TECHNOLOGY FOR WALNUT PRODUCTION IN BHUTAN

By

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3. PRE-PRODUCTION STAGE

A. Growing Conditions

Criteria	Description
1. Altitude	• Between 1,300-2,500 metres above sea level (masl). • Beyond 2,500 masl (like in Bumthang), commercial walnut production is not recommended as it result to erratic and even total crop loss in some years when there is late spring frost.
2. Temperature	• Adapted to cold temperate zone, requiring cool period in autumn to promote leaf fall and the physiological process of plant hardening and induction of dormancy. • Not recommended in areas where late spring or early fall frost is common as freezing temperature kills the growing point of walnut trees and severely affects production. • Temperature of 38^0C or more results in sun burning of hulls and shriveled kernels, with severe damage occurring at temperature over 40^0C.
3. Irrigation	• Requires 800 mm rainfall or irrigation equivalent. To obtain high yield, avoid planting walnut in drought-prone areas. • Spring rainfall is associated with increased problems from walnut blight.
4. Soil pH	• Requires slightly acidic soils between pH 5.5-6.5. • Prone to zinc and boron deficiencies, hence select a site wherein recent soil analysis show reasonable levels of zinc and a slightly acidic pH.
5. Soil texture	• Grows best on deep, friable loamy soil where roots can develop to 3-4 m depth. Besides good top-soil, the subsoil should be free of impermeable layers like clay and rock gravel and anaerobic conditions (clayey soil coupled with high rainfall). • Walnut can not tolerate wet soils for any extended period. A few hours of water-logging can cause severe damage.

6. Topography	• Gentle slopes are more easily managed. As walnut plantation is likely to be on steep slopes in Bhutan, there are two important factors to consider: 1. Choose a site with southerly and south-westerly facing slopes. This warms up faster in spring and cools down more slowly in the autumn, thus extending the growing season at higher altitude. Northerly and easterly aspects tend to be colder and more prone to frost damage at higher altitudes, but may allow walnut production at lower altitude. 2. Choose a site with good frost drainage. Unimpeded down slope drainage of cold air is important particularly in spring where a build-up of cold air in pocket behind a line of trees or in a fold in the ground can cause crop loss due to late frosts.

B. Choice of cultivars

The newly-released cultivars by the Ministry of Agriculture for general cultivation in Bhutan are indicated below:

Kanthel Selection

- Big and long trapezoid nuts, semi-erect, and vigorous
- Regular bearer
- Thin-shelled
- Leafing out in 1st week of April
- Flowering habit: Female flower first
- Disease: Tip die back
- Nut size index: 4.27 mm
- Nut in-shell average weight: 26.11 g
- Kernel average weight: 9.32 g
- Harvesting in end-September under Yusipang condition



(Photo courtesy of RNR RC-Yusipang)

Yusipang 2

- Big and long ovate nuts, semi-erect, and vigorous
- Regular bearer
- Thin shelled
- Leafing out in 1st week of April
- Flowering habit: Female flower first
- Disease: Some tip die back
- Nut size index: 4.00 mm
- Nut in-shell average weight: 20.75 g
- Kernel average weight: 8.3 g
- Harvesting in end-September under Yusipang condition



(Photo courtesy of RNR RC-Yusipang)

II. PRODUCTION STAGE

1. Plant propagation

a) Preparing the seeds

- Use the local walnut seedlings as rootstocks.
- Collect the walnut in September to October from the forest. Hull the seeds and air-dry in the open shed.
- Stratify walnut seeds either by early fall planting (planting in December where natural stratification occurs) or by moist cold stratification for spring planting (end of February).
- At lower elevation, stratify the seeds in moist sand or peat moss for about two months. At higher elevation, there is no need to stratify as they are naturally stratified by exposure to outside winter temperatures in a cold room or shady open area.
- Dip the seeds for one minute in hot water (that is, almost boiling condition) before fall planting or stratification.

b) Preparing the nursery

- For fall or spring planting, prepare the nursery carefully.
- Plant the seed in about 10 cm deep and 15 cm apart in rows and 50 cm between the rows. It takes more than two months for the seed to germinate in the nursery for fall planting without stratification while for spring planting (after cold stratification), the seeds germinate within 1-2 weeks after planting.
- Undercut the seedlings when it is about 30 cm tall. Irrigate the seedlings thereafter.

- Thin the seedlings, if required, a few days after undercutting.
- Make sure that the nursery is free of weeds. Irrigate frequently and fertilize the seedlings to correct soil deficiencies.
- If nursery is properly managed, seedlings attend grafting size within a years' time.

c) Grafting operation

The most suitable time to graft walnut under ambient condition is towards the end of dormancy or early spring season (mid-March) especially in an altitude of 700-2,100 masl. If the nursery is located at higher altitude, use grafting cable or hot callusing technique to maintain suitable temperature for walnut grafting (20º-30ºC).

Whip grafting is the best method to graft walnut if the size of rootstock and scion are same. For the large size rootstock, use modified whip grafting. Scion is a short piece of shoot containing dormant buds that is united to the rootstock on the upper portion of the graft and form the shoot system of the composite plant. The procedure is as follows:



Modified whip grafting
(Photo courtesy of RNR RC Bajo)

- Prepare the materials required for grafting such as sharp knife, grafting tape, wax and aluminum vessel, burner (to melt wax), and plant materials (scion and rootstock).
- Use 1-2 year old healthy rootstocks of *Juglans regia* and freshly collected scions of known cultivars for grafting. Use only dormant scion and active rootstock for grafting.
- Make a slanting cut (about 5 cm) with a sharp knife at the base of the scion and at the top of rootstock. For the rootstock, make the cut in the bark portion or lesser cut on wood portion depending on scion size.

- Fit the cut sections of rootstock and scion together making sure that the cambial layers of both rootstock and scion fit perfectly.
- Tie the fitting (graft union) with a grafting tape.
- Dip the scion portion of the grafted plant into the hot wax to prevent scion desiccation.
- Grow the grafted walnut in the nursery or in pots with a growing medium prepared as 1:1:1 ratio of sand, Farm Yard Manure (FYM), and soil. Add basal fertilizers.
- Remove the suckers or shoots growth from the rootstock as and when it appears.
- Irrigate the nursery 1-3 times a week depending upon the weather condition and soil types.
- Take note if bleeding occurs during grafting, that is, sap flow due to root pressure, as it kills the grafts. Control the bleeding by either cutting off the rootstock 5-8 cm above the grafting site about two weeks beforehand or make few slanting cuts in the rootstock through the bark into the wood as low as possible below the grafting point. If any later bleeding happens, it occurs through these cuts. Also, stop irrigation for about two weeks prior to grafting.

