Left: A farmer grafting tomato seedlings (Purusottam Gupta)
Right: A farmer in Syngia showing tomato seedlings that have been grafted onto improved root stocks. (Purusottam Gupta)

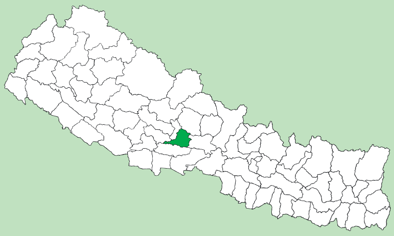
Tomato grafting

Nepal: कलमी प्रबिधिद्वारा गोलभेडा उत्पादन

Cleft grafting can be used to produce plants that are resistant to a number of pests and diseases and are often higher yielding than the original. Tomato seedlings can be easily grafted onto resistant root stock of the wild eggplant (*Solanum sysimbrifolium*) to produce a disease-resistant and commercially viable crop.

Some of Nepal's most lucrative vegetable cash crops, especially solanaceous crops such as tomato and eggplant, are particularly susceptible to attack by the root knot nematode, *Meliodogyne* spp, which costs Nepal's farmers millions of rupees in losses annually. In recent years, farmers found that this pest was becoming prevalent and that they could not control it permanently using either cheap or eco-friendly solutions. Researchers and development officers took up the challenge and found that grafting technology could successfully control not only the root knot nematode but also wilting disease. As a bonus, they also found that grafting can increase the yield potential of the plants and improve the overall productivity of the land.

Loam and silt loam soils with a pH of 6.0–7.0 are the most suitable for this type of cultivation. Grafting technology requires two plants: the scion and the rootstock. The scion is a detached shoot or twig containing buds from the desired woody plant. The rootstock is a plant with an established healthy root system, onto which a cutting or a bud from another plant is grafted. The scion seedlings are grown in raised solarized nursery beds, where care has been taken to see that the soil has been sterilised and all soil pests have been destroyed. Robust rootstock of wild eggplant (*Solanum sysimbrifolium*) is appropriate for tomato propagation. The rootstock seedlings are grown in multi cell trays and transplanted when they are 20–25 cm high and have a few leaves and a pencil thick stalk. Seeds for the rootstock seedlings are sown in March/April and are ready in 6–8 weeks; scion seeds are sown in April/May and are ready for grafting in 3–4 weeks. Both scion and rootstock plants should have achieved similar stalk thicknesses at the time of grafting. Cleft grafting is carried out and the grafted seedlings kept in polypots in a closed polyhouse for 7–10 days. Then the grafted seedlings are carefully transplanted to their permanent location. The grafted plants are watered the day after they are transplanted; the extent of watering depends on how moist the soil is and on local weather conditions. The field is mulched throughout the cropping period using straw and other farm biomass materials.



WOCAT database reference: QT NEP 33
Location: Arukharka -6, Syangja District, Nepal
Technology area: <0.1 km^2
Conservation measure(s): Agronomic
Land Use: Cropland, annual cropping
Stage of intervention: Income generation
Origin: Introduced through projects
Climate: Subhumid/subtropical
Related approach: Using the participatory market chain approach to help smallhold farmers market their produce (QA NEP 33)
Compiled by: Purusottam Gupta, IDE Nepal
Date: May 2011, updated March 2013

The technology was documented using the WOCAT (www.wocat.org) tool.

Classification

Land use problems

Insufficient water for irrigation, the soil is acidic, vegetable crops are attacked by pests and crop production is in decline.

Land use

Annual cropping (rainfed)

Climate

Subhumid/ subtropical

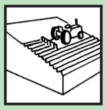
Degradation

Biological degradation: loss of production (pest attack)

Chemical degradation: low soil pH, fertility decline

Water degradation: soil moisture problem

Conservation measures



Agronomic measure

Stage of intervention

- ■ Prevention
- □ Mitigation/reduction
- □ Rehabilitation

Origin

- □ Land users' initiative
- □ Experiment/research
- ■ Externally introduced: IDE-Nepal
- □ Other (specify)

Level of technical knowledge

- □ Low
- ■ Medium: technical staff
- ■ High

Main causes of land degradation: Over use of chemical fertilizers, poor soil management, drought

Technical function/impact

Main:
- Reduces pest attacks
- Improves crop production

Secondary:

