Healthy Seedling Production

Training course guide

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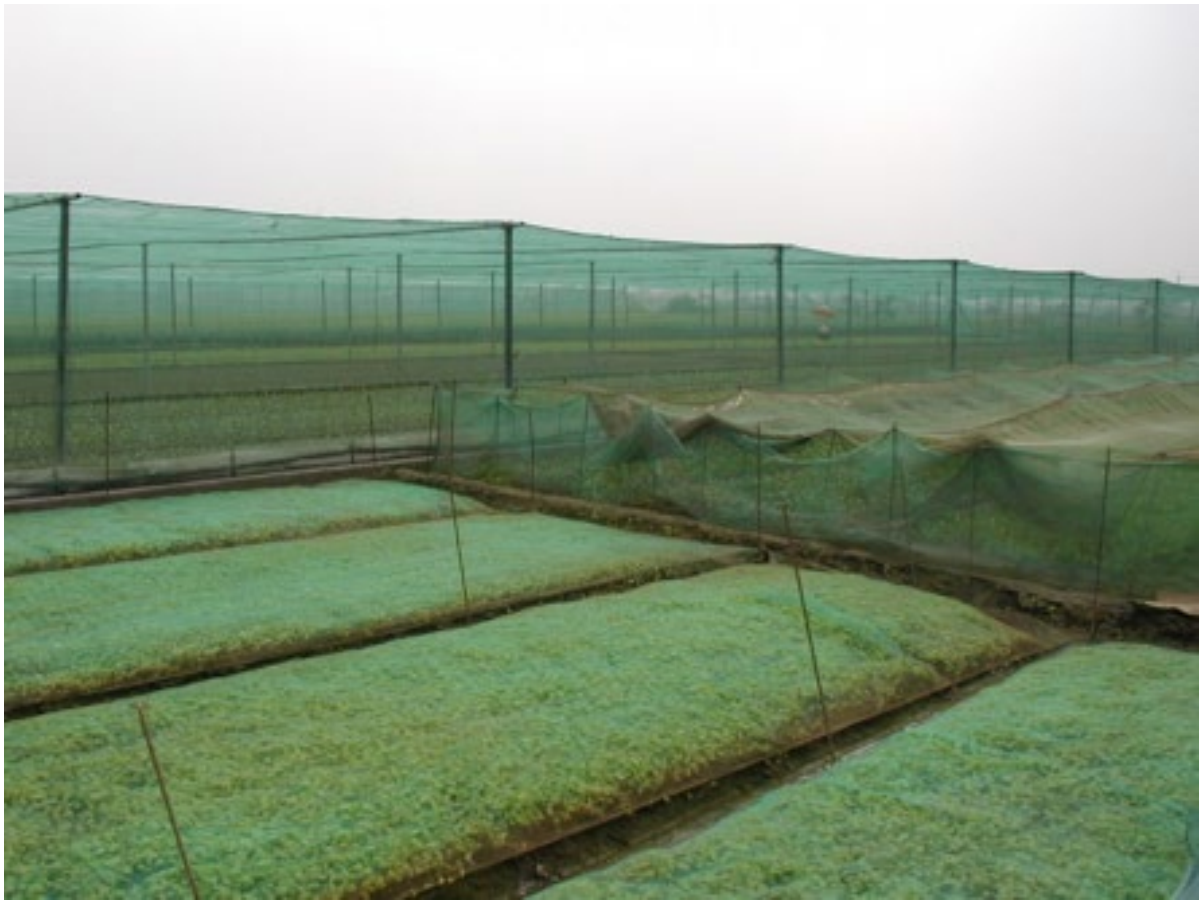
INTRODUCTION

The production of good quality vegetable seedlings is essential for improving yields and getting quality produce. In most advanced countries vegetable seedling production is undertaken by specialized companies or as a specialized activity.

In India, the vegetable seedling production system is gradually changing from open field nurseries to production in protected raised beds or seedling trays, and specialised seedling production industries are taking off in some intensive vegetable growing areas.

At present, vegetable yields per unit area are generally very low. One of the reasons for low yields is the lack of available quality seed of high yielding varieties.