2. Layout and tree density

- Layout the orchard in square or Quincunx (diamond) design in gentle slope and flat valley. Use contour planting for hilly and steep slope.
- Consider the number of trees to plant per unit area in terms of both short- and long-term productivity of an orchard. The short-term objective is to have maximum numbers of trees to obtain the earliest economic production potential per unit area. If the initial tree density is too high, remove specific number of trees 8-10 years after planting.
- Space the plants depending on the tree type and vigour. For small and compact tree, use initial spacing of 5 m x 5 m and adjust this to 10 m x 10 m at maturity (high density planting).
- For highly fruitful lateral-bearing but vigorous cultivars and terminal- bearing vigorous cultivars, maintain an initial spacing of 6 m x 6 m and finally adjust to 12 m x 12 m.
- As a general guide, use the following spacing:

Seedling trees	12 m x 12 m
Grafted on *Juglans regia*	10 m x 10 m
Grafted *Juglans nigra*	8 m x 8 m

- When pollenizers are required, place them in permanent position to avoid their elimination during the temporary tree removal. Every eight row, plant a pollenizer variety that is perpendicular to the usual direction of the wind.

3. Pit digging and filling

- On clayey or not very fertile soil, dig a pit 1 m deep and 1 m in diameter. For loamy soil, dig a pit 0.3 m deep and 0.3 m in diameter.
- Break the hard layer on any side of the pit.
- Keep the top surface soil but separate this from the subsoil.
- Fill the pit with mixture of rotten FYM and top surface soil at a ratio of 1:2.

4. Planting

- Order the planting materials in advance before planting.
- If planting is delayed, lay the seedlings in a trench. Cover the root portion with moist soil. Do not allow the seedlings to dry.
- Prepare a hole just enough to accommodate the entire root system. Spread the roots around in all sides and cover with soil. Make sure that the graft union is above the soil zone.
- Plant the seedlings in late dormant/early spring season. Irrigate immediately.
- In the first year, prune the young tree by cutting the top above the graft union but leaving 5-6 buds.
- Paint the trunk with whitewash.
- Stake the young tree in the windy area.
- As the tree leaf out and growth occurs, pinch the growing tip from the shoots other than the one selected as a main trunk.

5. Applying manures and fertilizer

- Use the following guide below as a indicative amount of NPK for the walnut in the absent of plant and soil nutrients analysis information:

Year	N Dose (g/tree)	Location: circle around the tree (m)
1	100	0.5
2	200	1.0
3	300	1.5
4	400	2.0
5-7	500	2.5
7-9	600	3.0
10 to full production	900	3.0

- In the first five years, place small amounts (about 100 g) of P and K per tree. From fifth year up to full production, apply 40-80 kg/ha of P and 60-100 kg/ha of K based on soil fertility and plant vigour.

6. Training

- Train the walnut after the first year using the Modified Central leader System (delayed open centre).
- After the 1st years' growth, head back to 2 m of its height. Remove all the lateral shoots on the leader, leaving one or two shoots at lower level on the trunk to provide shade on trunk's south and west sides.
- To avoid narrow crotches, remove all primary buds above 1.5 m from the ground to force secondary buds to grow.
- Select main scaffold limb 1.6 m above ground. Choose primary scaffold limbs in all directions on the trunk. Ensure that limbs have wider angles, more than 30 cm apart vertically on the main trunk.
- Remove the rest of the vigorous branches leaving small branches undisturbed for fruiting.
- Head back all the selected limbs on terminal fruiting cultivars but not for lateral fruiting ones.
- After 2-3 years, allow the secondary scaffold limbs on primary scaffolds to grow by removing the extra vigorous branches.
- Head back all scaffold limbs every year in terminal fruiting cultivars.
- For cultivars that are highly fruitful on lateral buds, head back a large number of new shoots on the periphery to reduce fruiting and increase vigorous shoot growth throughout the trees' periphery.
- On terminal bearing cultivars, head back selected branches and thin out limbs completely.

7. Pruning

- Carry-out pruning operation in the dormant season but early spring is preferable. Further delay causes excess bleeding.
- For young (16-17 year-old) and middle aged trees (34-35 year-old), cut back 3-year old shoots. For mature trees (40 year-old), cut back 4-5 year-old shoots.
- Initiate selective thinning out of limbs in the top and sides of the tree before overcrowding becomes serious. Do not remove more than 25% of the branch structure at any time.
- Treat all the cut surfaces with a tree wound dressing such Copper oxychloride or Bordeaux paste.

8. Tree thinning

- Practice tree thinning in closely-planted orchards (high density planting). Remove the tree before it begins to crowd.
- Remove the one-third temporary tree or alternate tree at one time as the tree gets crowded leaving trees on the edges of the plantation.

X	X	X	X	X
X	R	X	R	X
X	X	R	X	X
X	R	X	R	X
X	X	R	X	X
X	R	X	R	X
X	X	X	X	X

Alternate tree removal (R) leaving edge trees in place

9. Mulching

- Mulch the tree with plastic or organic materials like straw or grasses

10. Intercropping

- Intercrop walnut trees with legume fodders in areas traditionally under pasture farming system. For other farming systems, use low growing and non-competitive vegetables such as non-climbing beans and other legumes, tomato, and onion and more competitive vegetables such as chili and asparagus.
- Intercrop during the first 4-6 years after planting only.
- If sustained intercropping is planned from the establishment of the orchard, modify the spacing, that is, much wider between rows of mature trees.

11. Irrigation scheduling

- Do supplemental irrigation in dry spring and early summer before the start of monsoon period, that is, provide irrigation from April to June
- No irrigation is needed from June onwards until harvest since this is the monsoon season.

12. Top-working

- For walnut orchard establishment, plant the walnut seedlings directly in the production field without nursery grafting and top-worked two years later. This is the best method of orchard development in Bhutan.



Two-year old walnut seedling plantation
(Photo courtesy of RNR RC Bajo)



Top-worked walnut fruited two years after operation at 2,300 masl
(Photo courtesy of RNR RC Bajo)

- To avoid sap bleeding, either head back the stock two weeks before actual operation or make few slanting cuts on the stock through the bark into the wood just bellow the grafting point so that if any bleeding occur later, it occurs though these cuts.
- Select disease-free young trees for top-working.
- Cut the dormant scion wood from the parent tree in advance. Wax the scion, pack properly, and store in the refrigerator at 4^{o}C.
- Do bark grafting for top-working in late spring (end of March to April) or when new growth has taken place.
- Wrap the graft union with thick plastic sheet.
- Paint the stem portion with white wash.
- Remove the shoots other than the scion growing on the plant.