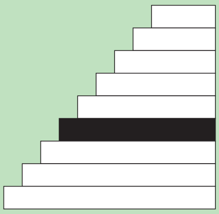
Environment

Natural environment

Average annual rainfall (mm)

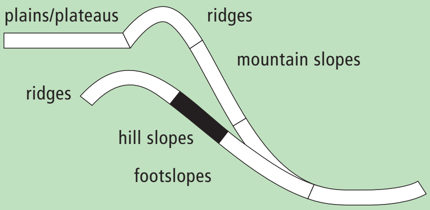
- □ >4000
- □ 3000–4000
- ■ 2000–3000
- □ 1500–2000
- □ 1000–1500
- □ 750–1000
- □ 500–750
- □ 250–500
- □ <250

Altitude (masl)

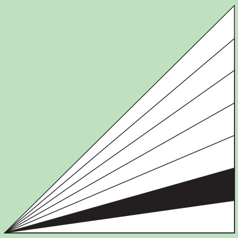


- >4000
- 3000–4000
- 2500–3000
- 2000–2500
- 1500–2000
- ■ 1000–1500
- 500–1000
- 100–500
- <100

Landform



Slope (%)



Soil depth (cm)

- □ 0–20
- □ 20–50
- ■ 50–80
- □ 80–120
- □ >20

Growing season(s): two
Soil texture: medium (loam)
Soil fertility: high
Topsoil organic matter: medium
Soil drainage/infiltration: good

Soil water storage capacity: medium
Groundwater table: <50 m
Availability of surface water: poor/none
Water quality: good
Biodiversity: high

Tolerant of climatic extremes: increases in seasonal rainfall, heavy rainfalls
Sensitive to climatic extremes: increases in temperature, decreases in the length of the growing period
If sensitive, what modifications were made/are possible: none

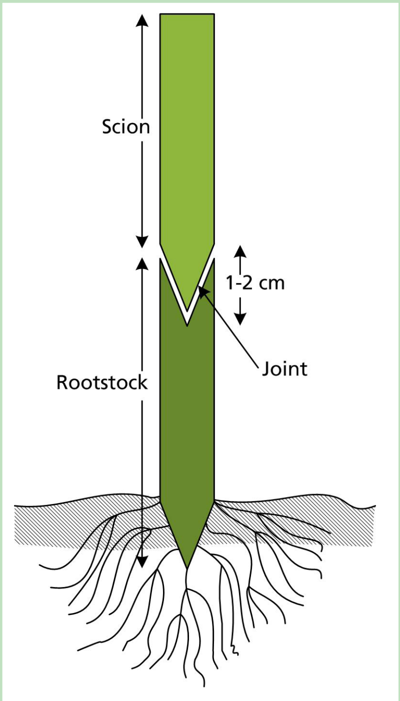
Human environment

Crop land per household (ha)

- □ <0.5
- ■ 0.5–1
- □ 1–2
- □ 2–5
- □ 5–15
- □ 15–50
- □ 50–100
- □ 100–500
- □ 500–1000
- □ 1000–10000
- □ >10000

Land user: individual/households
Population density: 200–500 persons per km^2
Annual population growth: 0.5–1%
Land ownership: individual/titled
Land/water use rights: individual and communal
Relative level of wealth: poor (50%), average (30%), rich (20%)
Importance of off-farm income: 10–50% of total
Access to service and infrastructure: moderate to high

Market orientation: mixed subsistence and commercial
Mechanization: animal traction
Livestock grazing on cropland: yes, a little
Livestock density: medium
Purpose of forest/woodland use: na
Types of other land: na



Technical drawing
Schematic diagram of a tomato scion grafted on to the rootstock of a wild eggplant.
(A. K. Thaku)