Much vegetable seed available in the market is uncertified and of inferior quality, and growers can be at the mercy of seed merchants or dealers. The moment seeds germinate, they need extra attention. It's just like raising children. In this manual we will learn how to care for seedlings so they grow up to be healthy plants.



Nursery under net house

A FRAMEWORK FOR TRAINING:

Purpose of this training package:
To provide practical technical skills and support for teaching by extension workers and community workers.

Participants for the training course:
Agriculture extension workers, field staff, seed company staff, NGOs and community development workers, who propose to train farmers.

Resource personnel:
Scientists from national and international research and extension institutes, leading seed companies, progressive and innovative farmers, who can apply the principles of adult learning.

Training approaches to be used:
The approach should include both classroom and field oriented hands-on sessions, with the majority being in the nursery field. The manual has suggestions and directions on how to conduct each session. Hands-on experience has to be provided to trainees through practical classes.

Duration of the training course:
Ideally a full two to three working days will be required with field visits to a nearby nursery for practical experience. However, the number of days required can be varied depending on the need.

Materials needed:
The training package contains a number of relevant technical bulletins and information sheets, as well as survey forms for use by the trainers. This package will help trainees when they actually go to the villages for training farmers. Ideally the trainees should also develop training packages in local languages to complement this training program

Monitoring and Feedback mechanism:
Feedback can be obtained from the participants immediately after the training program to help improve the next activities. A structured format with relevant points to evaluate the program can be sent to the trainees two or three months after its completion. This will help to refine approaches for future courses.

PRODUCING GOOD SEEDLINGS: HOME GROWN OR BOUGHT?

• The production of good quality vegetable seedlings is essential for optimizing crop growth and yields.
• High quality vegetable seeds are expensive, so buying the plants needed as seedlings can ensure that less seed is wasted. Buying seedlings instead of seeds can also give the vegetable grower a few weeks' advantage over crops that are started as seeds in the field. This earlier maturity can help in gaining higher prices and the extra effort and cost to grow, or purchase good seedlings is usually cost effective.
• Transplanting young seedlings into the field establishes the desired plant population in one operation.
• Where there are no commercial seedling production enterprises operating, growers have no option but to grow their own. This takes extra time and effort, but the main advantage of home-grown seedlings is that a grower can be sure of the soil and variety used and can have better control the dates of seeding and transplanting.
• However, in many cases the time and effort involved means that there will be increasing opportunities for commercial nurseries to meet the growing demand for vegetable seedlings.

Tomato seedlings

GROWING IN THE OPEN OR UNDER COVER?

If farmers decide to produce their own seedlings, the next step will be to choose where to raise them.

Outdoor Production:

• The easiest and cheapest way of producing seedlings is in a selected area in the ground. This is the traditional method, but exposes the plants to weather damage and early disease infections.

• If this system must be used, choose a location that is shielded from hot and cold winds, and has easy access to a dependable supply of water.

• It should be well drained to avoid waterlogged seedbeds, and the soil should be as free of weeds, insects, nematodes and diseases as possible.

This method has some disadvantages.
• The risk of seedling mortality due to exposure to pests and diseases and adverse weather conditions.

• Mechanical damage to the root system and shock when the seedlings are directly pulled from the soil.

• When the nursery is located far from the main field, the time taken between uprooting and transplanting of the seedlings may result in a lower rate of survival.

Considering the problems of seedling production under open field conditions, it is better to grow seedlings for commercial cultivation in a nursery under protective cover.

Over the last two decades nursery growers have become much more aware of the value of producing healthy seedlings in closed structures. However home gardeners find it easier to use seed bed/plug trays in an open nursery in a shady place to cut down on the cost of seedlings.

Growing seedlings in open land on raised beds

Production under protective shelters:

• Tomato seedlings can be raised in facilities ranging from simple shelters to sophisticated greenhouses. All structures should protect seedlings from heavy rainfall, low (≤ 5 °C) or high (≥ 35 °C) temperatures, intense sunlight, high relative humidity, and exposure to pests and diseases [3].

