Vegetable Farming Techniques

Manual

District Agriculture Development Office,

District Agriculture Development Office, Gorkha

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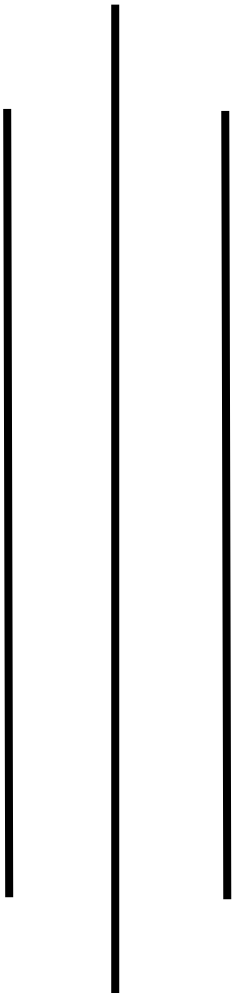
Manual



District Agriculture
Development Office,

District Agriculture
Development Office, Gorkha

Government of Nepal

Ministry of Agriculture Development

Regional Agriculture Directorate, central development Region

DISTRICT AGRICULTURE DEVELOPMENT OFIICE

Sindhupalchok, Chautara

Acknowledgement

Training Plays important role for the Change in behavior by improvement of knowledge, skill & ability of the farmers. To follow up and enhance more technically about the local methods, techniques, learning & experiences with current climatic requirement & technical needs are our major responsibility. Good Agricultural practices, traditional knowledge, skill & experience as well as research output techniques will be very helpful for successful Agriculture work. Successful Agriculture works refers to increment in the production of cereals, vegetables & cash crops as well as their marketing for raising the income. Management of the problems which arises during the farming like; disease pest occurrence, soil, Agro-materials also falls under the successive Agriculture work.

Regarding to the emerging context for commercialization, raising income and upliftment on livelihood of farmers by technical enhancement in simple way, we feel very happy by the preparation of Vegetable Farming Technique Manual with very useful technical knowledge. This manual which is prepared under the JICA project on Rehabilitation & Recovery from Nepal Earthquake (RRNE) not only useful for rural Farmers, but also very useful for every technician related to Agriculture offices for the training material. It has been hoped that this manual, especially addressing the vegetable production techniques will support for the increment of the productivity, improving in quality vegetable production.

JICA/RRNE & Good Neighbors Nepal has helped much more for the preparation, correction, edition, all other related works & funding. I am also glad to assisting the preparation of this manual directly & indirectly by all persons, DADO technicians & technicians of Agriculture service center. I am hoping for this type of manual publication support by all readers & JICA Nepal in near future containing other precise & important training contents & materials.

March, 2016

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Hikmat Kumar Shrestha

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Ministry of Agriculture Development

Regional Agriculture Directorate, central development Region

DISTRICT AGRICULTURE DEVELOPMENT OFIICE

Gorkha

Acknowledgement

Among various organizations working in Gorkha, situating on the central part of Agricultural country Nepal, by the support of the JICA project on Rehabilitation & Recovery from Nepal Earthquake with Good Neighbors Nepal as its implementation partner, this manual is very much helpful for the substantial and commercial farmers, agriculture related technicians, as it has been prepared including all technical parts, and it is seemed to be supported for the poverty alleviation, food security, and increasing farmers income by the increment of agricultural production and productivity.

Receiving as a reference to the available theoretical and practical educational materials included in this Vegetable Farming Techniques Manual; and as it has covered all technical aspects like introduction of kitchen garden, its principle, benefit and importance, nursery establishment and its management, vegetable cropping calendar, methods of vegetable consumption, cucurbit/vine vegetable cultivation techniques, legumes vegetable cultivation techniques, solanaceae vegetable cultivation techniques, identification and management of pest and disease affecting in vegetable, seed production techniques, preparation of compost and bio-pesticides etc., it is believed to be useful to especially farmers, respective technicians as well as to other readers.

Finally, I would like very much thanks to staff of the JICA Project Team & Good Neighbors Nepal for their hard work on preparation of this manual.

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PART I: GENERAL INFORMATION ON VEGETABLE PRODUCTION IN HOME GARDENS

1. Introduction

According to the World Health Organization (WHO), a matured person should consume daily 400 grams of vegetable (excluding potato) to live a healthy life. Similarly, the Government of Nepal suggests a daily intake of 375 grams of vegetables (excluding potato).

However, insufficient access to market and seasonal fluctuation of available vegetable makes it difficult to intake sufficient amount of vegetable for rural households. Thus, a home garden in rural Nepal is very essential where people can regularly grow vegetables in small piece of land. However, it is also commonly seen that many rural households do not apply appropriate cultivation techniques, which result in limited production, and frequent occurrences of pest and diseases attacks. As a result, it is compellation to enjoy with limited production of vegetables.

Hence, by utilizing effective techniques in home gardens with good seed and appropriate vegetable cultivation technologies, vegetable production can be significantly increased. This will enable the rural households to secure more vegetable for their consumption. At last, it will further contribute to the healthy lives of the rural population.

Fig. No. 1.1:Kitchen Garden

Source: JICA Project team

375 grams of vegetable (fresh)

375 grams of vegetable (fresh)

375 grams of vegetable (cooked)

Fig. No. 1.2: Per person per day required vegetable

Source: JICA Project Team

2. Concept of vegetable production in home gardens

The objective of vegetable production in home garden is to produce vegetable to support daily intake for the family members throughout the year. In regards to this point, home garden shall not aim only at increasing the amount of vegetable for a single production, but also aim at constant and sustainable production throughout the year. For this reason, the following concepts should be applied.

