INTEGRATED ORCHARD MANAGEMENT GUIDE

Handbook

Nursery Production & Management





March 2008

USAID
FROM THE AMERICAN PEOPLE

CNFA I-LED
Improving Livelihoods & Enterprise Development

Foreword

This training module focuses on presenting the basic activities and skills involved in producing and marketing perennial plans in a commercial nursery enterprise. Nursery production is a money making business. There is a demand in many sectors and regions for high quality dependable and healthy nursery material. The purpose of this training is to provide novice or intermediate nursery workers with sufficient background and information to effectively start and manage a nursery business.

The training materials strongly emphasize the production of fruit and nut trees. Learning objectives are provided to indicate the expected learning outcomes based on successfully completing the training. The training will show results if the content is followed by demonstrations and hands-on activities. It is suggested that the training schedule confine the AM sessions for discussion, Q&A, and demonstrations and the PM sessions for practical activities and hands on practice by participants targeted toward establishing one nursery site.

The training material has been developed to make the Handbook relevant for semi-literate and non-literate participants.

Objectives

By the End of the Training, Participants will be able to:

1. Explain the types of plants that are normally produced in commercial nurseries and the systems that can be used to produce them.
2. Describe the different approaches to marketing nursery stock and the implications that the marketing system has for production methods.
3. Evaluate potential nursery sites for suitability for the type of plants that will be produced and the type of marketing that is anticipated.
4. Design a simple nursery production system including the provision of important infrastructure to ensure successful production.
5. Distinguish between sexual and asexual propagation and will know how each type of propagation affects the plants that are produced.
6. List the criteria for selecting quality seed, for ensuring adequate germination, and good growth of seedlings when producing plants from seed.
7. Explain methods of producing new plants from cuttings.
8. Distinguish the role and characteristics of quality rootstock and scionwood materials.
9. Perform important nursery related tasks, e.g. whip and tongue graft, cleft graft on a top worked tree, Chip bud and T-Bud, establishment of a stool plant, formation of an air layered plantlet.

Session 1

Introduction to Nursery Operations

Session 2

Production Strategies

Session 3

Harvesting & Marketing Fruit Trees

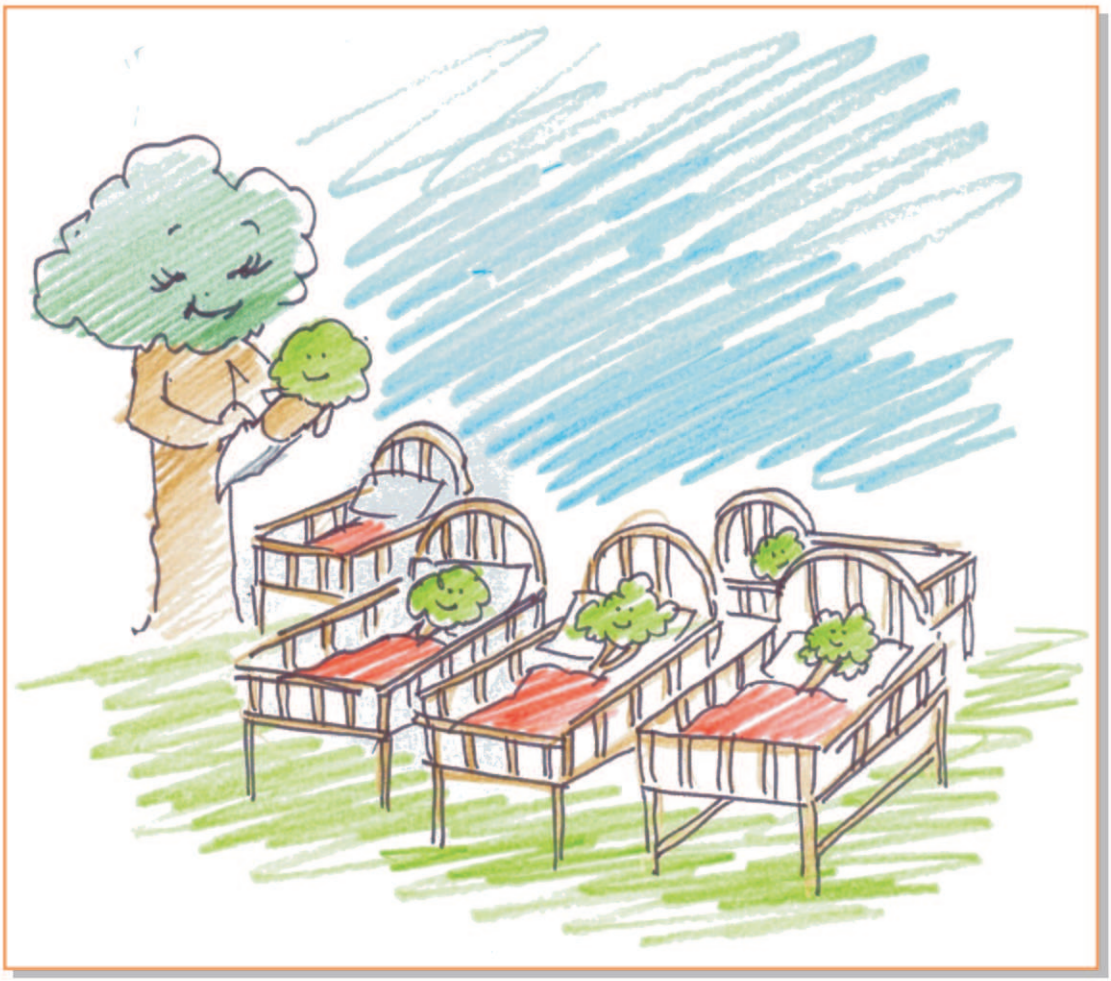
Session 4

Practicum Of All Related Activities

Introduction to Nursery Operations

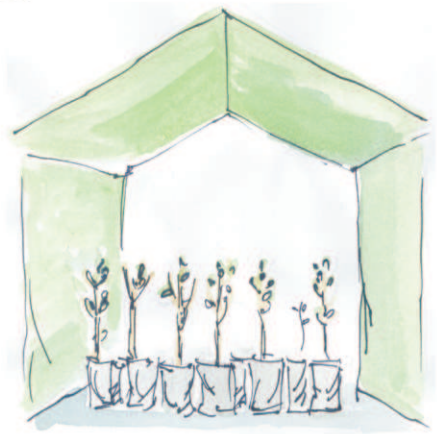
What is a Nursery?

An area designated for the short term growing and caring of plant materials in anticipation of moving them to other site locations at their appropriate maturity.



Main Activities of a Nursery

1



Producing new plants

2

Selling plants

Why are Nurseries Needed?