• Moderately simple net houses or net tunnels covered with 50- to 60-mesh nylon netting are recommended to prevent insect pests such as whiteflies and aphids from transmitting viruses to young tomato plants. If 50-60 mesh is not available, even 32-mesh netting will also prevent many pests from entering [3].

•Tomato seeds germinate best in the dark. After sowing, shade netting (50% light penetration) can be used to cover the tunnels, or it can be placed inside the net house under the plastic sheet to enhance seed germination. In the wet season, plastic sheets can be used to cover the tunnels to protect seedlings from rain [3].

Shade net house nursery

Shade netting on tunnels

Net house:

• A net house needs to be supported either by a wooden, stone or steel framework. Wooden frameworks have the advantage of being cheaper, but do not last as long as stone or steel frames. In southern India, granite pillars can be cheaper than a steel framework, with an approximate cost of INR 250 per m^2 of net house supported.

• Granite pillars are usually 3 m x 15 cm x 10cm in size and spaced at 5m x 5m intervals and cemented into foundations 60 cm deep. Those around the periphery of the net house should be tied to a peg stone using guy wire to provide additional support.

• The height of the structure should be 2.4 m. On top of each stone pillar, a used rubber inner tube is tied so that the sharp edges of the pillars do not damage the nylon mesh or shade nets.

• Normally farmers cover the sides with 60 mesh UV stabilized nylon insect proof net and the top with 50% UV stabilized HDPE shade net as well as the 60 mesh UV stabilized nylon insect proof net.

Nursery under a net house on granite pillars

Low tunnels:

• Low tunnels made of netting are the cheapest form of seedling protection. However they do not provide as convenient access as large walk-in net houses.

• Using 1 cm wide iron or aluminium bars, make them into inverted, "U" shapes 2 m wide and 1 m high over each bench or raised bed. Maintain a distance of 1 m between two adjacent bars within the row. [1]

• Place 60-mesh nylon net over the bar from one end of the row to the other. Pull the net tightly over the bars from all four sides and bury 10-15 cm of net edging in the soil. (any size up to 32 mesh can be used if 60-mesh net is not available).[1]

• Make sure there are no gaps between the soil and the net, as these gaps allow insects to get in.

Production of seedlings under low tunnels

GROWING IN A HEALTHY MEDIUM

The traditional method of raising seedlings was to sow them in soil in raised beds for better drainage. There is a shift towards using pro-trays because they can be easier to manage and more reliably produce healthy seedlings. However, if farmers are still using the seed bed method of nursery raising, certain good practices have to be adopted to produce healthy seedlings.

Using a Seedbed:

• To raise healthy seedlings in a seedbed, set aside a small area in the field that is sunny with good drainage and apply soil treatments to minimize soil-borne diseases.

• Use healthy and improved seed from a reliable seed source. If the seed is not already treated, mix in 2-3 g Thiram per kilogram of seed, or 200-300 mg per 100 g of seed.

• **Disinfect the nursery area by solarization:** Solarization is an easy, safe and cost-effective way to sterilize the soil and produce healthy seedlings. To solarize the soil, follow these steps: (1) Moisten the seedbed (2) Cover the soil with transparent plastic sheets for 3-4 weeks (bury the edges of the sheets in the soil) (3) After 3-4 weeks, remove the plastic sheets and plough the soil (4) About 2-3 days later, level the soil and sow the seeds.

Solarizing the seedbed soil before sowing will kill many insect pests and pathogens as well as weed seeds, and to prevent seedling damping-off and to reduce other soil-borne diseases. The best time for solarisation is during the dry season when there are high temperatures. [3] Under very hot and humid climatic conditions, African experiences suggests that covering the beds for a much shorter period of 1-2 days may be sufficient sterilise at least surface soil. [15]

•Burning straw over the beds is a simple and cheap alternative to sterilizing the soil. However, it is effective only on the top 4 to 5 cm layer of the soil.