2.1 Mixed cropping and preparation of cultivation plan

The timing and duration of harvest differs between different types of vegetables. This should be kept in mind when planting vegetable, so that vegetable can be harvested throughout the year. Vegetable crops should be grown in garden in the ratio of required vegetable on daily basis.

Table 2.1 Sample cropping pattern in home garden

Month	Timing of Harvest				
	Crop A	Crop B	Crop C	Crop D	Crop E
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					

Source: JICA Project Team

Furthermore, it should be noted that if the same vegetable is grown in the same plot every year, there will be a high possibility of disease / pest outbreak. Thus, the same plot should not be used basically for the same kind of vegetable for more than four years. Based on the above table, a cultivation plan (a schedule deciding what vegetable to be planted in which plot) should be prepared and applied for home garden vegetable production.

2.2 Self-production methods of vegetable seeds

A part of the vegetable should be kept to secure as seeds for the next season. In doing so, the first or second vegetable fruits would be better to be kept. Selecting better vegetable fruits will result in better production in the next harvest.

Fig. No. 2.2.1: Seeds of Different Vegetables

Source: JICA Project Team

2.3 Use of perennial vegetables

Perennial vegetables like: chili (*Akabare Khorsani)*, dundu (Chhepi type leafy green vegetable), squash, tree tomato, Kangkong, wild spinach, *(Jibre saag),* turmeric, ginger, Chayote (lettuce), Lamb's quarter (*Bethe*), etc., can be cultivated in the home garden.

Fig. No. 2.3.1: Perennial Vegetable

Source: JICA Project Team

2.4 Use of legume crops

Legume crops, such as cow pea and beans, are not only source of rich in protein but also easy to grow. It also helps to maintain the soil fertile. Therefore, legume crops should be frequently included in the production of vegetable in home gardens.

Fig. No. 2.4.1: Legume crops included in kitchen garden
Source: JICA Project Team

2.5 Use of local material, means and technology

Local resources, means and technology should be utilized to the maximum extent, in order to minimize the work and maximize the production of vegetable.

2.5.1 Use of compost made from local material

- Well ripened compost manure should be used more in kitchen garden rather than chemical fertilizers.
- Crop residue of vegetables and other weeds in garden after harvest can be used for preparing compost.

Fig. No. 2.5.1.1: Crop residue kept for preparing compost.
Source: JICA Project Team

2.5.2 Use of mulch to maximize the use of water

Waste water from kitchen and bathroom (after washing vegetables, utensils and clothes or taking bath) can be used to irrigate the kitchen garden during dry season. As securing of water for irrigation is often a problem faced in the home gardens in the mid-hill areas, mulching has to be followed. By covering (mulching) the soil surface with locally available material, it can be effectively utilized in the vegetable farm.

- Material that can be used for mulching: straw, dry leaves, *ashuro, titepati*, etc.

- Benefit of mulching:
  - It maintains the soil moisture
  - It holds soil during irrigation and rains
  - It helps preventing weeds.
  - Mulching materials later on can be used as manure.
- Use of *Titepati* and *ashuro* also helps to control pests in vegetables.

Fig. No. 2.5.2.1: Mulching kitchen garden

Source: JICA Project Team

Fig. No.2.5.2.2: *Titepati* used to control pests

Source: JICA Project Team

2.5.3 Minimum use of pesticides

If it is possible, pesticides in home garden should not be used. Potential pest and diseases can be controlled by using local resources and technology; it can be done by using such *Jholmol* and *Hamal Jhol* (Bio- pesticides) etc. Please refer back side of this manual to prepare *Jholmol* and *Hamal Jhol.*

3. Nursery Bed in Home Garden

3.1 Definition of nursery

A vegetable nursery is a place for raising young vegetable seedlings until they are ready for transplanting.

3.1.1 Advantages of nursery bed

- Various advantages of nursery in vegetable production.
- Convenient to look after the large number of seedlings in small area.

- Cost effectiveness in land management.
- Easy in management of pest, disease and weed control and irrigation.
- Possible to provide favorable growth conditions i.e. germination as well as growth
- Improved crop uniformity.
- Easy to produce strong and healthy seedling, saplings
- Maximum germination rate, and thus cost effectiveness
- Nursery can be prepared in unfavorable season.

3.1.2 Factors to be considered for raising a nursery

Location of the nursery should be:

- Land close to the house
- Well exposed to the sun, but protected against severe heat
- Well protected against animal damage and strong winds

Vegetable crops can be grown in two ways; either by sowing seed straight in the field, or by preparing seedlings in seedbeds and transplanting the seedlings in the permanent area. In general, the vegetables that are grown directly sowing seeds are - *chamsur*, spinach, beans, cow pea, radish, turnip, peas, pumpkin, sponge squash, etc.; whereas, the vegetables that are grown preparing seedlings are - cauliflower, cabbage, broccoli, broad leaf mustard, swish chard, *Jiriko saag*, onion, asparagus, tomato, brinjal, chilly etc. In addition to, the small seedlings of the cauliflower species should be re-transplanted to another bed in distance, which is known as hardening of seedlings.

3.2 Different types of nursery bed

3.2.1 Raised nursery bed (For rainy season)

This type of seed bed is useful during rainy season from June to September. But, if possible, sky nursery bed is very good option during rainy season (sky nursery bed is described below in 3.2.2 number) Raised up beds are made with 15 cm ridges in 1 meter in breadth and length as per need (Maximum 3 meters). While preparing such raised bed, it is better to use paddy field soil or use of fungicide to make the soil free from disease.

Well-decomposed compost should be added and mix properly in soil during bed preparation about 1-2 weeks before sowing seed. Seeds are sown in line 2-3 cm deep with finger at spacing of 5-7 cm between two seeds, and slightly watered the bed by sprinkler or with the help of making hole on lead of bottles.