There are buyers who require plants which they are unwilling or unable to produce for themselves.

1

Parks, highway, and forest services

2

Home owners

3

Orchard growers

4

Development projects

Infrastructure for Commercial Nurseries

Storage and office

Seed beds, Scion material, nursery rows, stoolbeds

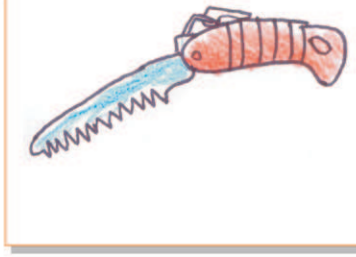
Shade and shade/Green houses

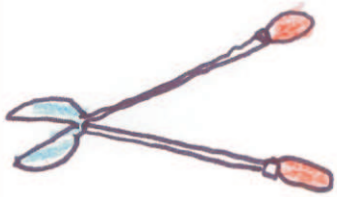
Customer entry points – access

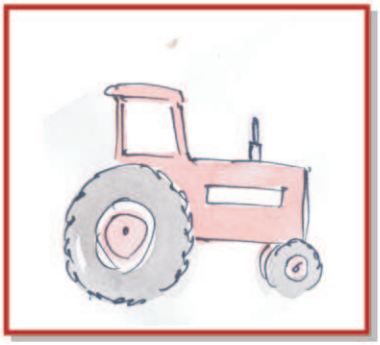
Irrigation

EXERCISE

Tools for A Commercial Nursery
Name The Tools



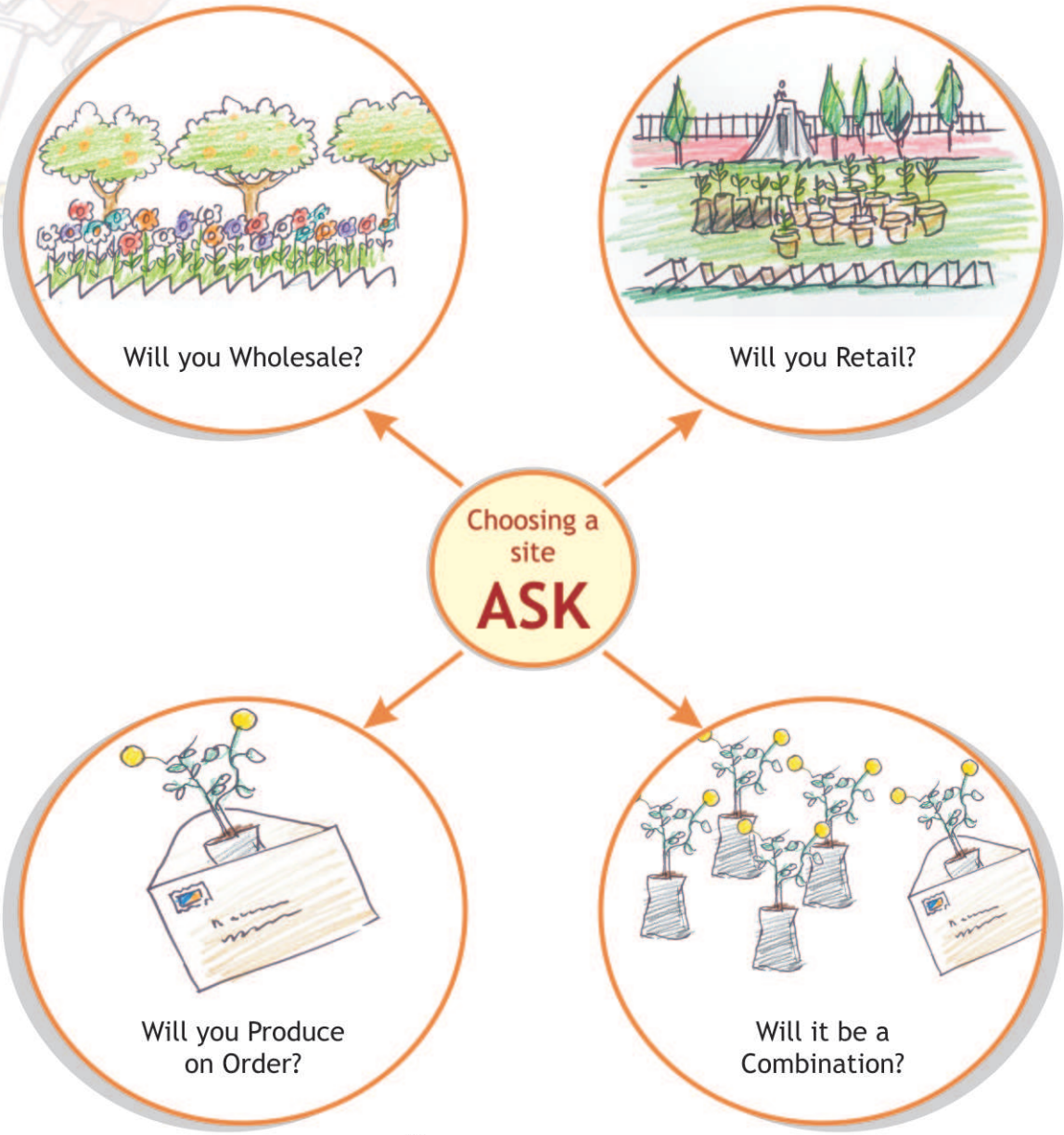




Considerations for Setting up a Nursery

1. Choosing a Site & Mapping it
2. Deciding what to produce
3. electing appropriate structures
4. Production Systems
5. Marketing & Selling Plants

1 - Considerations for Choosing a Site & Mapping it



Map your nursery

EXERCISE

Map Your Nursery Business

What will you do with your land?

2 - Deciding what to Produce

Ornamental Plants?

Forest species & Conservation plants?

Fruit, nut, and berry plants?

Vegetable seedlings for transplanting (Tomato, pepper, eggplant, small onions)?

