usually borne by the nursery. If the distance exceeds 50 km, then there is a 50:50 cost-sharing between the nursery and the farmer. Generally, the seedlings will be taken by the nursery to surrounding villages at a distance of about 4-5 km free of transport costs. The cost of transport is about 10 paisa per seedling. In Kadur, the cost of seedling transport is borne by the farmer who purchases the seedlings and not the nursery. The trays are folded in a circular manner and stacked in the tempo, and transported.



PHOTO 9: MINI-TRUCKS USED TO TRANSPORT SEEDLINGS

## STRATEGIES TO ATTRACT CUSTOMERS

In Narayangaon, many of the nurseries' staff visit farmers' plots to maintain good relations with their customers and to give technical support or advice if needed. They believe that providing good quality seedlings over time will attract more farmers. However, in Kadur the nurseries rarely make any visits to their farmer customers.



PHOTO 10: TRANSPORTATION OF SEEDLINGS IN KADUR

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## **ECONOMICS**

### **NURSERY MANAGEMENT**

In Narayangaon, only the big nurseries have managers to maintain their field operations, while the owners handle customer relations. A few big nurseries also have quality control managers. None of the nurseries are maintaining formal accounts, but just records of orders for seedlings and a register of seedlings coming in and going out. In Kadur, most of the nurseries are run very simply as home businesses without any managers. Labor may be engaged to support family labor.

### **OPPORTUNITIES FOR SELLING SEEDLINGS, AND FARMERS' PURCHASING METHODS**

There is a ready market for seedlings in both locations as tomato farmers either have no time to produce them as they are handling many other crops, or they have no experience in growing seedlings in trays. Farmers in both locations are aware of the advantages of seedlings produced from trays and the negative aspects of growing a nursery in soil. They also see the advantages as time saving, access to healthy seedlings, and less plant mortality after transplanting especially if they are also using plastic mulching. The main difference in farmer knowledge between the two sites appears to be that the farmers in Narayangaon are more informed about varietal performances than those in Kadur.

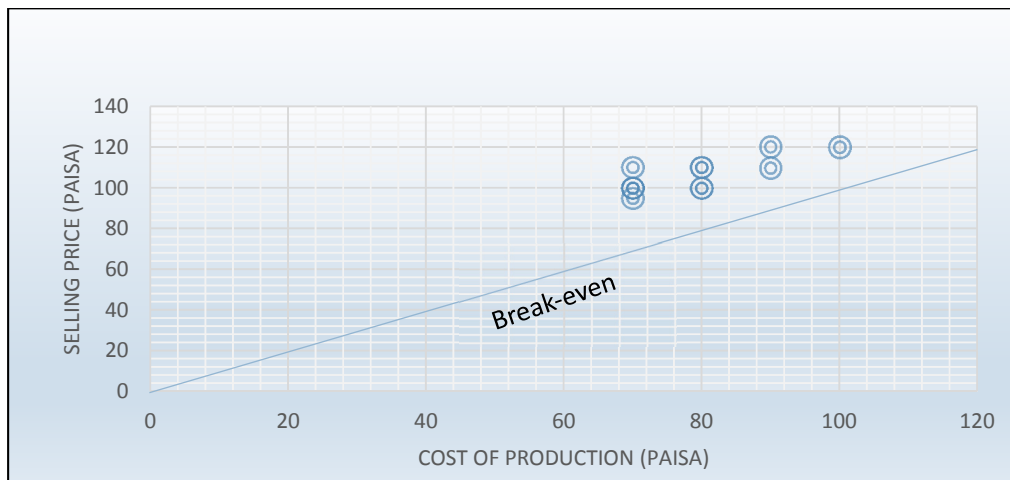
In Narayangaon, approximately 70 percent of tomato farmers book their seedlings in advance during the main production season, and 30 percent purchase them without any pre booking. During the off season there are generally no bookings for seedling purchases. In Kadur, only 10 percent of the seedlings produced are pre-booked, and 90% are purchased by direct visits of farmers to a nursery. Often, this results in overproduction, impacts on seedling price and causes high wastage of seedlings. The seeds are purchased from the seed dealers by the nurseries and not by the farmers. This may reduce the cost by purchasing in bulk, and reduce seed wastage.