Fig. No. 3.2.1.1: Raised bed

Source: JICA Project Team

3.2.2 Sky nursery bed (For rainy season)

Sky nursery beds are prepared in rainy season for producing seedlings of winter vegetables. During the months of June to September, rainfall is likely to continue for days if not weeks. In this period, raised nursery beds may not be sufficient in draining excess water, because rainwater will be frequently running on the ground.

Fig. No. 3.2.2.1: Sky nursery bed

Source: JICA Project Team

Furthermore, intensive rainfall falling directly on the seedlings are likely to damage leafs and hamper the production of healthy seedlings. By elevating the nursery from the ground, the seedlings will not be affected by the water running on the ground surface at times of rain, and it helps to prevent damaging leafs of the seedling from direct rainfall to it, by making the roof of white plastic sheet.

The nursery bed is prepared using wooden or bamboo stalks driven on ground and erecting about 60-70 cm above the ground with 1 m breadth and length as per the necessity, and placing 15-20 cm thick layer of soil on the planks or bamboo fibers. If it rains, the nursery bed should be roofed by plastic sheet; whereas, it can also be removed if it is not raining. There should not be roof for long time in sky bed. Application of compost and sowing methods are like in raised bed.

(Note: Vegetable seedlings have to be protected from severe rain and cold.)

3.2.3 Sunken nursery bed (For dry and hot season)

Fig. No.3.2.3.1: Sunken nursery bed (For hot & dry season bed)

Source: JICA Project Team

These types of seed beds are prepared during winter or dry season for holding moisture in soil. In contrast to the rainy season, rainfall is scarce and preparation of seedlings will require water during the months of February to May. During such season, nursery beds should be prepared to contain the moisture in the soil as much as possible. To prepare such nursery, the land should be dig out below the ground surface and keep the small raised boundary. The water would be preserved in effective way in comparison to raised bed; which help to grow up healthy seedlings. Application of compost and sowing methods are like in raised bed.

4. Seasonal Vegetable and Time of Cultivation

Vegetable produced in the mid-hill areas of our country is generally grouped in to three: A) Summer vegetable, B) Vegetable during rainy season, and C) Vegetable during the winter or dry season. Furthermore, the cultivation period of the each group is different from each other.

Table No. 4.1: Seasonal Groups of vegetable in Mid-hill areas of Nepal

Group	**Names**	**Ways to use/consume**
Summer vegetable	Cucumber	Salad, *pickles*
	Pumpkin	Shoots and curry
	Bitter gourd	Pickles, curry
	Sponge gourd	Curry
	Bottle gourd	Curry
	Tomato	Chutney, curry
	Lettuce	Leafy green

Group	**Names**	**Ways to use/consume**
Vegetable during rainy season	Brinjal	Curry
	Chilly	Pickles, curry
	Lima Beans	Curry, pulse
	String Beans	Curry, pulse
	Kangkong	Leafy green
	Chayote Squash	Shoots, curry
	Ladies finger	Curry
	Broad leaf mustard green	Leafy green
Vegetable during Winter or Dry season	Cabbage	Curry
	Cauliflower	Curry
	Radish	pickles, Curry
	Broad leaf Mustard Green	Leafy green
	Kidney bean	Curry, Pulse
	Fava bean / Horse Gram	Curry. Pulse
	Coriander	Pickles, Spice
	Onion	Spice
	Garlic	Spice
	Turmeric	Spicer
	Fenugreek green *(methi)*	Leafy green, Spice
	Potato	Pickles, Curry

Source: JICA Project Team

Fig. No. 4.1: Vegetables in kitchen garden during summer season

Source: JICA Project Team

Fig. No. 4.2 :Vegetables in kitchen garden during rainy season

Source: JICA Project Team

Fig. No. 4.3: Vegetables I kitchen garden during winter season

Source: JICA Project Team

Table No. 4.2: Cropping calendar of vegetable in Mid hill areas of Nepal

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	**Cucumber**		Salad, fresh chops										
	**Pumpkin**												
	**Sponge gourd**												
	**Bitter gourd**												

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Green bean												
	Yard long bean												
	Tomato												
	Brinjal												
	Ladies finger												

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	**Mustard green**												
	**Radish**												
	**Carrot**												
	**Coriander**												
	**Cauliflower**												

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Cabbage												
	Amaranth green												
	Kang Kong												
	Chayote squash												
	Razma (Kidney) bean												

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Chilly												
	Ginger												
	Onion												
	Turmeric												
	Fava bean												

Pictures	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Peppermint												
	Fenugreek green												
	Yam												
	Malanga												

= Time of sowing seeds = Time of transplanting seedlings = Time of harvest

Table No. 4.3: Methods of Using / Consuming

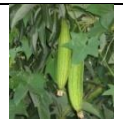
Photo	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Cucumber		Salad, fresh chops										
	Pumpkin			Fresh curry				Ripe pumpkin					
	Sponge gourd		Fresh curry										
	Bitter gourd			Fresh curry									
	Green bean			Fresh curry		Pulse							
	Yardlong bean			Fresh curry		Pulse							

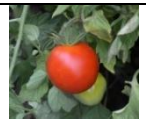
Photo	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Tomato		Chutney and Mixing with curry						Dry tomato and Pickle				
	Brinjal		Fresh curry										
	Ladies finger		Fresh curry										
	Mustard green	Fermented leafy green or dry leaves							Leafy green				
	Radish	*Gundruk, Sinki,* Pickle					Salad, Chatney& Curry						
	Carrot							Salad&haluwa					
	Coriander	Spice							Chatney				

Photo	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Cauliflower	Dry cauli & Pickle								Fresh curry			
	Cabbage									Fresh curry			
	Amaranth green	Leafy green											
	Kang Kong			Leafy green									
	Chayote Squash	Leafy		Fresh curry									
	Razma (Kidney) bean	Pulse										Fresh	
	Chilly			Fresh Chilly					Spice				