13. Harvesting and post-harvest operation

- Walnut trees from seedling bear nuts in 10-12 years and full commercial production 18-20 years from planting. On the other hand, grafted walnut starts production earlier, that is, in 4-5 years after planting and full commercial production in 8-10 years only.
- A fully-grown, big size tree produces as high as 100-150 kg nuts but the average yield is 40 kg per tree.
- Crop maturity and harvest in Bhutan starts from August-October depending on the elevation and cultivars. Do not delay harvesting to avoid deteriorating the nut quality kernel (brown colour kernel). The lightest kernel colour commands higher price in the international market.
- To determine maturity, observe the following:
  a) The nuts are mature when the nut dehisce and fall. In higher altitude, kernel matures earlier to hull dehiscence while in the lower altitude, hull dehiscence take place prior to kernel maturity.
  b) The walnut kernels are mature when the packing tissue between and around the kernel halves has just turned brown and crop can be harvested if 80% of the nut can be removed with 95% of them hullable. Harvest the remaining nuts few days after the first harvest.
- Collect the nuts from the ground. Clean, wash, and spread the nuts on a sheet or floor to dry them up to 8% moisture level.
- Grade the nuts according to size, colour, and variety.
- Store the nuts in gunny bags inside small well-ventilated rooms free from excessive humidity. Nuts have long shelf-life and it can be sold in extended marketing season.

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Chili Description



Chili is by far the most important vegetable in Bhutan. Local markets are never without chili, always teemed with different colours and sizes, in fresh and dried form. Bhutanese call this crop *ema* (in Dzongkha) or solo (in Sharchopkha). Chili is a staple vegetable in Bhutan; the famous *ema datsi* recipe is entirely made of chili mixed with local cheese. Chili is also important ingredients in almost all curries and food recipes.

All Dzongkhags grow chili for home consumption or for sale in the domestic market. Some Dzongkhags like Trashi Yangtse, Trashigang, and Wangdue Phodrang produces early chili that fetches premium price. The top chili-producing Dzongkhags in 2004 were Paro, Punakha, Wangdue Phrodrang, Thimphu, and Trashigang while Southern Bhutan produces chili in fewer amounts. In 2000, the country produced 2,848.6 t, of which 925.96 t are exported, mainly to India (Planning and Policy Division, 2003).

Bhutanese cultivate the chili in rice-based farming system and in dry land as monocropping or other cereal-based cropping system. In rice-based farming system, it is cultivated before rice and is mainly targeted for early season market to get premium price (Gyambo Tshering, personal communication). Chili production in dry land particularly in higher elevation is done for late season fresh or dry chili market. The yield varies from one area to another and based on management aspects but the average yield is about 15-20 t/ha.

The selling price of chili varies with season and cultivars. The market price is as high as Nu 100-200/kg in Thimphu for the fresh chili that appears first in the market, and then the price falls as production season progresses, and stabilizes at Nu 15-20/kg in the main season (June to September). The fresh chill price increases again in the local market late in the season (October to December) as production and supply chili falls (Gyambo Tshering, 2006, personal communication). On the other hand, the selling price of dried chili in the local market is Nu 50-60/kg.

The production cost of Bhutanese fresh chili is about Nu. 15.49/kg in the west-central region and farmers earns good profit from the chili farming enterprise.

TECHNOLOGY FOR CHILI PRODUCTION IN BHUTAN

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I. PRE-PRODUCTION STAGE

A. Growing Conditions

Criteria	Description
1. Altitude	• Between 250 metres above sea level (masl) such as in southern Dzongkhags to 2,600 masl like in Bumthang and Ha Dzongkhags • Growing seasons: a) Below 800 m (low elevation) – November to April b) Between 800 m to 1,500 m (mid-elevation) – February to October c) Above 1500 m (high elevation) – April to September
2. Soil pH	• pH range of 5.5 to 6.8.
3. Soil texture	• Grow ideally in loamy to clay loamy soils.
4. Temperature	• Grow best at 15^{o}-32^{o}C.

B. Choice of Variety

The choice of variety depends on end-users or market demand. *Sha ema* and *Baegop ema* are suitable both for fresh and dried purposes with high demand in the domestic market while Super solo is suitable for fresh and salad purposes but with less demand in the market at the moment. The recommended varieties are given below:

Variety Name	Altitude (masl)	Recom-mended Dzongkhags	Days to Maturity	Pest/Disease Reaction	Potential Yield (t/ha)
Sha Ema	250 - 2,600	All Dzongkhags	Depends on elevation/ temperature	Susceptible to *Phytopthora* wilt and chili mosaic virus	No data available

Baegop Ema	250 - 2,600	All Dzongkhags	Depends on elevation/ temperature	Susceptible to *Phytopthora* wilt and chili mosaic virus	No data available
Super Solo	1,000 - 2,600	In most of the Dzongkhags	Depends on elevation/ temperature	Susceptible to *Phytopthora* wilt and chili mosaic virus	48

Characteristics of Main Chili Varieties Grown in Bhutan

Sha Ema

- Plant size: Medium
- Fruit orientation: Pendent
- Fruit shape: Elongated, shoulder at the calyx area and with blunt tips
- Fruit colour (not ripe): Green
- Fruit colour (ripe): Red
- Fruit length: 8 cm
- Fruit width: 2.4 cm
- Average fruit weight: 23.7 g
- Seed percentage: 8%
- Pedicel length: 3.1 cm
- Fruit wall thickness: 0.3 cm (thick)
- Pungency: Mild
- Number of lobs: 3
- Yield: 15-25 t/ha



Photo courtesy of RNR RC Bajo

Baegop ema

- Plant size: Medium
- Fruit orientation: Pendent
- Fruit shape: Elongated, no shoulder, calyx covering the entire base of fruit and with pointed tips
- Fruit colour (not ripe): Green
- Fruit colour (ripe): Red
- Fruit length: 8.7 cm
- Fruit width: 1.7 cm
- Average fruit weight: 20.5 g



Photo courtesy of RNR RC Bajo

- Seed percentage: 9%
- Pedicel length: 3.2 cm
- Fruit wall thickness: 0.25 cm (thick)
- Pungency: Mild
- Number of lobs: 3
- Yield: 15-25 t/ha

Super Solo

- Plant height: 61 cm
- Pungency: Milder than *Sha Ema* though fruit shape is similar but pointed tips
- Fruit length: 18.5 cm
- Fruit width: 4 cm
- Fruit weight 80 g and fruit wall is thicker than *Sha ema*
- Good as fresh vegetable and salad purposes
- Not suitable as dried chili as it is difficult to dry and the quality of dried chili is poor



Photo courtesy of RNR RC Wengkhar

II. PRODUCTION STAGE

1. Nursery Preparation

- Plough and pulverize the soil thoroughly. Prepare nursery bed measuring 1 m wide and 15-20 cm high and of convenient length (3-5m).
- Treat seeds with Bavistin (Carbendazim) at 2 g/kg seed, against *Phytopthora* and other seed-borne diseases.
- Use seed rate of about 0.5-1 kg of quality seed per acre with minimum germination of 75%.
- Sow seeds about 2 cm deep in lines at 10 cm apart.
- In mid-elevation areas, raised nursery in polytunnel for early chili production and normal open nursery for main season chili production.
- In high-elevation areas, sow the seeds in plastic tunnel. This will bring forward the growing season by one month.
- The seedlings are ready for transplanting in about 30-60 days after sowing depending on the elevation under ambient conditions or when the seedlings attained 12-15 cm height.