• Prepare fine seed beds about 20 cm high and 1-1.5 m wide.
• Sow seed in lines about 5 cm apart, about 1-2 cm deep. Adjust the planting depth according to the seed size.
• Cover the seed with a fine layer of compost or animal manure. Be sure that the compost or animal manure is fully mature or decomposed.
• Mulch the nursery beds with paddy straw or dry leaves.
• Water the nursery beds with a sprinkling can twice a day. After the seedlings sprout, water once a day.
• Remove the mulch immediately after seedlings emerge from the soil.
• Protect the nursery beds from excessive rain and stagnant water by providing rain shelters. Allow for good air circulation to protect seedlings from damping off and foliar diseases.
• Harden the seedlings by withholding water 4-5 days before transplanting. Hardening is facilitated by the application of potassium chloride (KCl) at 1 ml per 250-300 ml of water, or the application of a 10% sucrose solution 7-10 days before transplanting. [15]
• Drench the nursery beds with water one day before transplanting.
• Transplant 4- to 6-week-old seedlings, preferably in the evening.

Single bed rain shelters at AVRDC headquarters

Using pro (propagation)/ plug trays:

• This is the preferred method for seeds that are very fine, expensive or slow to germinate. The disadvantage is the cost involved in buying trays and accessing the soil-less medium to grow the seedlings.

• Grafting can be made easier with the seedlings grown in trays, and this method is preferred if grafting will be used.

• Use healthy and improved seed from a reliable seed source. If the seed is not already treated, mix in 2-3 g Thiram per kilogram of seed. Alternatively, seed may also be treated with *Trichoderma viride* and *Pseudomonas flourescens*. Mix 10g of formulation per litre of cow dung slurry for treatment of 1 kilogram of seed before sowing.

• Use clean trays with cell holes 4 cm deep and 4.5 cm in diameter. Disinfect trays with a 1% solution of chlorine bleach.

• Prepare the growing media by mixing coco peat, perlite, and vermiculite in a 3:1:1 ratio. A mixture of peat moss, well-decomposed compost, and coconut coir in equal proportions also can be used.[4]

• Apart from using commercial potting mixture, other recommendations from AVRDC for growing medium are 1) Using a mixture of locally available materials such as soil, sand, well-decomposed compost and rice hulls in a 1:1:1:1 ratio 2)Decomposed cocodust, cow dung and soil in a 2:1:1 ratio 3)Grated coconut husk and soil in a 1:2 ratio [3].

• Any other locally available material that drains well can be explored.

• Fill the cell holes tightly with the premoistened media.

• Sow one seed in the center of each cell, about 0.5-1 cm deep, depending upon the seed size. Alternatively, sow two seeds per hole and thin the seedlings two to three days after the first true leaves appear. Cover the seeds with the same mixture [1].

(In commercial nurseries, seedling trays are planted with machines)

• Water at the rate of 15 ml per hole during first irrigation, subsequently giving 7-10 ml per hole daily each morning. Avoid watering late in the afternoon to minimize the occurrence of foliar diseases. Moistening the entire plug promotes root growth to the bottom of the plug. If the temperature is higher, especially during summer, apply 7 to 10 ml per hole twice a day, once in the morning and once in the afternoon.

• No irrigation is required before or after sowing if the coco peat is sufficiently moist.

• To promote initial germination, keep 8-10 trays stacked on top of each other and cover the entire stack of tray with a black polyethylene sheet. This ensures fairly uniform temperature and moisture for facilitating good germination. No irrigation is required till seeds germinate. Care must be taken to separate the trays when the seedlings are just emerging, to prevent them becoming thin and weak.

• Seeds start emerging at about 3-6 days after sowing depending on the season in which crops are sown. Shift the trays to a net house and lay them on a seedbed covered with a polyethylene sheet or on a table.

Mechanical sowing in seedling trays in a commercial nursery in Bangalore

The advantages of using seedling trays:

• Provides adequate space for each seedling to grow
• Improved germination and saving of expensive seeds
• Reduces seedling mortality or damping off because of sterilized growing media
• Uniform, healthy growth and early readiness of seedlings
• Ease in handling and cheaper transportation
• Better root development and less damage while transplanting
• Good field establishment and improved uniform crop stand.