Photo	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	Ginger	Spice						Fresh Spice					
	Onion	Leafy	Curry, Salad, Pickle & Chutney										
	Turmeric	Spice											
	Fava bean	Pulse										Fresh	
	Peppermint	Spice and Chutney											
	Fenugreek Green	Spice							Leafy			Spice	

Photo	Month / Vegetable	April-May	May-Jun	Jun-July	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan	Jan-Feb	Feb-March	March-April
	**Yam**								Fresh curry				
	**Malangaroot**					Leafy green			Fresh				

Source: JICA Project Team

Times of various consumption types

PART II: TECHNICAL ASPECTS FOR HOME GARDEN VEGETABLE PRODUCTION

5. Cucurbits/Vine Species Vegetable Production

The vegetables that come under cucurbit/ vine vegetables are especially useful for their young shoots, raw or ripen fruits, and the roots. Main vegetables under this category are – squash pumpkin, zucchini, cucumber, bitter gourd, bottle gourd, sponge gourd, pointed gourd, chayote squash etc. These gourd group vegetables are rich in nutrients such as carbohydrate, minerals, vitamins, protein, etc. The young shoots of vines vegetables such as pumpkin, chayote, etc., can be easily harvested during rainy season, when it is difficult to find other vegetables.

Table No. 5.1: Conditions for using the vegetables

Name of Crops	Shoots	Young fruit	Ripe fruit	Roots
Cucumber		√	√	
Pumpkin	√	√	√	
Sponge gourd		√		
Bitter gourd		√		
Chayote Squash	√	√		√
Balsam apple		√		
Bottle gourd		√		

5.1 Basic methods of cucurbits/ vine species cultivation

- Three to four seeds are sown in a 2-3 cm deep trench. The sowing spot should be sunken seed bed or sunken spot.
- The trellis is important for cucurbit group plant.
- Cucurbits group can be cultivated in different types of soils from sandy loam to heavy acidic; however, pH level between 6.0 and 7.0 is better for getting good yields.

- Cucurbits group can be grown in both summer and monsoon (rainy season). Especially, in warm-season, the vegetables are cultivated in Nepal. It thrives best between 20 °C and 26 °C.

Table No. 5.1.1: Timing of planting and harvesting

Geographical area	**Time for sowing, seedling transplantation**	**Time of harvesting**
High hills	March-June	June-November
Mid-hills	A) January-April B) June - August	A) March - July B) August - December
Lower-hills	A) December - January B) August - November	A) February - April B) November - January

5.1.1 Land preparation and manure application

(A) Land preparation

- Surrounding one meter ground of the sowing spots should be prepared well enough with removing weeds and residue of previous crops.
- The seed sowing spot should be dug well before sowing.

(B) Manure application

- To make the soil rich in micro nutrients, well decomposed compost manure or farm yard manure have to be applied.
- While preparing land for sowing seeds dig arm length deep and arm length breadth pit. Half of the pit should be filled up with well mixed upper soil and 1-2 kg compost in lower part of pit, and remaining half one should be filled up with soil in upper part. Only then, the seeds have to be sown.

Fig. No. 5.1.1.1 Preparing the compost

Source: JICA Project Team

5.1.2 Sowing / transplanting

- In case of direct sowing, it is good to sow seeds 7-14 days after compost filling in the pit.
- Sow 3-4 seeds in a 2-3 cm deep trench.
- After a month of germination, a healthier seedling should be kept and the rest should be removed.
- In case of transplanting seedlings, it should 7-10 cm tall with 4 - 5 true leaves in each seedling.
- One seedling should be transplanted at one place.
- In case of growing more than one pumpkin plant, bottle gourd or sponge gourd, the space should be at least 1.2 – 2.4 meter apart. Cucumber varieties can be spaced 0.9 meter apart.

5.1.3 Providing supporting trellis and training pruning

(A) Trellis

- The trellis is important for cucurbit group plants.
- To get more yields, supporting the vine in vertical way is preferred.
- Wooden stake or tree branches can be put near the plant as trellis.

Fig. No. 5.1.3.1: Cucumber on vine on trellis

Source: JICA Project team

Fig. No. 5.1.3.2: Rotten cucumber on vine without trellis

Source: JICA Project team

(B) Training and pruning

- Pruning and training the vine over the trellis is very important to get maximum yield from the plant.
- Allow the plant to grow without any lateral branches and tendrils up to about 12 nodes of stem. Then, the main stem should be pruned.
- By this pruning, laterals growing from the nodes can arise. We should not allow any laterals branches from plant below the trellis, and should put them upward on the trellis.
- Lightly tie the stem with the trellis using a string, and prune those tendrils which go above the trellis.

5.1.4 Watering (Irrigation)

- Do not ever let the soil completely dry out as cucurbits family plants need a lot of water.
- Collecting the waste water from kitchen and bathroom can also be used for the vegetable in kitchen garden.
- Waste water from dish washing utensils and bathroom can be collected by digging small pit or in a plastic tank or bucket.

Fig. No. 5.1.4.1: Pit to collect waste water

Source: JICA Project Team

5.1.5 Weeding

- Weeding is necessary for loosening soil and controlling the weeds.
- First weeding has to be done at the time of putting additional fertilizer, and second weeding would be better at the time of covering plant root by soil.

5.1.6 Top dressing (Additional fertilizer application)

- In case of direct sowing, about 15-20 days after sowing, apply about 1 kg of well decomposed compost or FYM around the base of each plant. In case of

transplanting, 25-30 days after transplantation, about 1-2 kg well decomposed compost manure should be applied around the base of plant.