3 - Selecting Appropriate Nursery Structures

Work Shed

Small Greenhouses

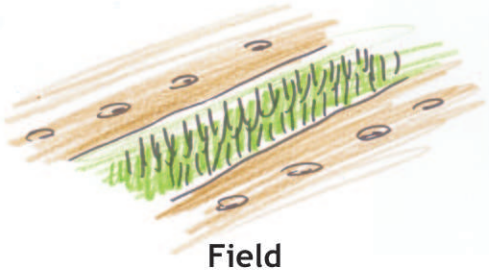
Small Greenhouses

Temporary shade

Nursery shade house

Netting shade house

4 - Deciding on Production Systems

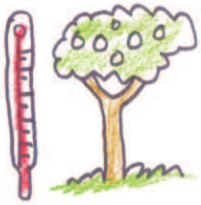


Field
Plants are produced in the fields in beds or rows

Container
Plants are produced in trays, flat pots, or bags

Pros & Cons

Little control over growing conditions



Greater control over growing environment

Highly seasonal sales

Year round sales

Mainly bareroot plants

Mainly potted plants or transplants

Introduction to Nursery Operations

Production Strategies for new Plants

Sexual

Growing new plants through seeds

Limitations
Cannot predict outcome. 'Children' may not look like their parents

Asexual

Using existing plants to grow new plants

Advantages
Can grow exact replicas. And why is that important? To acquire same shape, size, color, texture, taste for marketing

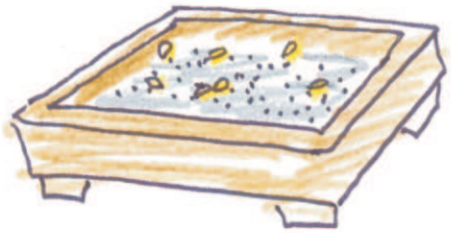
Sexual Propagation
Reproduction through Seeds

Benefits	Limitation
Production of new plants is extremely efficient	Every seed will produce a plant that is slightly different from all the rest
Little time needed to plant and care for seeds	Some fruit may be similar, others can be quite different in terms of plant's resistance to pest and diseases, the strength or vigor of the plant, or the eventual size or shape
Seeds are inexpensive	
Some plants are difficult to produce by any other technique	Some plants don't produce viable seeds.

Sexual Propagation
Methods of Seed Production

Seed dormancy and stratification

Seed treatments



Seed beds

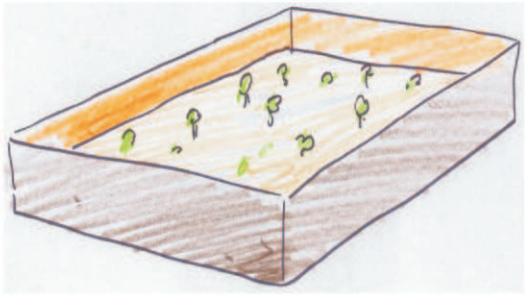
Transplants

Seed Germination Requirements

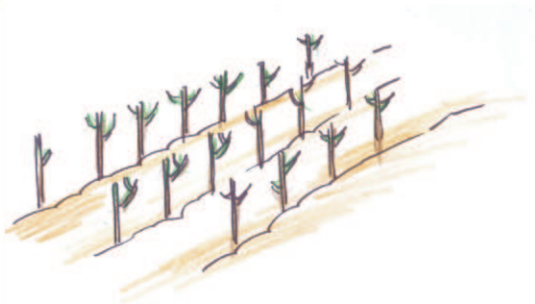
Seed Type	Days of stratification	Stratification conditions	Other treatments	Seeds per kg	Expected germination %
Apple Malus spp.	60-90d cold			28000	60-80
Pear Pyrus spp.	30d cold 5°C	Cold water only		70000	60-70
Plum Prunus spp.	30-60 warm & 60-90 cold	1st warm moist 2nd cold moist	Warm + cold stratification	2200	
Apricot Prunus spp.	30d Warm & 90d cold	1st warm moist 2nd cold moist	Warm + cold stratification		50-60
Cherry Prunus spp.	45d warm & 100d cold	1st warm moist 21°C 2nd cold moist	Warm + cold stratification		60-80
Walnut Juglans spp.	90-120d cold		Use only fresh seed	85	60-80
Persimmon Diospyrus spp	none	Plant immediately after removing from fruit		7000	
Peach	60d cold 5°C				

d = day

Methods of Seed Production

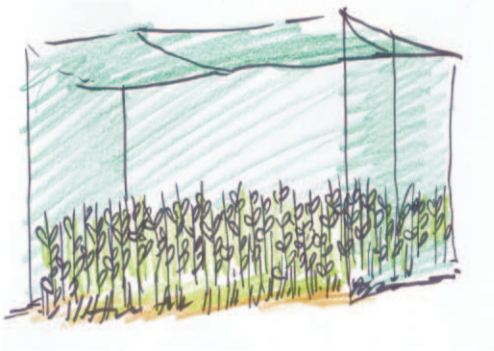


Rootstock seed being started



Rootstock in a field

Rootstock in polybags



Bareroot nursery:
Rootstock seedbed -

Asexual Propagation

Softwood and hardwood cuttings

❖Use of IBA – rooting hormones

Layering

I. Air layers -

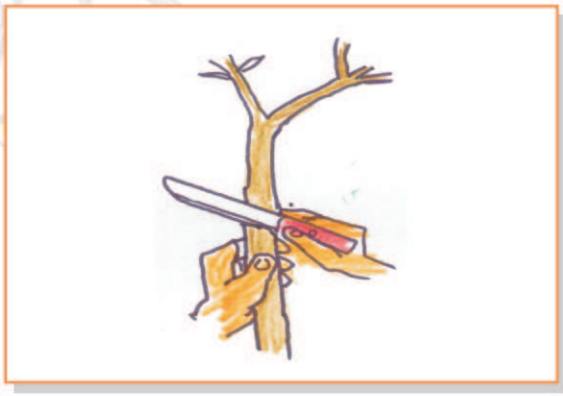
ii. Stool beds -

iii. Tip layers -

Grafting

❖Rootstocks and scions

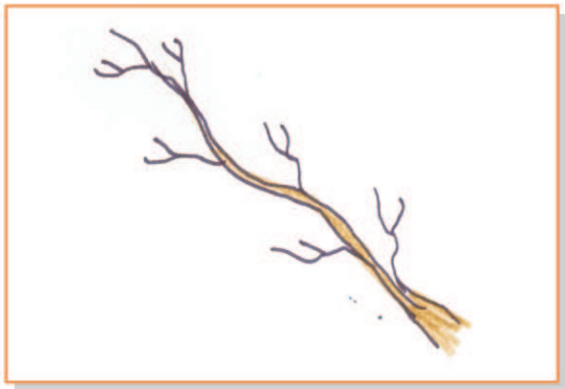
a. Softwood & Hardwood Cuttings



Use of IBA (rooting hormone required for high percentages of most fruit species)

Hardwood and softwood cuttings can be made to produce new plants

Success Depends on Variety, Timing and Skill



Hard wood cuttings made while plants are dormant

Soft wood cuttings made while plants have caves

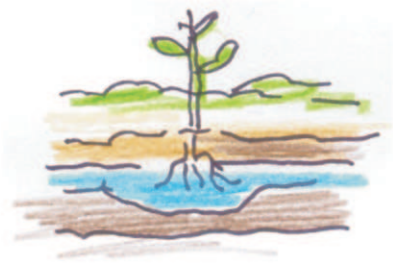
Requirements for Cuttings of Fruit Varieties