2. Field Preparation

- Cultivate, pulverize, and level the field after bringing soil to a good tilth.
- Raise 1 m wide, 15-20 cm high beds and any convenient length (3-5 m). Ensure proper levelling of field and beds for water and disease management. Raised bed and drainage is important for chili wilt management
- Apply 10-12 t of well rotten Farm Yard Manure (FYM) and 20:30:15 NPK kg/acre as basal dose.
- Apply all FYM during field preparation. Apply all the basal fertilizer at about 9-10 g of fertilizer mixture per planting hill and mix them into the soil using hand hoes.

3. Transplanting

- Transplant seedlings of 12-15 cm high, preferably during evening time and water immediately to avoid transplanting shock.
- Transplant the seedlings at 45 cm between rows and 30 cm between plants in a row or a population of at least 25,000 plants per acre.
- Top-dress the crop with 10 kg of additional nitrogen after 30 and 60 days after transplanting. Split the top dressing fertilizer in two halves in very light soils.

4. Weeding

- Maintain the crop free from weeds to avoid competing for water, air, nutrients, and space and eventually effecting on crop performance.
- Apply 3-4 weeding/hoeing depending upon the weed pressure, soil structure, and weather conditions of the locality.

5. Irrigation

- Irrigate manually using water cans or hose pipe. The frequency of irrigation depends on the moisture retention capacity of the soil, amount and frequency of rainfall, and local weather conditions (evapo-transpiration).
- Maintain the soil moisture regime at field capacity right after transplanting until harvest.
- Avoid excess water or water-logging as it is harmful to plants and makes congenial environment for *phytopthora* wilt disease to explode and completely destroying the crop.

6. Harvesting

- Chili matures in 120-130 days after sowing in mid-altitudes and might take even longer in higher elevation or harvest it when few fruits turns red colour.
- Do 3-6 harvests/pickings depending on the elevation of area and crop management aspects. At higher elevation, do less numbers of pickings than in mid elevation areas.

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Tomato Description



There are many varieties of tomatoes based on uses (processing and table types) and growth habits (determinate or bush type and indeterminate types). In Bhutan, tomato is called *lambenda* (in Dzongkha and Sharchopkha). This crop is one of the most important vegetables in the country with local markets selling assorted colours and sizes, mainly in fresh form.

Tomato is practically grown in almost all of the Dzongkhags mainly for home consumption or for local retail. Paro, Thimphu, Punakha, and Wangdue Dzongkhags are the top tomato producers in 2005.

A Bhutanese grower obtains an average yield of 10-15 t/acre per season. There is mainly two growing seasons in Bhutan, namely: summer production in higher elevation and winter production in southern foot hills. Tomatoes are usually grown in less than an acre with average production cost of Nu 5.20/kg. In local markets, a kilo of fresh tomatoes fetches Nu 10-30 depending on the marketing season.

Tomatoes are important ingredients for almost all delicacies and cooking. It is also consumed fresh as salad.

In 2004, Bhutan produced 39.8 t of tomatoes and exported both fresh and processed products such as sauce and ketchup to other countries.

TECHNOLOGY FOR TOMATO PRODUCTION IN BHUTAN

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I. PRE-PRODUCTION STAGE

A. Growing Conditions

Criteria	Description
1. Altitude	• Between 300 metres above sea level (masl) such as in southern Dzongkhags to above 2,200 masl like Paro and Thimphu Dzongkhags • Growing seasons: a) Below 1,000 masl, from October to middle of April. Start nursery sowing from first week of October to mid-December. b) At 1,000-1,500 masl, from March to October. Start nursery sowing from first week of March to end of May. c) Above 1500 masl, from April to September.
2. Soil pH	• Soil pH range is 6-7. • Apply dolomite powder at 1.5 t/acre if the soil pH is below 5.
3. Soil texture	• Grows ideally in loam and sandy loam soils.
4. Temperature	• Grows well when the day temperature is between 13^0-35^0C

B. Choice of Variety

The choice of variety depends on the market requirements such as for fresh or table purposes. The recommended varieties are given below:

Variety Name	Altitude (m)	Recom-mended Dzongkhags	Days to Maturity	Pest/ Disease Reaction	Potential Yield (t/ha)
Roma	300-2,300	All Dzongkhags	80-100		20-30
Ratan	300-2,300	All Dzongkhags	80-100	Tolerance to blight	20-30
CHT160	300-2,300	All Dzongkhags	60-100		20-30

Characteristics of Main Tomato Varieties Grown in Bhutan

Roma

- Determinate or bush type
- Oval or pear-shaped and red fruit
- Fruit length is 5.8 cm; width is 4.3 cm
- Plant height is 85 cm
- Good for cooking and processing
- Can withstand long distance transport and have better shelf-life.



(Photo courtesy of RNR RC Bajo)

Ratan

- Determinate variety
- Deep red, round, and large fruits
- Fruit length is 5.7 cm; width is 5.62 cm
- Plant height is 81 cm
- Ideal for salad and cooking
- Need staking and raw mulching
- Need plastic roofing if rainy/cloudy period is prolonged during fruit maturity



(Photo courtesy of RNR RC Bajo)

CHT160

- Indeterminate variety
- Deep red, round, and medium size fruit
- Fruit length is 3.62 cm; width is 3.58 cm
- Plant height is 138 cm
- Ideal for salad and cooking
- Need staking and raw mulching
- Need plastic roofing if rainy/cloudy period is prolonged during fruit maturity



(Photo courtesy of RNR RC Bajo)

II. PRODUCTION STAGE

1. Nursery Preparation

- Prepare the nursery soil thoroughly two weeks before sowing. Raise nursery beds to 15 cm high and 1 m wide.
- Before sowing, treat the seeds with fungicide like Thiram or vitavax at 2 g/kg seed.
- Use seed rate of 200 g/acre of good quality seeds with 75% minimum germination.
- Sow seeds at 1.5 cm deep in rows at 10 cm apart.
- To produce good seedlings – particularly above 1,000 m for early planting – sow seeds in plastic tunnels. Use semi-circular structure of bamboo sticks lay over the nursery bed at 1 m apart. Lay the plastic sheet over the structure and cover the edge of the plastic with soil. Keep the tunnel open during sunny days. Irrigate daily using a sprinkler by opening the plastic cover.