- If it is available, a tea spoon (2-3 grams) urea can be applied as top dressing after 25-30 days of transplantation near to each plant, and cover it by soil.
- Cow's or buffalo's urine can be used as top dressing. One part of Cow's or buffalo's urine can be mixed with 4/5 part of water, and it should be sprinkled at the circle of 20 – 30 cm around the plant.
- After a month of first weeding, or when the plant starts flowering, about 2 kg compost should be applied in each plant as second top dressing.

5.1.7 Seed production method of cucurbits from home/kitchen garden

The following two things are very important while producing seeds from cucurbits in the kitchen garden:

(A) Selection of plant

- The plant that is disease free and has tasty fruits should be selected.
- The plant that has properly grown up and comparatively yielded more fruits should be selected.
- The plant having leaves at shorter distance in stem should be selected.

(B) Selection of fruit

- The fruit that looks properly grown and healthy should be selected.
- The second or the third fruit yielded in vine should be selected.
- The seeds can be enough from one or two fruits; hence, a better fruit should be selected.

Fig. No. 5.1.7.1: Ripen cucumber kept for seeds

Source: JICA Project Team

Fig. No. 5.1.7.2: Ripen pumpkin kept for seeds

Source: JICA Project Team

Well-ripe fruit should be picked and stored. The seeds should be taken out cutting the fruit. The seeds should be washed properly with clean water, dried them in sun, and stored safer place (pest free and dry place like pet bottle).

5.2 Specific Methods for Cucumber Cultivation

The local species of cucumbers are popular in Nepal, which have more disease and pest resistant.

Fig. No. 5.2.1: Local variety

Fig. No. 5.2.2: Hybrid cucumber ready

cucumber ready for harvest	for harvest
Source: JICA Project team	Source: JICA Project team

5.2.1 Health benefits

Cucumber has much medicinal importance. It can reduce gastric, acidity and control constipation, and also help in weight control and help keeping body temperature cool during summer season. Likewise, cucumber is good source of Vitamin "B".

5.2.2 Planting distance

The distance between the seeds sown or transplanted plant should be 1-1.5 meters apart in sunken bed or sunken pit.

Table No. 5.2.2.1: Cultivation and harvesting time of cucumber

Geographical Area	**Time of planting seeds and transplanting seedlings**	**Time of Harvesting**
High hills	March - July	July - October
Mid-hills	(A) January - April (B) July - August	(A) March – July (B) August - November
Low hills	(A) November – December (B) August - November	(A) February – April (B) October - January

Source: JICA Project team

5.2.3 Pruning

- Generally, the local cucumber has main vine, second vine and third side vine.
- The main vine should be pruned at 5-6 leaves stage, and keep the second vine. Local varieties have fruiting on the second vines.
- The third side vine has to be pruned if no fruiting. Likewise, old and disease infected leaves, over ripe fruits needs to be removed time to time.
- During summer season, the main shoot of cucumber should be trimmed when the vine gets 4-5 leaves so that the new stem shoots that grow in vine and it will give more and better yields.

5.2.4 Harvesting

- Generally, cucumbers can be harvested from 70 to 80 days after sowing.
- Normally, the cucumber is ready to harvest after 15-20 days of female flower setting.
- The harvest should be done in the early morning as fruits temperature is low. As a result, the fruits can be kept fresh for few days. But, it should not be kept out side.

Fig. No. 5.2.4.1: Farmer picking cucumber/ harvesting
Source: JICA Project Team

- When fruits grow very larger, it gives pretty seed. Cucumbers grow very fast, sometimes it seems like they grow overnight. The plants should be checked daily for mature cucumbers.
- The cucumber with scars cuts and of the unusual sizes need to be picked early.
- The harvested fruit should not be kept in the sun.

5.3 Specific Methods for Pumpkin Cultivation

- Pumpkins are popular vegetable crop cultivated during summer-rainy season.
- The pumpkin is popular due to high yielding and holding good storage capacity.
- The tip of the vine 40 – 50 cm (young shoots) can be used as green vegetable.

Fig. No. 5.3.1: Fresh pumpkin and tendrils
Source: JICA Project Team

- Apart from young tendrils, fruits are also used as green vegetable. And, ripe fruits can also be used as vegetable curry.

5.3.1 Health Benefits

A ripe-yellow pumpkin is rich in Vitamin A, and it has many medicinal values.

5.3.2 Planting distance

The distance between the seeds sown or transplanted plant should be 1.5 to 2 meters apart in sunken bed or sunken pit.

Table No. 5.3.2.1: Cultivation and harvesting time of pumpkin

Geographical Area	**Time of planting seeds and transplanting seedlings**	**Time of Harvesting**
High hills	Mid-April to Mid-June	Mid-June to Mid-October
Mid-hills	Mid-Feb to Mid-Aug	Mid-April to Mid-November
Low hills	Mid-January/Mid-March to Mid-October	Mid-April to Mid-June to Mid-July

Source: JICA Project Team

5.3.3 Harvesting

- Generally, the first fruit is ready to harvest after 110 – 120 days from seed germination.
- We can harvest young side shoots as green vegetable, green fruit and ripe fruit.

Fig. No. 5.3.3.1: Green fruit of pumpkin

Source: JICA Project team

5.4 Specific Methods for Sponge gourd Cultivation

- Cultivation of sponge gourd plant thrives best in warm and humid climatic condition. But, there is comparatively less female flowering in this condition

- Sowing under low temperature, warm and humid (like in months of February, March) climatic condition, there is flowering of more female flower, which results to more production.
- Generally, sponge gourd is cultivated in April May. In high temperature and high humid season (June, July), there is flowering of more male flower only, which results to less production.
- September October is suitable for harvesting sponge gourd.