Fruit variety		Type of cutting	Size	Rooting hormone	Time to take cuttings	
Apple		Softwood New growth	4-6 inches	5000 ppm IBA	Late spring	
Plum		Softwood firm wood	6-10 inches	5000 ppm IBA	Mid-summer	
Apricot		Not Possible				
Cherry		Difficult				
Peach		Semi-hardwood	8-10 inch tops	Wound basal end	Late summer	Leave terminal leaves
Walnut		Very poor results				
Pear		Softwood	8-10 inch	2000 ppm IBA	Early summer	

ppm = parts per million

Considerations for Soils Mixes for Cuttings

Soil mixes and material for cuttings can be prepared from many materials.
Some important considerations are:



Ensure that Soil has water holding capacity

Check the physical weight of the materials - lighter is better

Ensure that the mix is a combination of sand, peat, sphagnum moss, Vermiculite, perlite, compost, shredded cardboard, bark and sawdust

Mix should have sufficient fertility to allow for the initial strong development of the cutting

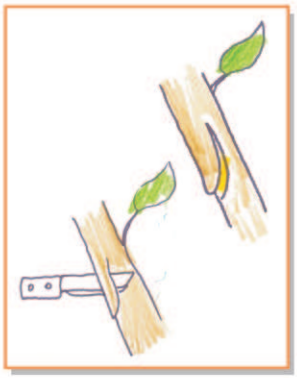
Mix should not contain weeds, unwanted seeds, nematodes, and other noxious organisms

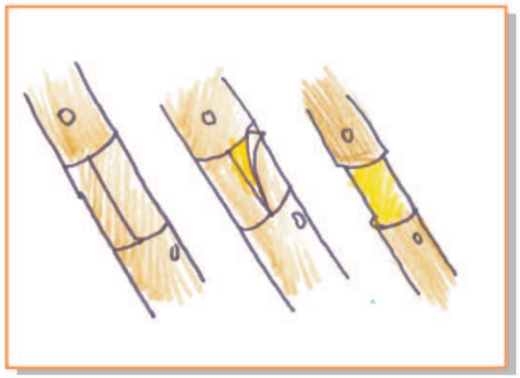
Mix should have pores that will allow draining of excess water.

b. Layering

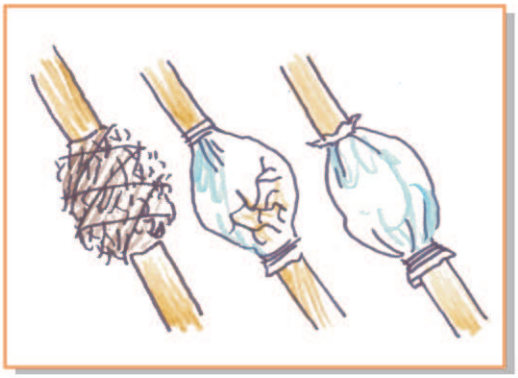
i. Air Layering

Air layering is used to produce roots on an intact branch by girdling – usually accompanied by hormone application. Air Layering stimulates the formation of callus tissue by the tree and the formation of new roots.





A narrow strip of bark is completely removed from a living tree or a cut is opened by slicing the bark and a sliver is wedged in to hold it open.



Wet moss or peat around the girdle, which is then covered is wrapped with plastic.

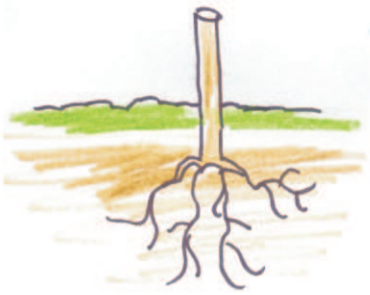
Roots form in the layer which is cut and replanted in a high humidity environment.

An Example: Here are some air layers on Keiffer pear.

ii - Stool Beds

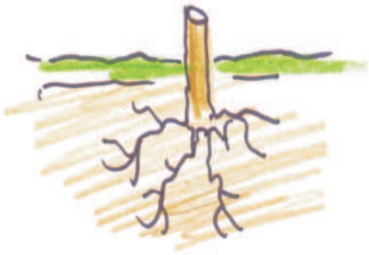
While much rootstock can be produced with seed, rootstocks like MM106 must be produced using vegetative means – essentially by a layering technique for commercial purposes air layering is too time consuming.

Creating beds to grow shoots to be rooted and cut off for rootstocks is known as stooling. The process is as follows:



Spring Year 1
Plant Parent

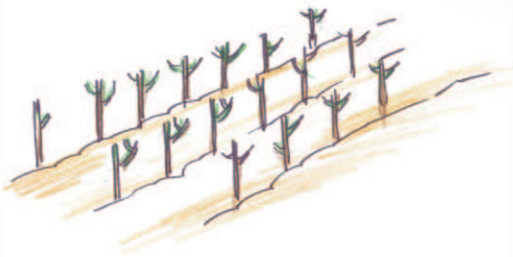
Fall Year 1
Formation of Strong Root System



Spring Year 2
Cut Back an Inch Above Soil

Summer Year 2
Mound Sawdust

Fall year 2
New Shoots Have Formed Roots



Winter Year 3
Remove Sawdust, Harvest
Plant new rootstocks in lines

C - GRAFTING

Grafting covers a range of propagation techniques, a rootstock is combined with a scion variety with some desirable characteristics.

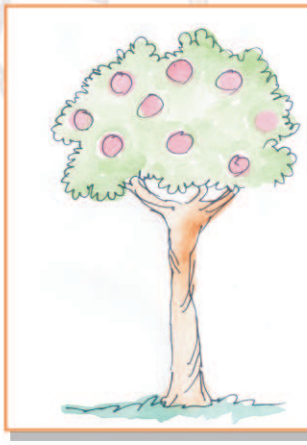
ROOTSTOCK, which is the lower portion of the grafted plant, provides the root system for the new plant.

The SCION forms the above ground part of the grafted plant.

A number of different techniques are used to join or graft the two.

Rootstock

What is a Rootstock?



Rootstocks are nothing more than fruit trees produced from seeds or cuttings.

Rootstocks are selected for the special characteristics they give to a tree and for the ease of producing them.

The tops are cut off and a chosen variety of fruit is grafted on by grafting or budding.

Where do Rootstock come from?

Some rootstocks have been bred in scientific programmes to produce tree with special characteristics

Others are produced from seeds of trees which naturally show desirable traits.