### **COSTS OF PRODUCTION AND PROFIT MARGINS**

In Narayangaon, seedlings can be produced for 50-70 paisa each and these sell for 90-130 paisa. The variation in selling price is because of the variety (related to the cost of seeds) and the type of tray used. Nurseries claimed that the profit margin is decreasing each year due to static sale prices for seedlings, increasing competition and increases in the costs of inputs such as seeds and coco peat. For more than half the nurseries surveyed the production cost is 70 paisa and the selling price is 100 paisa per seedling (Figure 4).



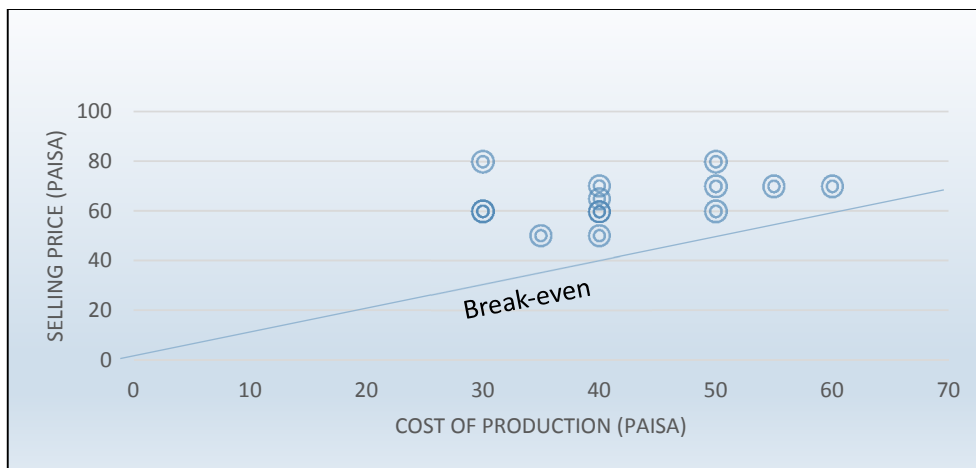
**FIGURE 4: MARGIN PER SEEDLING - NARAYANGAON (2016)**



Three quarters of the nurseries are able to make a margin of 20 paISA per seedling after deducting the cost of transport of the seedlings which comes to approximately 10 paISA per seedling. Most farmers (70-80 %) are purchasing their seedlings using immediate cash payments, although a few are provided with credit for up to a week or for months.

In Kadur the production cost is lower due to lower input costs. The production cost ranges from 30 to 60 paISA per seedling and the selling price ranges from 60 to 80 paISA, giving a margin of 10-30 paISA per seedling.

**FIGURE 5: MARGIN PER SEEDLING - KADUR (2016)**



**VIEW OF EXISTING NURSERY OWNERS ON NEW ENTREPRENEURS STARTING NURSERIES**

In Narayangaon, there were very mixed responses to questions about the prospects for new entrants into the industry. About 39 percent believed that new nurseries had good potential, but cautioned about the effect of increased competition especially over the last three years. About 28 percent believed it would not be wise to start a new nursery business as it might not be profitable, while about a third had mixed views. In Kadur, most existing nurseries believed that new nurseries were likely to be profitable.

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## PROBLEM RECOGNITION

### TRAINING IN PRODUCTION TECHNOLOGY

In both the locations no specific trainings had been received by those who started nurseries and only about 20% claimed to have any knowledge about the industry before starting. Most learned from their neighbors, or with the support of other experienced persons. None received any formal training. They learned on the job and by seeing others. There is a huge technology awareness gap as a result.

### PROBLEMS RECOGNIZED BY NURSERIES

Most of the nurseries in both locations believed they faced no major problems. Almost all mentioned the recent issues of more field diseases in the variety 1057, and a loss of farmer confidence in this variety resulting in mass destruction of unsold seedlings. Few also indicated poor germination of the seeds as an issue and diseases in seedlings during the rainy season. Other issues are increasing labor costs, reduced margins due to competition, farmers not turning up after booking the seedlings due to unexpected droughts, and late pickup of seedlings by farmers increasing the maintenance cost to nurseries. So most of the issues they raised were seen to be the result of external factors.