Fig. No. 5.4.1: Sponge gourd fruit

Source: JICA Project Team

5.4.1 Health benefits

Sponge gourd contains various antioxidants, minerals, vitamins, nutrients and lipids. It is an excellent source of Vitamin "A", Vitamin "B"- 5, Potassium, manganese, potassium, etc.

5.4.2 Planting distance

The distance between the seeds sown or transplanted plant should be 1.5 to 2 meters apart in prepared land. While sowing or transplanting sponge gourd, the soil should be raised a little bit.

Table No. 5.4.2.1: Cultivation and harvesting time of sponge gourd

Geographical Area	**Time of planting seeds and transplanting seedlings**	**Time of harvesting**
High hills	Mid April to Mid-June	Mid-June to Mid-August
Mid-hills	Mid February to Mid-August	Oct-Nov
Low hills	Mid-January/Mid-March to Mid-October	Mid-April to Mid-May

Source: JICA Project Team

5.4.3 Harvesting

Sponge gourd fruit grows to a smoothly cylindrical and about 60 cm in length and 8 cm in diameter. In general, the fruits should be harvested at young stage with thinner skin and green. Normally, fruits are best to be consumed when it is small (less than 12 cm in length) and still green. The fruits will be ready to harvest 20-25 days after the flowering. It is best to harvest before the fruit grows sponge inside.

5.5 Specific methods for bitter gourd cultivation

- Like in other members of the cucurbits family, it is also a fast-growing, trailing or climbing vine with thin stems and tendrils. Thus, it requires a trellis to support their climbing vines.
- Bitter gourd is characterized by soft lengthwise ridges and uneven pebbly surface. Depending upon the variety type, its immature fruit is light to dark green, and have oblong or oval shapes with a pointed tip at the blossom end.

Fig. No. 5.5.1: Bitter gourd fruit

Source: JICA Project Team

- Internally, the flesh is white with rough-edged seeds, somewhat similar to ridge gourd seeds in appearance. As the fruits begin to mature, they gradually become hard, turn yellow or brown in color.

5.5.1 Health benefits

- Bitter gourd notably contains insulin-like substances, Phyto nutrient, and polypeptide etc. mostly known to lower the blood sugar level.
- It has small amounts of B-complex vitamins such as niacin (vitamin B-3), pantothenic acid (vitamin B-5), pyridoxine (vitamin B-6) and minerals such as iron, zinc, potassium, manganese and magnesium, which are essential for developing immunity power of body.

5.5.2 Planting distance

The distance between the seeds sown or transplanted plant should be 1.5 to 2 meters apart in prepared land. While sowing or transplanting sponge gourd, the soil should be raised a little bit.

Table No. 5.5.2.1: Cultivation and harvesting time of bitter gourd

Geographical region	**Time for sowing seeds and transplantation**	**Time for harvesting**
High hills	April to June	July to August
Mid-hills	Mid- February to May	June to August
Low hills	Mid-January to Mid-June	May to October

Source: JICA Project Team

5.5.3 Harvesting

- Generally, the first crop of bitter gourd is ready for harvesting after 50-60 days of seedling transplantation or 80-90 days after sowing.
- The young fruits of bitter gourd will be ready to harvest in 2-3 weeks after flowers setting in summer; while in 4-5 weeks in autumn season.
- The fruits can be harvested at the interval of 2-3 days.

5.6 Major diseases and pests, and their control in cucurbits

Generally, all types of vegetables in this cucurbits group are susceptible to similar types of diseases and pests; however the ratio of infection and infestation vary from crop to crop.

5.6.1 Major diseases

The main diseases of cucurbits family are powdery mildew, downy mildew, bacterial wilt, cucumber mosaic virus in farming.

(A) Powdery mildew

- White powdery substance occurred on the leaves. That powder is the spores of fungi, which can be transmitted by wind to healthy plants.
- It slowly covers the upper parts of the leaves, stems and even on fruits, which appear like white power then the leaves turn yellow and dry out.
- It also causes the leaves to twist, break and get distorted or shrunk, and the fruit gets smaller and unhealthy fruits.

Fig. No. 5.6.1.1: Powdery mildew affected leave
Source: Crop Protection Directorate, Harihar Bhawan

(a) Cause of disease occurrence

The disease of powdery mildew in cucurbits is caused by the fungus.

(b) Integrated Pest Management

- **Traditional practices to control pests**
  - The land and soil should be kept clean and removing diseased leaves or crop residues and weeds too.
  - Application recommended nitrogen fertilizer (Urea).
  - Cultivate the disease resistant varieties.
  - Change location from year to year.
- **Natural practices to control pests**
  - It can be controlled by sprinkling solution prepared mixing one part of cow's or buffalo's urine with 8-10 parts of water, 3-4 times at the interval of 4-5 days.

(B) Downy mildew disease

- Downy mildew is a serious disease of cucurbit crops.
- Downy mildew can affect plants at all stages, but in many growing regions, it appears in late stage. Initial symptoms are small chlorotic spots on the upper leaf surface from the older leaves.

Fig. No. 5.6.1.2: Leaf affected by Downy mildew

Source: Crop Protection Directorate, Harihar Bhawan

- Fungus of the downy mildew cannot be survived without live plants. Hence, to grow and survive such fungus, it is necessary of live cucurbit crops.

(a) Cause of disease occurrence

- Downy mildew is caused by a kind of fungus (Pseudoperonospora cubensis) of water.
- Under humid conditions, downy mildew starts to develop underside of leaf, which causes on the underside forming the light yellowish lesions.
- This downy growth is particularly noticeable in the mornings or wet weather.