With some fruit types very little work has been done and almost any rootstock will be acceptable.

Selection of Suitable Rootstocks

		With woody plants, most rootstocks used are closely related species to the scion.
		Many are seed propagated.
		Easy to propagate and fast growing.
		The vigor characteristics of the rootstock usually determine the size and vigor of the grafted plant.
		This means that many grafted trees grow to a large size. when produced with seedling rootstocks.

What Characteristics do Rootstocks Influence?

COLD TOLERANCE

DROUGHT TOLERANCE

TREE VIGOR

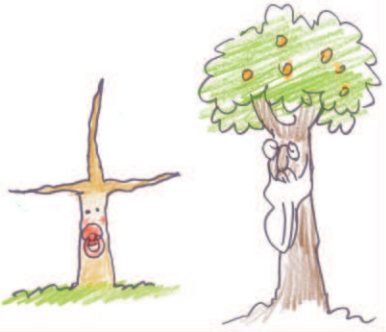
TREE SIZE

EARLY OR LATE BEARING

RESISTANCE TO PESTS AND DISEASES

PERFORMANCE ON WET SITES

LIFE SPAN— OLD OR YOUNG



Reasons for Grafting Plants

To propagate plants which cannot be economically propagated by other techniques. E.g. cultivars of small fruits, nuts, and fruit trees.

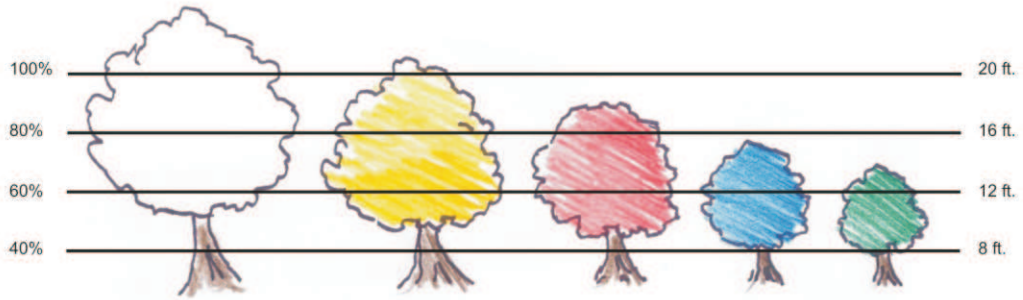
To control the growth and performance of trees, e.g. Apple and pear orchards Malling 111, 106, 27, 26, 9; OHxF – Old Home by Farmington clone; Quince – A and various quince clones.

To confer resistance to pathogens to the grafted plant, e.g. MM106 & Wooly apple aphid, OHxF and fireblight resistance.

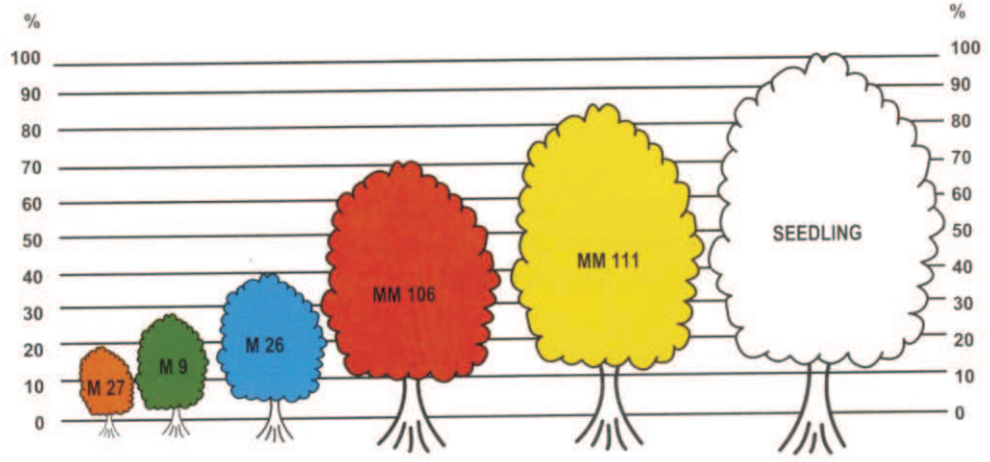
To bring fruiting plants into fruit production earlier in the life of the plant, e.g. fruit at 3 to 4 years instead of 5 to 7.

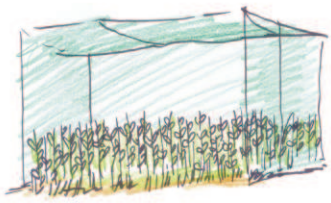
Grafting to obtain special effects in plants, e.g. Multiple fruits on the same tree, addition of pollinators to "hard to pollinate" varieties, topworking to change fruit varieties.

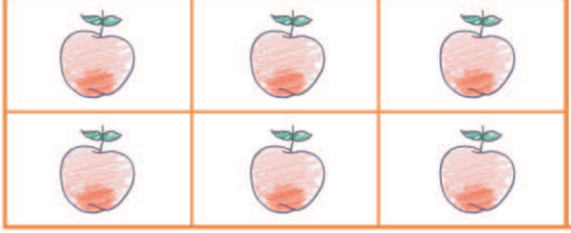
Rootstock Selection



Rootstock	Pyrus betulifolia	Pyrus calleryana	Bartlett Seedling	OHxF-333 OHxF-513	Quince
Preferred Soil	Does well on rocky soils, good Fe uptake	Tolerant of Heavy soils	Widely adapted	Widely adapted	Fertile, well drained soil. Not adapted to wet sites
Hardiness	Better Hardiness then P. Calleryana	Only Moderately Hardy	Good Hardiness	Very hardy	Susceptible to cold injury
Disease Susceptibility	Resistant to Pear decline	Resistant to fireblight, wolly, aphids, nematodes	Susceptible to fireblight	Fireblight resistant	Nematode resistant
Anchorage	Well anchored	Well anchored	Well anchored	Well anchored	

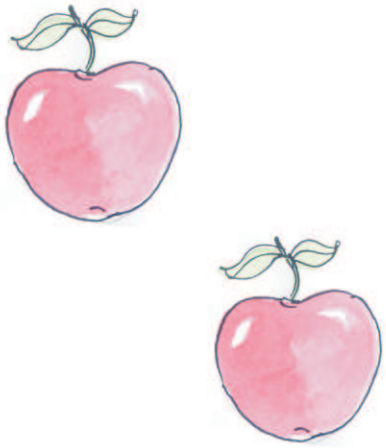


Rootstock Production		
		
From seed Apple, pear, plum, apricot, cherry, walnut	**From cuttings** Apple, pear, plum, cherry	**From stools** Apple, pear, plum

Scion Wood Small pieces of branch from fruit trees that produce a high quality fruit	
Role	**Sources**
Used to produce large numbers of trees with IDENTICAL fruit 	Germplasm repositories • Mother trees at nursery • Identification of superior cultivars in field • Importation from fruit breeding centers

Interstock		
An INTERSTOCK or intermediate rootstock may be used with some fruit trees where a degree of incompatibility occurs.	Interstocks are not normally needed though some interesting benefits can be achieved.	Grafting with interstocks is referred to as DOUBLE WORKING.