2. Field Preparation

- Plough and level the field thoroughly.
- Raise 1 m wide beds and 15-20 cm above the ground and of convenient length depending upon the field condition.

3. Fertilizer Application

- Since tomato has a high nutrient requirement, determine the adequate fertilizer required for each plot during field preparation with the assistance of the National Soil Service Centre (NSSC) in Semtokha, Thimphu.
- Take note that fertilizer application depends upon soil fertility and other factors. In general, apply an indicative fertilizer requirement during field preparation on a per acre basis as 6-8 t of Farm Yard Manure (FYM) and 10:20:20 kg of N:P:K/acre as basal. Mix all the fertilizer thoroughly. Apply basally in hills (spot application) about 250-300 g of FYM and 6 g of fertilizer mixture. Mix with soil properly up to a depth of 20 cm.
- Thirty days after transplanting, top dress the crop with 10 kg additional N. Apply the nitrogen in rings around the plant and cover with soil. In light soil, split the top dress application into two at 30 and 60 days after transplanting.

4. Transplanting

- Place the seedlings in the baskets. Make sure not to damage the roots or dropping all the soil from the roots.
- Transplant when the seedling are 12-15 cm tall, normally in about 30-50 days after sowing depending on the elevation.

- Plant the seedlings at a spacing of 40 cm plant to plant within a row and 50 cm between rows or row to row, or a population of at least 39,000 plants per acre.
- Transplant the seedlings preferably in the evening and irrigate immediately so as to reduce the transplanting shock.
- Since indeterminate varieties require stacking, use bamboo stake after flowering and tie the plants to it loosely as it grows.
- Regularly prune or pinch the side shoots and suckers for indeterminate or stacking type of tomatoes. For bush-type of tomatoes, do fruit thinning to get better size and quality fruits.
- For stacking type of tomatoes, remove all suckers on the lower 50 cm of the stem, then let the plant bush out with branches tied to a stake to achieve early and quality fruit production and to avoid sunscald.

5. Weeding

- During the first few weeks after transplanting and even throughout the growing season, frequently weed the plot to keep it free from weeds that will compete with water, nutrients, air and space, or light.
- Weed manually with hand or use garden hoe without damaging the shallow tomato roots.

6. Irrigation

- Water the young plants at field capacity for few weeks after transplanting to encourage good vegetative growth. Reduce the amount of irrigation and frequency in 4-5 weeks after transplanting to provide little water stress which will enhance tomato flowering and production.
- After the fruit set, maintain uniform soil moisture to avoid blossom-end rot and fruit cracking and to improve fruit quality.
- Reduce irrigation slightly towards the time of harvest to get good flavour and less watery fruits.

7. Harvesting

- Harvest the fruits 80-90 days after transplanting but it will largely depend on the type of tomato, varieties, and distance from the market**.**
- For best quality, harvest tomatoes at fully ripe stage, that is, when green fruit turns to normal varietal colour. However, for long distance market, harvest tomatoes at mature and half-ripe fruit stage.
- Pick tomatoes by twisting rather than pulling the fruits. Pack the fruits in crates lined with straw or similar materials which are placed at the bottom, sides, and at the top.

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1. Additional New Horticulture Technology (2005), RNRRC-Bajo, CORRB, MOA.
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3. Guidelines for tomato cultivation (1994), IHDP, Ministry of Agriculture.
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6. RNR Statistics (2004), DOA, MOA.
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8. G. Tshering (2006), Personal communication.

Attachment 5

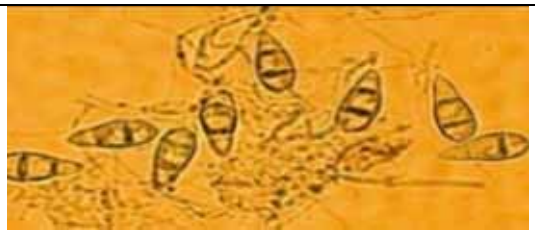
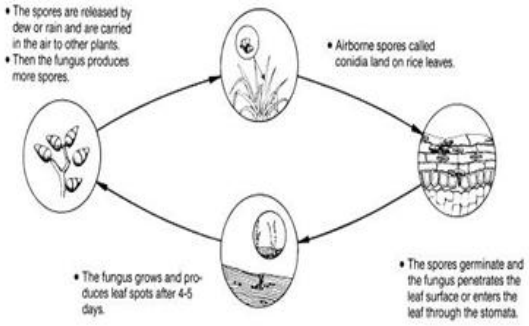
TECHNOLOGY FOR MAJOR PEST AND DISEASE MANAGEMENT OF AGRICULTURAL CROPS IN BHUTAN

By

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A. Rice

1. Rice Blast

Causal Organism	Fungus: a) Sexual state - *Magnaporthe grisea* (Hebert) Barr b) Asexual state - *Pyricularia grisea* (Cooke) Saccardo	 **Rice blast spores (Photo courtesy of Rice Blast Genomics Project)**
Parts affected	• Leaf blades • Stem nodes • Panicles	 **Rice blast life cycle (Photo courtesy of IRRI)**

<table>
<tr><td rowspan="3">Symptoms</td><td>On leaf blades
• Presence of lesions (wounds) on the leaves
• New lesion (wound) colour is white to grey-green with darker green borders
• Older lesions are whitish to grey with necrotic (burned) borders
• Lesions on younger leaves are less than 1cm long while in older leaves are larger (2 cm and above)</td><td>
Leaf blast
(Photo courtesy of IRRI)</td></tr>
<tr><td>On stem nodes
• Infected nodes have blackened appearance
• Culm breaks easily at infected nodes.</td><td>
Neck blast
(Photo courtesy of NPPC)</td></tr>
<tr><td>On panicles
• Few, no seeds, or white heads when neck is infected or rotten</td><td>
Panicle blast
(Photo courtesy of The American Phytopathological Society)</td></tr>
<tr><td colspan="3">Control Measures</td></tr>
<tr><td>1. Cultural Control</td><td colspan="2">• Use disease-free seeds. Never use seeds from a blast-infected field since the fungus can be transmitted through seeds.
• Raise seedlings on a wet bed, as dry nurseries generally favour blast.</td></tr>
</table>

	• Do not apply too much manure or fertilizer as high Nitrogen will increase the susceptibility of paddy to blast. • Avoid high density planting. Maintain at least 20 cm planting distance. • Farmers in the same area should transplant at the same time. • Do not leave the fields dry after transplanting. Paddy is more resistant to blast when grown under proper water management. • Burn infected straw and stubble in the field.
2. Varietal Control	• Use resistant varieties like Bajo Kaap, Chumroo, No. 11, and IR64.
3. Chemical Control	Seed treatment: • Soak seeds in water for 24 hours. • Treat the seeds with Tricyclazole at 3 g/kg of seed. • Germinate the seeds for 24-48 hours before sowing. Field Spraying: • Monitor rice nurseries/field regularly for blast infection. • If there are blast symptoms on the leaves, spray early on with Tricyclazole at 1 g/litre of water.