### PROBLEMS RECOGNIZED DURING THE STUDY

During interviews and visits to the nurseries a wide range of production problems were noticed by Dr Ravishankar that could be readily rectified with appropriate training. In some cases, the effect on the quality of seedlings was obvious to the nurseries, but a solution may not have been. In other cases, the effect on quality would have been felt by the farmer, by which time it could be difficult to pinpoint the cause as poor seedling management, rather than poor crop management on-farm. There is a need to make all players aware of these opportunities to improve production and the quality of seedlings for the overall good of their industry. A summary of issues arising and recommendations is provided below. Photographs taken from the two locations and reflecting the issues highlighted in this table are also attached.

No.	Particulars	Narayangaon	Kadur	Recommendation
1	Doors	None of the nurseries have double doors.	Except for one, all nurseries have a single door.	It is advised to have a double door system to prevent the entry of insect pests and viral vectors.
2	Closing of the door	The concept is completely missing. The closure of the doors is to protect the seedlings if nobody is there.	The concept is completely missing. The closure of the doors is to protect the seedlings if nobody is there.	Awareness needs to be created to close the door to prevent insect entry.

No.	Particulars	Narayangaon	Kadur	Recommendation
3	Holes	All nurseries have holes/spaces for entry of insects apart from open doors.	All nurseries have holes/spaces for entry of insects apart from open doors.	Awareness need to be created to repair the holes, and wear and tear immediately.
4	Weed mat	Only few nurseries are using proper weed mat, which will allow excess water to drain. Others use polythene.	Most of the nurseries use polythene as weed mat. Some do not allow water to drain creating damping off and root damage.	Advise to use proper weed mats and proper education needs to be given on their use.
5	Quality of water	Water quality in not much of a problem as the source is from the dam water or reasonable quality bores or wells.	Most of them are using water from bore wells that contains appreciable levels of salt that damages the seedlings.	Water pH, EC and TDS need to be tested and appropriate actions need to be taken to reduce the negative effects of poor quality water.
6	Quality of media	Most of them are using composted coco peat as media and few are using un-composted media. The un-composted media produces more root damage.	Most of them are using composted coco peat as media and few are using un-composted. The un-composted media produces more root damage.	Media quality needs to be tested.
7	Pest infestation	The seedlings of all the nurseries showed white fly and thrips damage symptoms despite regular spraying of pesticides.	The seedlings of all the nurseries showed white fly and thrips damage symptoms despite regular spraying of chemical pesticides.	Using whitefly proof netting and yellow sticky traps inside the nursery. Rotate the use of chemical pesticides or use biopesticidal alternatives
8	Disease infestation	Damping off of seedlings observed in only a few nurseries.	Damping off of seedlings was observed in many nurseries.	Proper drainage holes need to be made in the trays, and uniform watering applied especially in the mornings.
9	Nutrient deficiencies	A few nurseries show nutrient deficiencies.	Most of the nurseries show nutrient deficiencies.	Proper EC and pH needs to be maintained. Use of good quality water (Low TDS) with proper drainage.

No	Particulars	Narayangaon	Kadur	Recommendation
10	Hardening	Most nurseries keep the seedlings outside protected structures enabling pest infestation and viral diseases.	Most of them kept seedlings inside the protected structures during the hardening process.	Hardening needs to be done in semi protected conditions to prevent whitefly and viral infestations.
11	Protection	Most of the nurseries are not using insect proof netting.	A few of the nurseries are using insect proof nets, but all the nurseries have holes which nullify the benefits of using such netting.	A double door system is needed and awareness of closing the doors. Use of insect proof nets to prevent pest entry, and repairing wear and tear when noticed. Neem spray on the structures can deter the entry of pests through the structures.
12	Watering	A few nurseries are over watering resulted in damping off.	Many nurseries are overwatering with poor quality water resulting in root damage and damping off.	Uniform watering just for saturation of the media and watering in the morning hours.
13	Fertilizers	Most nurseries use liquid fertilizers based on the need. There may be over accumulation of fertilizers in the media causing root damage.	Limited use of liquid fertilizers.	Misapplication of fertilizers is mostly due to improper management of media EC and pH, over-watering, and leaching. Using a media of Coco peat: Perlite: Vermiculite in a ratio of 3:1:1 will provide a good amount of nutrients, reducing the need for foliar application of fertilizers.
14	Pesticides	Most nurseries use a few insecticides without any rotation causing pest resistance in nursery itself.	Most nurseries use a few insecticides without any rotation causing pest resistance in nursery itself.	Use of pesticide rotations, or sequences of different insecticides.
15	Chemical application	Most spraying is done without any protective clothes and while laborers are working inside the structures, putting all staff at risk.	Most spraying is done without any protective clothes and while laborers are working inside the structures, putting all staff at risk.	Spraying should be done in the evening after the laborers have left, to allowing time to reduce any chemical vapors present inside the nursery. The person should wear proper protective clothing (mask, jacket) while spraying.