Factors to Consider While Grafting



Grafting within species - Grafting same kind of fruit

Grafting of species within the same genus - e.g. lemons & oranges

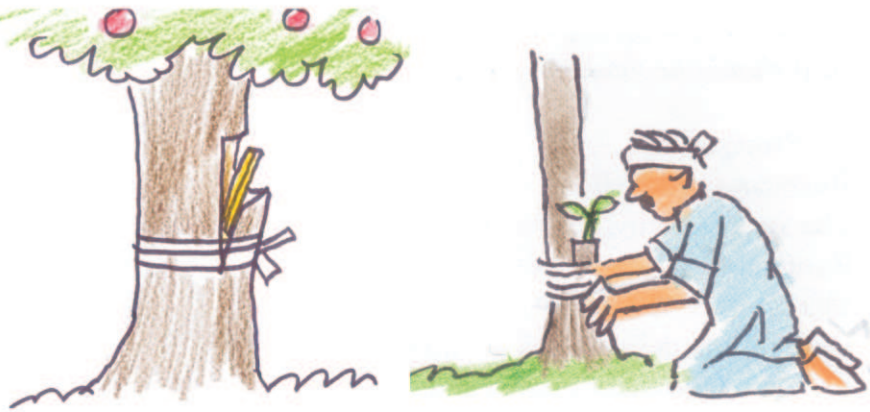
Grafting of different genera within the same family -

Grafting between families: - e.g. apples and pears

Other Factors to Consider

	
Time of year	Scion material at correct stage of growth
	
Standard and quality of cuts	Tying of the graft
	
Growing environment	Correct matching of the bottom of the scion with the top of the rootstock

Incompatibility in Grafting



Graft compatibility implies that when two closely related plants are grafted together, there is no physiological or morphological reason why a union should not form. Yet sometimes it does not.

Grafting Systems

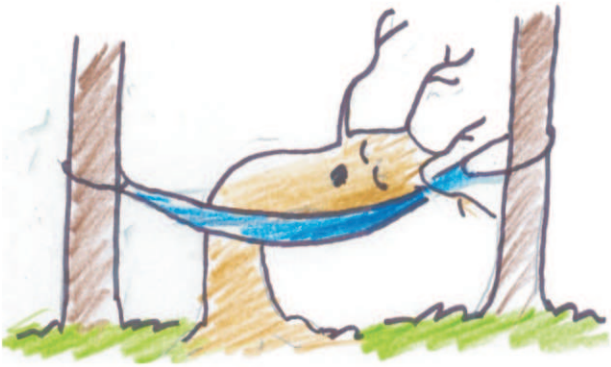
1

Field Grafting

Traditional system where rootstocks are grown and grafted in the field on actively growing plants.

2

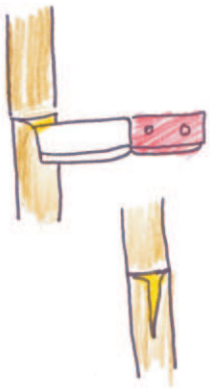
Bench Grafting



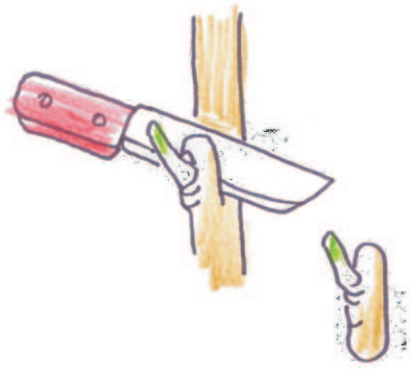
Carried out at a bench on dormant rootstock. Generally worked on in the winter and planted out again in the spring.

Grafting

Steps



Make clean cuts in the tissue of the two pieces so that the CAMBIUM tissues can be matched together.



Cambium is the main layer of meristematic tissue in woody plants. It is located as a thin layer of tissue immediately under the bark in stem and roots.

Successful grafting requires that the two pieces remain in direct contact long enough for the cuts to heal and new growth develop to link the two.

Systems of Grafting

Bud Grafting
(Budding)
Best defined as a technique during which a single bud of the scion is joined using one of several different techniques to the rootstock.

Top grafting
(Top working & Grafting)

Budding

A contraction of BUD GRAFTING where a single bud is attached to the rootstock.

Advantages of Budding:

1		Simple to learn.
2		Fast to do.
3		High success rates.
4		95-100% common.
5		Production of a strong union.
6		Many trees produced from a small amount of budwood.
7		Important with new varieties when material in short supply.
8		Number 1 option for grafters.

Plants Which are Budded

Deciduous fruit trees

Stone fruits

Nut trees

Citrus

Subtropical fruits

Climbing fruits

Roses

Ornamental trees

When to Bud & How?

Dormant versus summer budding

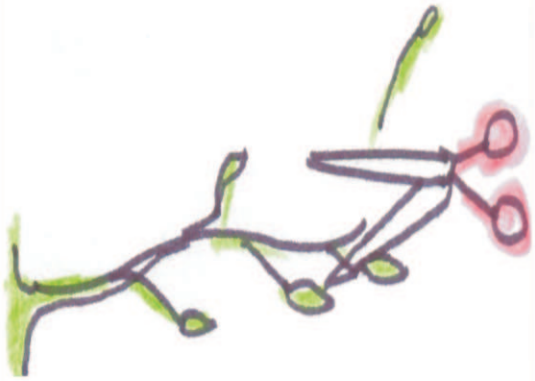
During summer, clip any branches in the lower areas where budding is to be done.