2. Stem Borer

Causal Organism	Insect: a) Yellow stem borer (YSB) *Scirpophaga incertulas* (Walker) b) White stem borer (WSB) *S. innotata* (Walker) c) Striped stem borer (SSB) *Chilo suppressalis* (Walker) d) Gold-fringed stem borer *C. auricilius* Dudgeon e) Dark-headed stem borer *C. polychrysus* (Meyrick) f) Pink stem borer *Sesamia inferens* (Walker)	**YSB, SSB, Dark-headed SB, and Pink stem borer (Photo courtesy of www.doae.go.th)** 
Parts affected	• Tillers • Panicles	

<table>
<tr><td rowspan="2">Symptoms</td><td>On tillers
• Central tiller dries and dies during vegetative stage.
• Dried/dead tillers can be easily pulled from the base.
• Small holes on stems and tillers.
• Faeces or excretion of the larvae inside the affected stems.</td><td>
Dead tiller/heart
(Photo courtesy of IRRI)</td></tr>
<tr><td>On panicles
• Panicles are unfilled, empty or chalk-like.</td><td>
Whitehead at reproductive stage (Photo courtesy of IRRI)</td></tr>
<tr><td colspan="3">Control Measures</td></tr>
<tr><td>1. Cultural Control</td><td colspan="2">• Harvest the crop at ground level to remove the larvae in stubble. Remove and destroy stubble and volunteer rice – these are rice plants that grow on its own from seeds left in the field.</td></tr>
<tr><td>2. Chemical Control</td><td colspan="2">• Do not spray chemical as it alters the natural predators' ecology.</td></tr>
</table>

3. Weeds

<table>
<tr><td>Causal Organism</td><td>Bog Pond Weed or Shochum
(Potamogeton distinctus A. Benn.)</td><td>
Flowering Shochum
(Photo courtesy of NPPC)</td></tr>
</table>

Effect on rice	• Reduces yield up to 35% • Competes with nutrients and space.	 **Shochum growing vigorously along with rice (Photo courtesy of RNR RC Bajo)**
Control Measures		
1. Low weed (grass & sedge) pressure	• Do hand weeding at least two times (20 and 40 days after transplanting [WAT]). If hand weeding is to be done, keep in mind to closely space the plants and do the first weeding not later than 30 days after transplanting (DAT).	
2. High weed (grass & sedge) pressure	• Use line planting and rotary weeding. If line planted, do two rotary weeding at 20 and 40 DAT.	
4. Low Shochum pressure	• If there is no or little *Shochum* but weed pressure is expected to be high, apply Butachlor at 12-16 kg per acre 3-6 DAT. Do not use Butachlor in areas heavily infested with Shochum.	
5. High Shochum pressure	• Do intensive hand weeding 3-4 times thoroughly at 2, 4 and 6 WAT, by removing and destroying the weeded Shochum biomass. • Pull out the roots/turions and dispose the weeds in a pit away from the field. • To minimize Shochum problem, adopt cultural methods like increased tillage, deep ploughing, and restricting the physical movement of plant parts from one field to another. • Since weeding is laborious and the use of herbicides is not environment-friendly, use indirect complementary weed control methods like good land preparation, proper water management, and use of weed-free seedbeds and seeds.	

B. Chili

1. Chili Blight

Causal Organism	Fungus: *Phytophthora capsici* Leonian	 **Spores of *Phytophthora capsici* (Photo courtesy of Michigan State University)**
Parts affected	• Leaves • Stems • Fruits • Roots	
Symptoms	On leaves • Lesions (wounds) are circular and water-soaked initially and become grayish-brown as the disease advances. • Infected leaves are usually "half-moon shaped". • Leaves wilt and die.	 **Water-soaked lesions on leaves caused by *P. capsici* (Photo courtesy of NPPC)**

	On stems • Dark lesion girdles the base of the stem and may expand on the stem restricting the upward movement of nutrients and water from roots. • Stem girdling results in sudden wilting of the plant.	 **Black stem lesion caused by *P. capsici* (Photo courtesy of NPPC)**
	On fruits • Starts as "small, water-soaked, dull green spot" that rapidly spreads to the whole length of the pod under favourable conditions. • Infected fruit shrivel but remain attached to the plant.	 **Fruit rot caused by *P. capsici* (Photo courtesy of NPPC)**
	On roots • Root rots and hence restricts the movement of water and nutrients to other parts of plant.	 **Root and crown rot caused by *P. capsici* (Photo courtesy of NPPC)**

Control Measures	
1. Cultural Control	• Select a site that has not been used for chili cultivation. • Avoid water-logged fields. • Follow crop rotation with non-solanaceous crops such as cabbage, cauliflowers, broccoli, etc. • Sterilise the soil by burning straw/mulching materials. • Use healthy seeds and seedlings. Never buy from weekend markets. • Raise and transplant seedlings on a raised bed at least 30 cm high and 1 m wide to ensure that moisture does not collect at the base of the plants. • Avoid planting too densely; maintain 30 cm row-to-row and 20 cm plant-to-plant distance. • Maintain the height of the bed and drain water throughout the cropping season. • Drain out standing water from the field immediately after rainfall. • Rogue out any infected plants and burn the plants.
2. Chemical Control	Seed treatment: • For 500 g chili seeds, dissolve 2.5 g Copper Oxychloride and 2 g Ridomil in 500 ml water. Mix the solution thoroughly. • Soak the seeds for 10-15 minutes. Leave overnight and air dry in a shade. Seedling treatment: • Prepare fungicide solution by dissolving 2.5 g Copper Oxychloride and 2 g Ridomil in 1 litre water. • Dip seedlings for 10-15 minutes with the roots fully immersed in the solution. Foliar Spray: a) Under low rainfall condition • 1st Spray- Use Ridomil at 2 g/litre of water within two weeks of transplanting. Observe waiting period of at least seven weeks before harvesting. • 2nd Spray- Use Copper Oxychloride at 2.5g/litre of water 14 days after 1st spray • 3rd Spray- Use Copper Oxychloride at 2.5g/litre of water 10-14 days after the 2nd spray b) Under heavy rainfall condition • 1st Spray – Use Ridomil at 2 g/litre of water within 10 days of transplanting.