GRAFTING

To manage seedlings from soil borne diseases-Fungal, Bacterial and nematodes, grafting of Tomato seedlings on resistant Egg plant rootstocks is one of the recommendations. This technique will be discussed and dealt in detail as a separate module.

INTEGRATED PEST MANAGEMENT

• If the seedlings were not treated with chemical or biological agents, apply a locally available and recommended fungicide (eg. chemical name – etridiazole 35%WP; Trade names- Truban/ Koban/ Terrazole /Dwell @ 0.25 g/500 ml) to control soil borne fungal diseases. Apply 5 ml of the solution mixture per seedling one to two days prior to transplanting [1]

• Fungicide (Copper Oxychloride or Copper hydroxide @ 2.0g /L of water) may also be sprayed on the trays as a precautionary measure against seedling mortality. (5 ml per hole or approximately 500 ml per tray) [4]

• Spray systemic insecticides like Imidacloprid (0.2 ml/litre) twice, 7-10 days after germination and before transplanting, for managing insect vectors of viruses. If the seedlings are well-protected from insects within a net house this may not be needed.[4]

• Remove the net and apply the fungicides or fertilizers as quickly as possible. Close the net again promptly to prevent insects from entering. If the seedling trays are kept in several benches or beds, open only one bench or bed at a time.

FERTILIZATION

• Around 3 weeks after sowing, if the seedlings seem thin or the leaves turn a pale yellow-green color, especially on the older foliage, apply one of the following treatments once to the seedlings: [3]

Option 1) 0.5% ammonium sulfate solution (5 g ammonium sulfate dissolved in 1 L of water)
Option 2) 0.25% urea solution (2.5 g urea dissolved in 1 L of water)
Option 3) 0.1% foliar nitrophoska solution (1 g dissolved in 1 L of water).
Apply again one day before transplanting.

• Do not over-apply nitrogen or the plants will grow too tall and thin. Monitor seedling growth; if the seedlings grow too rapidly before transplanting, apply less fertilizer.

• When the seedlings have 4 true leaves (around 20-25 days after sowing), harden the seedlings by slightly reducing the water supply. Around 6-9 days before transplanting, slightly reduce watering further, remove the netting and expose the seedlings to strong sunlight so that they will be stocky and sturdy. Thoroughly water the seedlings 12-14 hours before transplanting them to the field.

• Transplant 4- to 6-week-old seedlings, preferably in the evening.

SELECTION OF SITE FOR NURSERY

Establishing a nursery may be considered if a great potential for market has been identified in the surrounding areas for healthy seedlings and the farmer is interested to grow into an agri-preneur.

Criteria for selection of nursery site:

• The nursery site should be located in the nutrient rich/medium soil, near to water source, free from soil pathogens and insects, availability of cheap and skilled labor and has good access to the main road for easy transportation.

• The site should be on gently sloping area and away from other tall crops: this is important for good drainage as well as to encourage air circulation.

• Generally a good nursery should consist of water tank/pond, water pump/pump house, seed and fertilizer store room, implement shed, germination/mother bed area; potting/container filling area, seedling raising area, worker mess/ hall, office room, propagation structures, compost area, etc.

• An open area is needed at one end, where works such as sieving of soil and filling of containers can be done. Usually a room/ shelter is required for staff and the watchman, and where equipment can be securely stored.

• The nursery should be readily accessible, close to a permanent source of clean water for irrigation, not prone to erosion and at least 50m away from vegetable farms to avoid spread of pests and diseases.

• Avoid sites very close to major roads and factories. For seedbed seedling production, sites with well drained and fertile soils free of soil borne diseases and pests including nuisance weeds are preferred.

To sum up, qualities of a good site are:
1) Nearness to road 2) Near a habitat 3) Suitable climate 4) Neither shady nor exposed area
5) Sufficient sunlight 6) Good irrigation facilities
7) Good soil condition 8) Good transport facility

INDICATIVE SESSION PLAN

• Break the curriculum into sequential sessions to provide enough scope for logical understanding of the subject. The more practical sessions, the better.