(b) Integrated Pest Management

- **Traditional practices to control pests**
  - Healthy and treated seeds should be used.
  - Diseased plant and weeds should be removed from field.
  - If possible, disease resistant variety should be applied, and fungicide treatment should be done before sowing.
- **Fungicide control by chemical method**
  - In case the diseases appear on the plant, mixture of 2-3 gram of Ridomil and one liter water should be sprinkled 4-5 times at the interval of 8-10 days.

5.6.2 Virus

(A) Cucurbit Mosaic Virus (CMV)

- Cucurbit Mosaic Virus (CMV) is one of the most common plant viruses, causing yellow mottling, distorted leaves and stunted growth in a wide range of garden plants, not just cucumbers.
- Mosaic spots that starting from the edges of older leaves, and reach to the main veins.

Fig. No. 5.6.2.1: Cucurbit virus on cucumber leaf

Source: JICA Project Team

Fig. No. 5.6.2.2: Cucurbit virus on cucumber

Source: JICA Project Team

(a) Cause of disease occurrence

- This virus is transmitted by white fly, aphids and seed borne disease.

(b) Integrated Pest Management

- **Traditional practices to control pests**
  - Seeds should be collected only from healthy plant.
  - Disease resistant variety should be cultivated.
  - It is difficult to cure this virus disease once it appears on plant, hence it is better to uproot and remove the affected plant from the field and burning it.
  - Soil in the kitchen garden should be kept clean destroying crop residues and weeds.
- **Disease control by chemical methods**

- Controlling the transmitting pests by sprinkling solution prepared mixing 1 ml (4-5 drops) of Rogor with per liter water for 2-3 times at the interval of 15 days, this disease can be controlled.

5.6.3 Pests

Generally, red pumpkin beetle, spotted beetle, pumpkin fruit fly, vine borer, squash bugs, etc. are the major insects/pests that attack on squash or pumpkin group vegetables.

(A) Red pumpkin beetle

Both the adult pest of this category and larvae damage the crop. The larvae eat underground roots and stems, and the adult beetle feeds on leaves.

Fig. No. 5.6.3.1: Red Beetle and damage caused by it
Source: Crop Protection Directorate, Harihar Bhawan

Prevention or management

- The land should be plowed deeply after the harvest which helps controlling the grubs or larvae alive underground.
- Neem based pesticide such as Margosom-3 ml for per liter water can be mixed and sprinkled.
- Local medicinal plants such as marigold, mug wart, China berry or bead tree (*Bakaino*), comfrey, *Twallo* tree etc. can be crushed to juice, and one part of liquid mixing with 5-6 part of water can be sprinkled as pesticide.
- Hamal Jhol 1 and 2 can be used to control pests. Hamal Jhol 1 is used against the pests feeding on roots while Hamal Jhol 2 is used against the pests feeding on parts above the ground.
- Pests can also be controlled by burning all the crop residues after the harvest.

(B) Fruit Fly

It is a fly with colorful wings. The female fly lay eggs piercing upper layers of flower or fruit. The eggs hatch into larvae and start feeding on inner part of fruits. Then, the fruits turn yellow, gets rotten and fall off.

Fig. No.No. 5.6.3.2: Adult fruit fly infesting cucumber

Source: JICA Project Team

Fig. No. 5.6.3.3: Adult fruit fly infesting sponge guard

Source: JICA Project Team

Prevention and management

- Dip the rotten fruit or yellow-turned fruit in water.
- Male insects can be controlled by hanging 2 - 4 pheromones or cue-lure *(Mohani Paso)* made using 4 drops of cue-lure and 5-7 drops of Malatheon or Nuvan at the height of 4-5 feet in every Ropani of land.
- 8-10 grams sugar and 1 ml Malatheon liquid are mixed and sprinkled on crops. Flies lick the poisonous liquid and die.

Fig. No. 5.6.3.4: Pheromone trap or *Mohani Paso* for trap fruit fly
Source: JICA Project Team

- Use of Bio- pesticide (Hamal Jhol2): 1 part of Hamal Jhol- 2 should be mixed with 5-7 parts of water and sprinkled on plants after flowering at the interval of 2-3 days. The liquid helps deterring flies off the plants.
- If there is less number of fruits, it can be wrapped with a bag and protected from insects.
- The trap with yellow glue (yellow trap) can be used for controlling pests.

6. Legumes Crops

- Young and matured fruits and pulse are consumed under the legumes crops vegetable. There are also legume plants that are not edible but have many of soil health benefits; it is used for livestock forage and silage.
- Mature pods and beans of vegetables under legumes group are consumed as pulse.
- Main vegetables under this category are - beans, black eye beans, fava beans, soybean, peas, and Broad beans.

Table No. 6.1: Edible parts

Name of plants	Young pods	Un-ripen pods	Ripen pods
Soya bean		✓	✓
Green bean	✓		✓
Yard long bean	✓		✓

Source: JICA Project Team

The most popular legume plants are peas and beans. Pole (vine) such as yard long bean beans provide long slender pods, while peas may provide edible pods. Strings less variety of beans are easier to eat and peas have such soft shells that the entire pea becomes soft, and whole pod can be eaten.

Table No. 6.2: Timing of planting and harvesting

Geographical area	Sowing seed / transplanting seedling	Harvesting time
High hills	March - May	June - September
Mid-hills	February - May	April - August
Low hills	July - September	September - December

Source: JICA Project Team

Legumes (Pulses) are the important sources of proteins, vitamins and minerals and are popularly known as “Poor man’s meat” and “rich man’s vegetable”, which contributes significantly to the nutritional security of the country.

Fig. No. 6.1 Pods of string beans

Source: JICA Project Team

Fig. No. 6.2 Pods of yard long beans

Source: JICA Project Team

6.1 Basics cultivation methods of legume crop

Majorly, we are discussing here focusing String beans and Yard long beans, but the cultivation practices and all technical works are almost similar for all legume vegetables.