Implementation activities, inputs and costs

Establishment activities

1. **Prepare the land:** Plough the soil two to three times and then plank; add well decomposed compost or farmyard manure (25–30 quintal per 338 m^2), di-ammonium phosphate (DAP) and potash (at 15 kg each per 338 m^2), and zinc and borax (0.5 kg each per 338 m^2), and mix into the soil.
2. **Prepare scions:** Sow seeds to a depth of 0.5 cm, cover with fine soil, and add biomulch. Remove mulch as soon as the seeds begin to grow.
3. **Prepare rootstock:** Grow wild eggplant seed (*Solanum sysimbrifolium*) in multi-cell trays and transplant at the 2–3 leaf stage into individual 10x15 cm (4 x 6 inch) polypots.
4. **Grafting:** Carry out grafting when the stalks of both the scion and rootstock plants are about the thickness of a pencil.
   - Cut the upper part of the rootstock and lower part of the scion and remove leaves and spines. The scion should have 2 or 3 upper leaves only.
   - Make a 1–2 cm long V-shaped notch in the upper portion of the rootstock.
   - Cut the tip of the scion into a 1–2 cm inverted V-shape.
   - Fit the scion into the root stock and bind the two together with the help of a grafting clip, parafilm tape, or a section of vinyl tubing to protect it from direct contact with water and air.
   - Keep grafted seedlings in their polypots in a closed polyhouse (grafting chamber) for 7–10 days at a temperature of 25–30˚C and humidity of 80–85%. Approximately 500 transplanted seedlings can be kept in 5 x 2.7 m grafting chamber.
5. **Transplant grafted seedlings:** Plant out seedlings at their final location. The planting distance depends on the tomato variety. For example, Srijana tomatoes are spaced 90 cm (R-R) x 60 cm (P-P).

Note: For more eco-friendly production, chemical fertilizers can be replaced by biofertilizers.

Establishment inputs and costs per 500 m^2

Inputs	Cost (USD)	% met by land user
Labour (5 person days)	21	100%
Equipment		
- spade, scissors, sharp scalpel, multi cell tray, hoe, plough	22	100%
Materials		
- polypots, grafting chambers, parafilm tape, sprayer	225	100%
Agricultural		
- seed	28	
- manure	65	
- fertilizer	17	
- pesticide	21	
- plant tonic	7	
TOTAL	**406**	**100%**

Maintenance/recurrent activities

1. Both scion and rootstock seeds are watered after sowing. The seedlings are monitored and watered as needed.
2. After transplanting, the grafted seedlings are watered the next day and twice weekly thereafter. As the plantlets mature, they are watered at 10-day intervals and the surface of the soil is mulched. The moisture level in the soil is monitored throughout the cropping period.
3. Top dressing with biofertilizers (N, P, K, and vesicular arbuscular mycorrhiza VAM) and bio-hume is applied to the root zone.

Maintenance/recurrent inputs and costs per 500 m^2 per year

Inputs	Cost (USD)	% met by land user
Labour (16 person days)	68	100%
Materials		
- electricity and water charges	8.5	100%
Agricultural		
- seed, manure, fertilizer, and pesticides	68	100%
TOTAL	**144.5**	**100%**

Remarks:
- All costs and amounts are rough estimates by the technicians and authors. Exchange rate USD 1 = NPR 72 in May 2011

Assessment

Impacts of the technology

Production and socioeconomic benefits

+++	Increased crop yield by 50%
+++	Increased farm income, by as much as 2–3 times
++	Moisture is maintained in the soil
++	Increase resistance towards pests and disease

Production and socioeconomic disadvantages

none

Socio-cultural benefits

+++	Improved food security and self-sufficiency by 200%

Socio-cultural disadvantages

none

Ecological benefits

+++	Increased biological pest disease control by 90%

Ecological disadvantages

none

Off-site benefit

none

Off-site disadvantages

none

Contribution to human wellbeing/livelihood

none

Benefits/costs according to the land user

Benefits compared with costs	short-term	long-term
Establishment	negative	positive
Maintenance/recurrent	neutral	positive

Acceptance/adoption:
Most (90%) of the farmers are implementing the technology voluntarily and there is a spontaneous trend for adoption. In the area studied, about 20–30 households per year are adopting this technology.

Concluding statements

Strengths and ➔how to sustain/improve	**Weaknesses** and ➔how to overcome
The technology is highly effective at controlling pests and disease. ➔ The wild eggplant rootstocks are somewhat difficult to graft because they are spiny. Spine-free rootstock seedlings would be easier to graft.	Grafting is time consuming and difficult because wild eggplant root-stock plants are spiny. ➔ Need more research to identify other possible rootstock plants.
The grafted seedlings themselves are a good source of income for farmers. ➔ Create awareness among farmers and encourage nurseries to provide grafted seedlings. Support farmers during the start-up stage.	Grafting can be expensive and requires an initial investment in training; specialized materials are needed. Technically demanding, needs practise. Specialized materials are difficult to get. ➔ Nurseries need to be supported and need to have access to specialized materials on time.

Key reference(s): None

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