• The timing of training can impact the effectiveness of technology transferred. Conduct the training at least a month before the main growing season, at a time of the week when participants are most likely to be available. Advertise the program well in advance.

• The preferable venue for the training course is a nursery field or an institute where a nursery is being managed on its farm.

•The session plan can be flexible and changed as needed, but this is one suggestion:

S.No	Topic	Duration	Resource person /facilitator
Day I			
1	Understanding the need to produce good seedlings	40 min	Agronomist
2	Seedling production through different methods	60 min	Agronomist
3	Hands-on practice of sowing in plug trays	30 min	Agronomist/Commercial nursery man/expert farmer
4*	Integrated Pest and Nutrient Management in nurseries	60 min	Plant protection specialist/ expert farmer
5*	Common problems in nursery management	60 min	Agronomist/Commercial nursery man/expert farmer

*Sessions 4 and 5 can be combined and conducted in the nursery field.

PRACTICAL EXERCISES

Producing healthy seedlings:

Purpose: To help the participants decide on the correct methods of healthy seedling production.

Activities: The participants will be divided into two groups. Both the groups will be given a time of 30 minutes. Within that period, they should discuss the following points and come out with their ideas.

Group 1: How do farmers in your area produce seedlings?
Which methods of seedling production do they adapt?
What issues do they face in producing seedlings?
Suggest some remedial measures for their problems.

Group 2: Review the case study of a farmer on 'Nursery management'. Identify good practices adopted by the farmer. Find out if any improvements are needed.

Hands on practice of sowing in trays

Purpose: To provide hands-on experience on how to grow seedlings in germination trays.

Activities: The traditional soil seed bed and the seedling tray methods will be discussed.

Participants will be supplied with raw materials such as pro trays, coco peat, seeds etc. and asked to practice sowing in pro trays.

Integrated Pest and Nutrient Management in nurseries and common problems

Purpose: To help the participants identify the symptoms of pest and disease problems.
To help distinguish between pest or disease infestations and nutrient deficiency symptoms.
To communicate critical practices in nursery raising.

Activities: Two groups of participants will go around in the nursery to identify suspect symptoms. One group will find what they believe are plants affected by pests or diseases, while the other will identify plants with suspected nutrient deficiencies, so that they can compare and contrast symptoms.

These will be observed by the trainer, compared and explained to the participants along with a discussion on management measures.
The two groups will then be able to come up with solutions for the most common problems seen in their areas.

COMMUNICATION MATERIALS

Handouts of

A case study of vegetable farmer's Nursery management experiences

Heathy Seedling Production.

Power points on

Raising a nursery in pro trays
Nursery management

Videos from YouTube

Vegetable Nursery Bed preparation and seed sowing
https://www.youtube.com/watch?v=haukgnfPzQI
A video on Establishing a vegetable nursery in a plastic tray
https://www.youtube.com/watch?v=Juh79XRsEps

QUIZ (PRE AND POST-TEST)

1. The preferred method of raising seedlings is to use-
   a. Seed Beds **b. Seedling trays**

2. A growing medium like coco peat is better than soil for nursery raising
   a. Yes **b. No**

3. Net tunnels should be constructed over the seedling trays to protect the plants from adverse weather conditions and insects.
   a. Agree **b. Disagree** **c. No idea**

4. Seed treatment has to be done to reduce losses from damping off
   a. Yes **b. No**
5. Mulching is done on nursery beds
   a. Yes **b. No**
6. Uniform healthy growth and better development of seedlings can be ensured when they are grown in
   a. Seed Beds **b. Seedling trays**

7. Nursery area has to be disinfected before raising seedlings to minimise the infestations.
   a. Yes **b. No** **c. Don't know**
8. Burning straw over the beds is a simple and cheap technique to sterilize the soil.
   a. Agree **b. Disagree** **c. No idea**

GLOSSARY

NGO	Non Government Organisation
°C	Degree Celsius
INR	Indian Rupees
m^2	Square meter
m	Meter
HDPE	High-density polyethylene
UV	Ultraviolet
cm	Centimetre
g	Gram
ml	Millilitres
min	Minutes

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