Associated Photographs from the two locations are provided below.



**PHOTO 11: HOLES IN SHADE NET**



**PHOTO 12: NURSERY DOORS USUALLY LEFT OPEN**



**PHOTO 13: HARDENING OF SEEDLINGS OUTSIDE NURSERY**



**PHOTO 14: HARDENING OF SEEDLINGS OUTSIDE NURSERY WITH DOORS OPEN**



**PHOTO 15: STAKING AND COVERING OF SEED SOWN TRAYS TO INCREASE GERMINATION**



**PHOTO 16: TOMATO CROP GROWING OUTSIDE NURSERY WITH DOOR OPEN**





**PHOTO 17: HARDENING WITHOUT PROTECTION**



**PHOTO 18: YELLOW STICKY TRAPS – FEW INSTALLED IN NURSERIES VISITED**



**PHOTO 19: INFREQUENT WATERING RESULTING IN DRYING OF SEEDLINGS**



**PHOTO 20: OVER-WATERING AND POOR DRAINAGE**



**PHOTO 21: OVER-WATERING OF SEEDLINGS**



**PHOTO 22: PESTICIDE APPLICATION WITHOUT PROTECTIVE CLOTHING**





**PHOTO 23: FEW DRAINAGE HOLES IN TRAYS**



**PHOTO 24: MAGNESIUM DEFICIENCY IN KADUR DUE TO POOR WATERING AND MEDIA**



**PHOTO 25: CASUAL HANDLING OF SEEDLINGS CAUSING DAMAGE**



**PHOTO 26: SEEDLING HANDLING FACILITIES WITHIN NURSERY RARELY USED**



**PHOTO 27: CRATES USED FOR TRANSPORTING SEEDLINGS IN NARAYANGAON**



**PHOTO 28: GAPS UNDER DOOR AND SIDES AND SURROUNDED BY WEEDS**



**PHOTO 29: DUMPING OF UNSOLD SEEDLINGS JUST OUTSIDE NURSERY**



**PHOTO 30: DISCARDED AND UNUSED SEEDLINGS INSIDE NURSERY**



**PHOTO 31: UNEVEN SEEDLING GROWTH DUE TO PENETRATION OF ROOTS THROUGH TRAYS AND WET MAT INTO SOIL**



**PHOTO 32: POOR PLANT STAND DUE TO OVER-WATERING AND POOR DRAINAGE**



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## CONCLUSIONS

This study of two tomato-growing areas in Maharashtra and Karnataka showed both the differences in how nursery industries could develop as a result of local circumstances and government policies, but also the common needs across both locations.

Nurseries will continue to grow in importance as a source of planting materials for tomato farmers for reasons of convenience, time and cost-saving. How the seedlings are handled can have a profound effect on their later susceptibility to disease, and their ability to respond well to nutrient and water supplies. India's average tomato yields are well below those of many other major producers and producing healthy seedlings is an important component of improving yields.

Nurseries also act as major gatekeepers in helping to promote new varieties. So far the main focus of farmers has been on the fresh market, and seeking higher prices to fit in with the off-season for other producing districts. If the processing industry is to expand through the use of new varieties, it will be primarily through the nurseries that they are made available to farmers.