Preparation of rootstock for budding

Tips for Collecting Scionwood for Budding

Collection is best done at dawn

Choose long unbranched shoots from last year



If stick is dormant, remove the tip as tip buds do not perform well

If collecting summer budwood, clip the leaves leaving a small stub to help handling

Budding Techniques

1

T-budding

2

Inverted T-budding

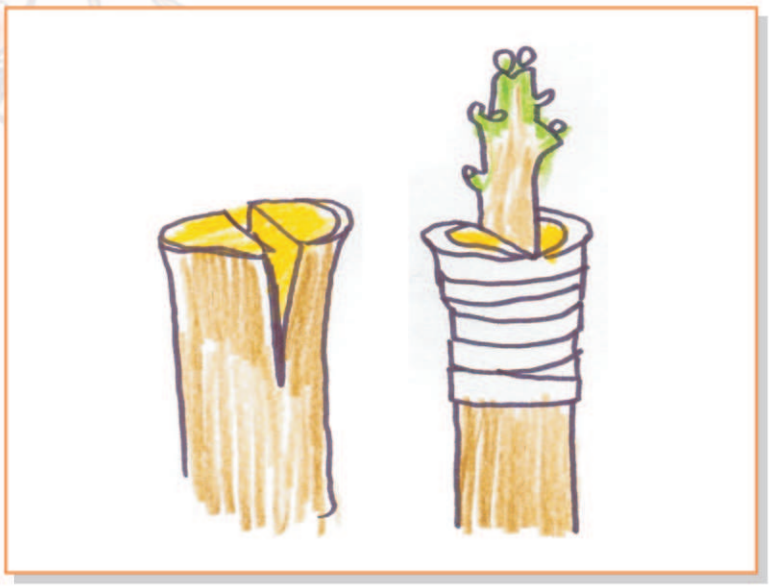
3

Chip budding

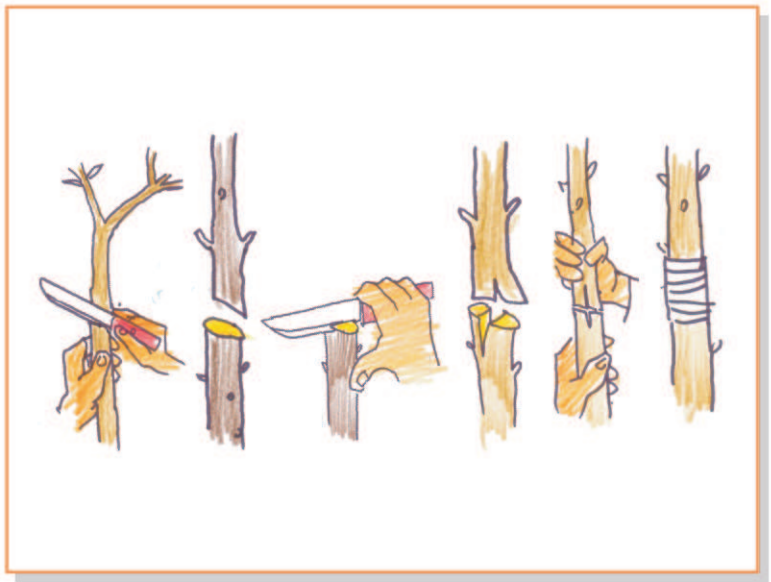
4

Patch budding

Grafting Techniques



Cleft grafting



Whip and tongue

Top Grafting

The top is removed from the rootstock and the scion shoot is grafted in to the top end of the rootstock stem.

Top grafting is much slower to perform than budding:

Many styles are complicated to carry out:

Often used in spring when t-budding is not possible:

Top Grafting

Examples of plants top grafted:

1

Apple

2

Avocado

3

Pear

4

Feijoa

5

Plum

6

Grape

7

Cherry

8

Passionfruit

9

Pecan

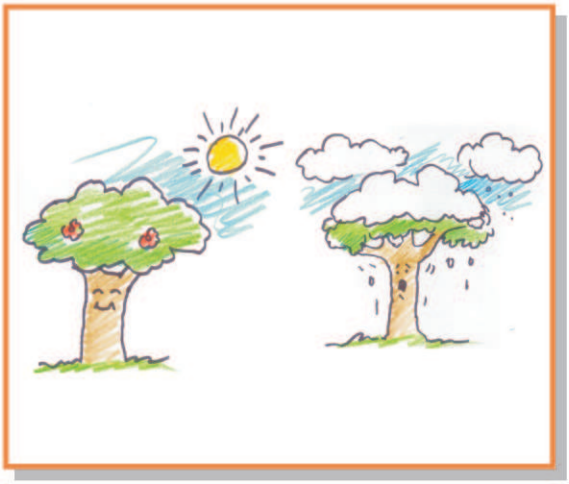
10

Grevillea

Grafting Cuttings

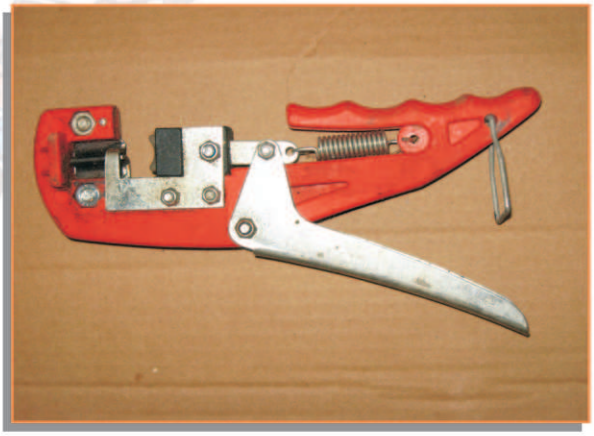
Grafting onto unrooted cuttings is an innovation designed to eliminate the production period of the rootstock.

The development of a root system on the unrooted cutting occurs simultaneously with the healing of the graft union.



Both processes need the same greenhouse environment to maintain warmth and humidity.

Grafting Tools



This picture shows three different kinds of budding-grafting knives

This is an omega speed grafter which makes the task of grafting dormant materials much faster. Using the omega grafter one person may successfully graft several 1000 trees per day.

This is parafilm which can be used with excellent results to wrap and tie graft or bud unions.
The most important characteristics of this film is that is stretches substantially without breaking allowing it to be pulled very tight creating a nearly airtight covering. Additionally is is rather clinging which allows it to stick well to the wood material and to itself.

This is an omega speed grafter which makes the task of grafting dormant materials much faster. Using the omega grafter one person may successfully graft several 1000 trees per day.

Tying Materials for Grafting

A number of tying materials are available for securing the graft union.

Choice of material:

- Depends on the grafting technique and the post-grafting environment to be used.
- What can be obtained easily.

Main aim in tying the union:
To keep moisture from entering or leaving the graft union.

Tip for Success:
Ensure that the ties are tight enough to stabilize the graft union so that it doesn't move.

Tying Materials to Consider:
With t-budding simple rubber budding patches are often used. The rubber is biodegradable and it will disintegrate within 4-6 weeks.

PVC budding tape is widely used but must be cut off after the graft union has formed.