	• 2nd Spray – Use Ridomil at 2 g/litre of water 15 days after the 1st spray. Observe waiting period of at least seven weeks after the last spray before harvesting. • 3rd Spray – Use Copper Oxychloride at 2.5 g/litre of water 14 days after 2nd spray. • 4th Spray – Use Copper Oxychloride at 2.5 g/litre of water 10-14 days after 3rd spray.

C. Chili and Potato

1. Common Cutworm

Causal Organism	Insect: *Agrotis segetum* (Denis and Schiffermüller)	 **Cutworm caterpillar (Photo courtesy of NPPC)**
Parts affected	• Stems	
Symptoms	On stems • Stem of seedlings above the ground level is cut though. • Leaves of cabbage seedlings are cut off. • Below ground the caterpillar also feeds on crops like potato, turnip and turnip.	 **Chili seedling damaged by cutworm (Photo courtesy of NPPC)**
Control Measures		
1. Cultural Control	• Dig out and expose pupae and larvae to the sun and natural enemies. • Clean the field and remove weeds to reduce larvae population in the soil. Weeds serve as host for cutworm to lay eggs and supply food for the larvae. • Mulch chilli plots with Artemisia, a shrub, locally known as	

	Khempa, Mayreng-ma, Titepathi, to prevent build-up of cutworm population.
2. Mechanical Control	• Collect and manually remove the larvae from the affected fields. • Dig the soil around the affected plants to expose and kill the larvae.
3. Natural Control	• Protect birds like Hoopoes as they feed on cutworms.
4. Chemical Control	• Dip seedlings in Chlorpyrifos solution (4 ml/litre water) before transplanting. • In case of severe infestation, spray with Chlorpyrifos at 4 ml/litre water.

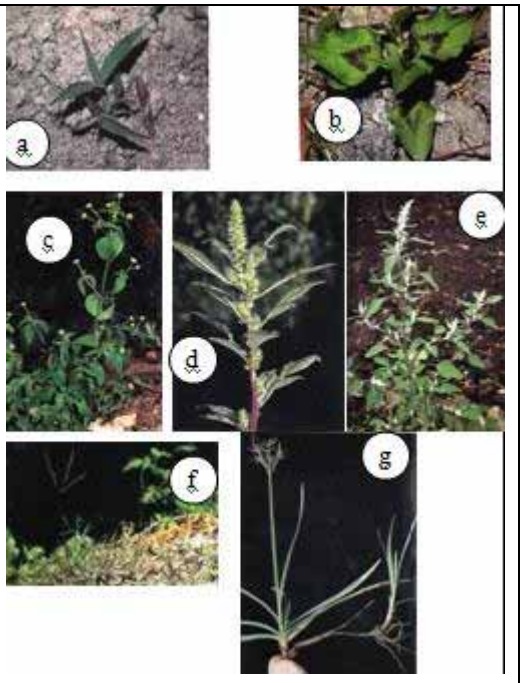
D. Potato

1. Late Blight

Causal Organism	Fungus: *Phytophthora infestans*	 **Sporangia of *P. infestans* (left) and Oospores of *P. infestans* (Photo courtesy of Cornell University)**
Parts affected	• Leaves • Tubers	
Symptoms	On leaves • Small light to dark green water soaked spots with a chlorotic halo. • Lesions become bigger rapidly and turn brown or purplish black. • Affected leaves covered by a cotton-like white mouldy growth on the underside of the leaf or stem. • Infected leaves die within a few days.	 **Late blight lesion on potato leaf (Photo courtesy of Cornell University)**

	On tubers • Infected tubers show irregular and slightly depressed areas of brown to purplish skin. • Tubers may rot completely due to secondary infections.	 **Late blight tuber rot (Photo courtesy of The Pennsylvania State University)**
Control Measures		
1. Cultural Control	• Select a site that has not been used for potato cultivation. • Avoid water-logged fields. • Follow crop rotation with non-solanaceous crops such as cabbage, cauliflowers, broccoli, etc. • Use certified healthy seeds preferably from Druk Seed Corporation (DSC). • Sort out infected tubers during seed selection.	
2. Chemical Control	Foliar Spray: • Monitor potato field for late blight symptoms. • Spray immediately on emergence of first disease symptoms. Use Mancozeb at 2 g/litre water followed by a second spray, if needed, with Copper Oxychloride at 5 g/litre water. During rainfall, use sticker (e.g. Sandovit) with the chemical.	

2. Weeds

<table>
<tr><td>Weeds</td><td>a) Crab Grass (Digitaria ciliaris),
b) Helpsi, Shido (Persicaria runcinata, P. nepalinsi)
c) Jagyouma, Jasasuju (Galingsoga parviflora)
d) Pig Weed (Amaranthus spp.)
e) Lambsquarters/Fat Hen (Chenopodium spp.)
f) Bermuda grass (Cynodon dactylon)
g) Nutsedge/Nutgrass (Cyperus rotundus)</td><td></td></tr>
<tr><td>Effect on potato</td><td>• Reduces yield by as much as 50-60%
• Competes with nutrient, water, and light
• Damages tubers</td><td></td></tr>
<tr><td colspan="3">Control Measures</td></tr>
<tr><td>1. Mechanical Control</td><td colspan="2">• Plough or use power tiller to control established annual and perennial weeds.
• Clear and remove roots/rhizomes of perennial weeds manually.</td></tr>
<tr><td>2. Physical Control</td><td colspan="2">• Do first weeding and ridging as soon as the potato emerges (4 weeks) or sooner if weed growth is heavy.</td></tr>
<tr><td>3. Chemical Control</td><td colspan="2">• Before the potatoes emerge, spray Metribuzin (Sencor) at 1 g/litre water. During rainy condition, use a suitable sticker (e. g. Sandovit).
• Supplement chemical application with hand weeding.</td></tr>
</table>

3. Potato Tuber Moth

Causal Organism	Insect: Potato Tuber Moth, *Phthorimaea operculella* (Zeller)	 **Close-up view of potato tuber moth (Photo courtesy of NPPC)**
Parts affected	• Tubers • Leaf Veins • Petioles • Stem	
Damage Symptoms	On tubers • Presence of galleries inside infested tubers when cut open	 **Infested tubers (Photo courtesy of NPPC)**
	On leaf veins, petioles, and stem • Tunneling of the above parts • Wilting of the plant	 **Potato leaf showing signs of damage caused by the PTM (Photo courtesy of the Virtual Museum of Canada)**

Control Measures	
1. Cultural Control	• Do deep planting (at 10 cm deep) with frequent hilling-up of the soil to reduce field infestation.
2. Sanitation	• Use only healthy tubers as seed. • Clean storage conditions. Clean the walls and the floor of the store properly and dispose off old leftover potatoes to reduce infestation. • Store potatoes in a cool area as low temperature limits the development of the pest.
3. Natural Control	• Natural enemies like parasitoids may play an important role in keeping this pest in check. Avoid improper and indiscriminate use of chemicals to encourage the presence of natural enemies.
4. Resistant Variety	• Use resistant varieties like Desiree to reduce infestation.
5. Chemical Control	Field: • Apply either Cypermethrin (1 ml/2 litres water) or Chlorpyrifos (4 ml/litre of water) when pest appears in the field. • For severe infestation, spray with Chlorpyrifos at 4ml/litre of water. Store: • Mix Fenvalerate dust with the infested tubers at 100 g/100 kg potato).