Virus diseases are growing in importance as major sources of crop loss in tomatoes across India. In the study sites this has led to rapid changes in farmer preference for one variety over another with rumors of susceptibility spreading quickly. Excluding virus-transmitting insects from the seedling growing environment is very important. Tomatoes can often cope with a late virus infection in the field with little yield loss, but early infections in the seedling stage which may not even be obvious at the time of purchase can be devastating.

Rapid early root growth can also help seedlings get better established. The use of appropriate media, good watering, pest control and fertilizing practices can have a big impact on helping plants to get rapidly established after transplanting and to produce good yields.

This study showed that nursery owners did not receive any technical training and are entirely self-taught. Most do not recognize the technical problems that are constraining their productivity and could be leading to major production problems for their farmer customers. These are important to overcome to enhance the profitability of the industry both for fulltime and part-time operators.

A training program for both nursery owners and their customers is recommended to help them recognize the benefits to all of a few simple changes in practices. These could include:

### **1. How to manage virus infections**

- How viruses are spread and the importance of preventing early infections
- Simple methods for preventing insect entry – doors, repairs
- Insecticides and other IPM alternatives including the use of Yellow Sticky and Pheromone Traps
- Hardening off methods

### **2. Water, nutrient and media management**

- How to recognize water and nutrient problems and deal with them
- Selecting the right planting media
- How to do your own experiments to improve production

### **3. Nursery management and marketing practices**

- Simple bookkeeping systems to track profitability
- Selecting and promoting varieties
- Managing bookings and deliveries

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## ANNEXURES

### ANNEXURE 1: LIST OF NURSERY OWNERS SURVEYED

S.No.	Name of Respondent	Name of the Nursery
	<b>Location: Kadur</b>	
1	Srikant	Thottada Siddeswara Hitech Nursery
2	Vijayan	Pushpagiri Hitech Nursery
3	Ranganath	Ranganath Hitech Nursery
4	Chikanna	Renukamba Hitech Nursery
5	Pradeep	Gurusidda Rameswara Hitech Nursery
6	Raju	Paviputra Hitech Nursery
7	Manu	Manu Hitech Nursery
8	Jaykumar	Jevukallu siddeswar Hitech Nursery
9	Siddigouda	Rameswara Hitech Nursery
10	Clonnaxidregouda MR	Hulikalluveera Badeshwar Hightech Nursery
11	Mallikarjun	Doaru Hitech Nursery
12	Pavish	Ganavi Hitech Nursery
13	Satish MB	Chandu Hitech Nursery
14	ShivSwami	Rudresh Hitech Nursery
15	Naveen	Maruthi Hitech Nursery
16	Satish	Satish Hitech Nursery
17	Umeshappa	Priti Hitech Nursery
18	Mahalingappa	Dosaveswari Hitech Nursery
19	Umesh	Vinayak Hitech Nursery
20	Krishnappa	Viswanath Hitech Nursery
	<b>Location: Narayangaon</b>	
21	Amul Deshmukh	Malshej Hitech Nursery
22	Devduddd Dumbre	Sreenath Hitech Nursery
23	Hanumanh Dhamale	NA
24	Harish Chandra Paymore	Krushidhan Hitech Nursery

25	Satish_Manager	Adivinayak Hitech Nursery
26	Ramdas Bhalerao	Ganesh Hitech Nursery
27	Ashok Bhelakar	Srinath Hitech Nursery
28	Gautam Sonavane	Vikas Hitech Nursery
29	Mahendra Jaitap	Alfa Hitech Nursery
30	Srikant More	Pratik Hitech Nursery
31	Sandeep Shete	Shri Krishna Hitech Nursery
32	Vilas Bidger	Muktai Ropvatika
33	Rajesh Shivaji Goudae	Gowdae Patil Hitech Nursery
34	Prasanth_Manager	Mauli Hitech Nursery
35	Chirag Korhale	Yasodha Hitech Nursery
36	Hemavati Kakade	Vignahar Ropvatika
37	Pankaj Wajhule	Shetkre Nursery
38	Mahah Kandare	Kulsami Ropvatika

ANNEXURE 2: SURVEY LOCATIONS IN NARAYANGAON AND KADUR

**Survey Locations in Narayangaon, Maharashtra**



**Survey Locations in Kadur, Karnataka**