Two-inch roll of medical laboratory tape "PARAFILM". This is a thin, stretchable tape that seals the graft union very effectively against the entry of water.

Other plastic film that stretches works well.

Harvesting & Marketing Fruit Trees

Considerations For Selling Fruit Trees

1

When in field or container beds, label trees by rows or by block. Use aluminum tags, stakes and markers with names, lists giving rootstock and variety names by row number, paint marks or stipes

Labeling systems for trees

2

Trunk Diameter
Well branched
Whip or feathered

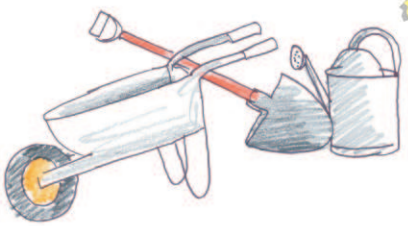
Trees that Sell

Other Aspects of Marketing

1

Establish Credibility - A tree should be what you say it is

2



Consider selling services - assistance with planting, after sale service, rental of tools and equipment

3

Have a range of varieties in order to reach out to a larger market

4

Advertise through 'word-of-mouth', pamphlets and cards

5

Ensure your pricing is at level with the market

6

Participate in shows and local fairs

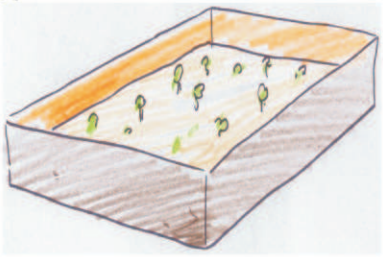
Best Practices in The Production of Common Species

Fruit Type	Grafting	Timing	Others
Apple	✓	✓	• Greatest development in rootstock selection • Wide range of dwarfing, early bearing, and disease and pest resistant rootstocks available
Pear	✓	✓	Various rootstocks are used for pears.
Plum	✓	✓	• Propogated on seedling Rootstocks • Late summer chip and T-buds are common • Early springs are also possible
Apricot	✓	✓	• Almost always produced on Prunus manshurica seedlings • Bench grating on dormant scionwood and rootstocks
Cherry	✓	✓	• Chip or T-buds are preferred • Late summer is the preferred time
Peach	✓	✓	• Peach seedlings still principal rootstock • No known peach rootstock cause dwarfing in peaches
Persimmon	✓	✓	• Rootstocks • Grafting • Timing
Walnut	✓	✓	• Rootstocks • Grafting • Timing

Practicum Of All Related Activities

Practicum of All Relevant Activities

1



Laying out of seed beds

2

Seed boxes

3

Establishing stool beds

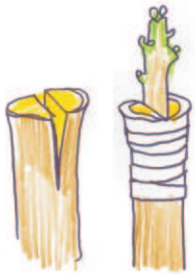
4

Stratifying seeds

5

Lining out trees

6



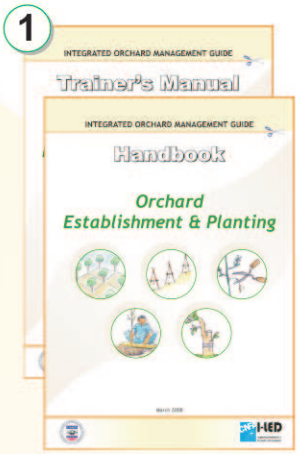
Grafting and budding

7

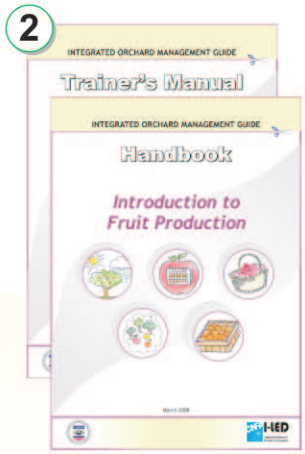
Labeling trees

INTEGRATED ORCHARD MANAGEMENT GUIDE

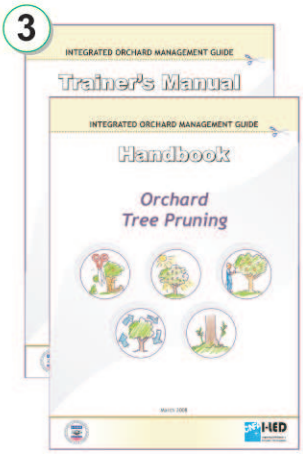
1



2

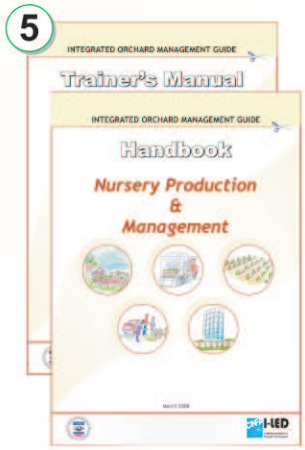


3

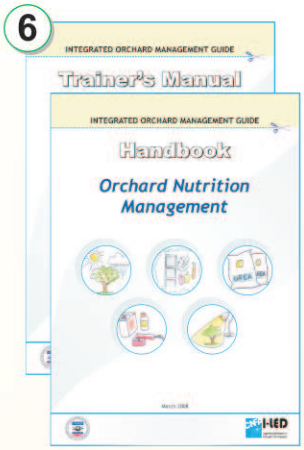


4

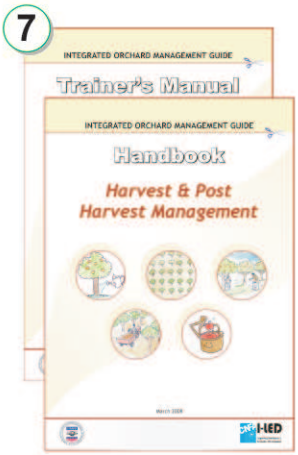
5



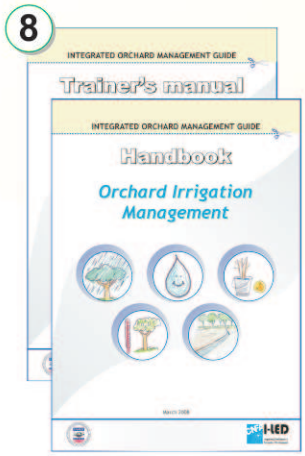
6



7



8



9

EMPOWERMENT THRU CREATIVE INTEGRATION
eci

ECI (Pvt.) Ltd.
Plot 11-13, Raja Iftikhar Sabri Street, Phulgran Road,
Bahara Kahu, Islamabad, Pakistan.
Ph: +92-51-2230895-97
www.eci.com.pk, info@eci.com.pk