E. Tomato

1. Late Blight

Causal Organism	Fungus: *Phytophthora infestans*	 **Sporangia of *P. infestans* (left) and Oospores of *P. infestans* (Photo courtesy of Cornell University)**
Parts affected	• Leaves • Stems • Fruits	

<table>
<tr><td rowspan="3">Symptoms</td><td>On leaves
• Pale green, water-soaked spots, often beginning at leaf tips or edges.
• Lesions/wounds of 1-2 mm diameter are visible on leaves after 3-4 days of infection.
• Lesions/wounds have a brown dead centre, surrounded by host tissue that has died and appears either water soaked, grey-green, or yellowed.</td><td>
Tomato leaves with late blight lesions (Photo courtesy of T.A. Zitter, Cornell University, Ithaca, NY)</td></tr>
<tr><td>On fruits
• Large, firm, brown, leathery-appearing lesions/wounds, often concentrate on the sides or upper fruit surfaces.
• Abundant white mould growth on the lesions.
• Rotting of entire fruit if secondary soft-rot bacteria gains entry in the wounds resulting in a slimy, wet rot of the entire fruit.</td><td>

Phytophthora blight of tomato (Photo courtesy T.A. Zitter, Cornell University, Ithaca, NY)</td></tr>
<tr><td>On stems
• Infected stems appear brown to black.</td><td>
Infected tomato plants with lesions on stems and foliage (Photo courtesy T.A. Zitter, Cornell University, Ithaca, NY)</td></tr>
</table>

Control Measures	
1. Cultural Control	• Select a site that has not been used for tomato cultivation before. • Avoid water-logged fields. • Follow crop rotation with non-solanaceous crops such as such as cabbage, cauliflowers, broccoli, etc. • Use certified healthy seeds preferably from Druk Seed Corporation (DSC). • Sort out infected tubers during seed selection.
2. Chemical Control	Foliar Spray: • Monitor potato field for late blight symptoms. • Spray immediately on emergence of first disease symptoms with Mancozeb at 2 g/litre water followed by a second spray, if needed, with Copper oxychloride at 5 g/litre water. During rainfall, use sticker (e.g. Sandovit) with the chemical.

F. Walnut

1. Walnut Blight

Causal Organism	Bacteria: *Xanthomonas campestris* pv. juglandis	
Parts affected	• Nuts • Shoots	
Symptoms	On shoots • Black lesions, and leaves show irregular lesions on blade.	 **A shoot infected with walnut blight (Photo courtesy of University of California)**

	On Nuts • Black, slightly sunken lesions at the flower end (end blight) when young; • More lesions develop on the sides of the nut as it matures (side blight).	 **Blight infection on side of young walnut (Photo courtesy of University of California)**
Control Measures		
1. Chemical Control	• Spray Copper oxychloride at 5 g/litre water when the first nutlet/pistillate flower emerge. In areas with heavy rainfall, spray 7-10 days after first spray. Use sticker (Sandovit) when spraying chemical during rainy periods. (Source: http://www.ipm.ucdavis.edu/PMG/r881100111.html)	

2. Red-spotted Longhorn Beetle

Causal Organism	Insect: Red-spotted Longhorn Beetle *Batocera rufomaculata* (De Geer)	 **An adult red-spotted longhorn beetle (Photo courtesy of NPPC)**
Parts affected	• Branches • Bark	
Damage Symptoms	On branches • Presence of “ring barks”. • Damage of growing tips and branches.	

	On bark • Presence of cuts on the barks. • Excretion of fluid after oviposition (laying of eggs). • Presence of tunnels. • Large quantities of saw dust like frass removed out of feeding holes. • Presence of exit holes.	
Control Measures		
1. Preventive	• Do timely weeding and bush clearing, basin making, and other proper orchard management practices. • For small trees, maintain only one trunk so that it is easy to check for infestations later. • Collect adult beetles in April-June. Put them in a closed jar and exposed to the sun.	
2. Curative	• Regularly monitor the trunk base for tiny wet or swollen spots. Scrape the bark open with a small knife and kill the small larvae. • Remove weeds around the trunk to easily monitor infestations. • Poke the entry holes of the beetles with an iron wire to kill the older larvae. Plug the holes with petrol-soaked cotton or inject the holes with petrol. Close the hole with mud preferably mixed with cow dung. Monitor the treated trees for fresh frass (saw dust-like wood powder produced as a result of the beetle's feeding) and repeat the treatment if frass is still produced.	
3. Sanitation	• Remove and burn heavily-infested unproductive trees. • Destroy dead trees as they can serve as breeding place for the beetle	

G. Pear

There is no major pest and disease of pear that have been recorded to date in Bhutan.

Poultry Description



In Bhutan, raising poultry (chickens) is an age-old tradition, mainly for egg production. The produce is intended for home consumption but farmers also sell surplus eggs to nearby markets. They also raise live chickens to earn additional income or rear them until death. Farmers rear mostly local breeds under scavenging condition with little food as supplementary feed. The local breed is easiest to rear and resistant to most poultry diseases. However, they produce fewer eggs than improved breeds.

Practically, chicken is raised throughout Bhutan, with local names as *bja* (in Dzongkha) and *goa* (in Sharchopkha). Leading egg producers are those coming from the south. Each household raise an average of 5-10 chickens. Local breed produces an average of 80 eggs per year while improved ones generate 240 eggs per year. The average production cost to raise chicken within 1.5 years is around Nu 200 under farmers' condition.

Bhutanese consumes an average of 24 eggs and 330 g of meat per year (Renewable Natural Resources Statistics, 2000). India supplies part of the requirements, which also caters to the needs of expatriates' living temporarily in Bhutan.

Farmers obtain technical support from extension agents side by side with the RNR research experts.