- Legumes group crops can be cultivated in wide range of soils from sandy loam to clay with pH between 6.0 and 6.5 is best for getting good yields.
- Legumes group crops can be grown in both summer and monsoon (rainy season); however the favorable temperature is between 20 ℃ and 26 ℃.

6.1.1 Land preparation and Manure Application

(A) Land Preparation

- Surrounding 1m ground of the sowing spot should be prepared well enough to remove weeds and residue of previous crops.
- The sowing spot should be dug well and make fine soil before sowing.

(B) Manure application

- To make the soil rich in organic matter, well decomposed FYM (farm yard manure) or compost should be applied.
- While preparing land for sowing seeds dig arm length deep and arm length breadth pit. Half of the pit should be filled up with well mixed upper soil and 1-2

kg compost in lower part of the pit, and remaining upper half of the pit should be filled up with soil. Only then, the seeds have to be sown.

- Urea (Nitrogen) has not to be applied for legumes crops.

6.1.2 Sowing

- Beans can also cultivated together with Maize in kitchen garden or as mix cropping, and the maize plant functions as trellis for bean vines.
- It is good to sow seeds 7-14 days after compost filling in the hole.
- Sow 2-3 seeds in a 2-3 cm deep trench with sunken seed bed type.
- The gap between a plant and the next should be 50 cm.
- After a month of germination, a healthier seedling should be kept and the rest should be removed.

Fig. No. 6.1.2.1: Bean cultivated with maize as mixed cropping

Source: JICA Project Team

6.1.3 Providing supporting trellis and training pruning

- **Trellis**
  - A trellis is important for Legume group plants.
  - To get more yields, supporting the vine in vertical way is preferred.
  - Wooden stake or tree branches can be put near the plant as trellis.

Fig. No. 6.1.3.1: Bean trained bamboo cuts and tree branch as trellis

Source: JICA Project team

- **Training & pruning**
  - Pruning and training the vine over the trellis is very important to get maximum yield from the plant.

- Allow the plant to grow without any lateral branches and tendrils up to about 12 nodes of stem. Then, the main stem should be pruned.
- It needs to give support to tendrils to go up including necessary pruning.
- By this pruning, new nodes are come up. We should not allow any laterals branches to be grown up below the trellis if possible, and it should put them upward on the trellis if it remains.
- Count each lateral branch to 12 nodes and prune the rest, and remove all lateral branches and tendrils also.
- Train the vine over the trellis system by tying the laterals with a string.

6.1.4 Watering (Irrigation)

- Lack of water causes less pods, less seeds inside pods and the pods remains undergrowth.
- Crop yield decreases if soil turns dry while the plant is flowering.
- During a crop cycle, it is necessary to water the crops 6 - 7 times or when the soil seems very dry.
- Waste water can be collected cementing the floor of the dish washing area and bathroom.

Fig. No. 6.1.4.1: Pit dug to collect waste water
Source: JICA Project Team

- Water can also be collected through a pipe to a plastic tank or bucket or digging a pit near the kitchen garden from where, easily we can carry water to the kitchen garden.
- Moisture can be maintained using straw, wood dust, dried leaves as mulching.

6.1.5 Weeding

- Weeding is necessary for loosening soil and controlling the weeds.

- First weeding has to be done at the time of putting additional fertilizer (When plant gets 4-5 leaves, after 2-3 weeks of sprouting) and second weeding would be better at the time of covering plant root by soil (after one month of 1st weeding).

6.2 Pests and diseases in legume crops

6.2.1 Pests

Name of Insects	Symptoms of damage	Management
 Fig. No. 6.2.1.1: Caterpillar Source: JICA Project Team	• The larvae or caterpillars eat all green part of leaves, and the leaves turn white, yellow and look like paper. • Finally the plant remains without leaves.	• Pick the leaves with caterpillar masses, collect them and destroy together. • If the attack is massive, sprinkle solution of Deltramethrin 2.8 % EC 1 ml with per liter of water. • Use pesticide with *Neem*. • Sprinkle Hamal Jhol 2 properly on the leaves.
 Fig. No. 6.2.1.2: Aphids Source: JICA Project Team	• Plant gets infected, cannot grow and turns yellow.	• Sprinkle solution of soap and water on leaves or areas invaded by aphids. • Sprinkle mixture of tobacco and water. • Sprinkle ash dust targeting on masses of aphids. • Protect the lady bugs- friendly insect, which prey on aphids.
Pod borer hosted by beans	• Feeds on inner flesh of beans.	• Use cue-lure or *mohanipaso* to trap the flies. • Pick and burry the fruit with pod borer or dip in water. • Use light trap.

6.2.2 Diseases

Name of diseases	Symptoms of damage	Management
 Fig. No.6.2.2.1: Rust disease Source: Crop Protection Office, Harihar Bhawan	• Initially small spots like bubbles are seen on leaves, and those turn brown and finally burst into powders. • These spots may appear on the pods also. • The infected leaves dry and the plant dies soon.	• Keep the garden clean by collecting the infected parts of plant, residues and weeds, and duly burning them down. • If this disease appears in the seed producing crop, spray the mixture of the sulfur and lime stone at the 1:2 ratio. • Sprinkle solution of 80% DP sulfur 3 gram with per liter water in the affected areas.
Bean common mosaic virus (BCMV) *(Bean common mosaic virus* is the most common and widespread virus of common bean because it is seed-born and aphid-transmitted)	• Disease appears as a light green-yellow and dark green mosaic pattern developing on the leaves. • Often veins of leaves are dark green; whereas the affected areas become light green-yellow. • Later on leaves start downward curling and rolling, and leaves become small. • Plants infected at a young age cannot elongate and grow well.	• Use of disease resistant variety if available. • Beans should not be grown in the area where, the viral disease already occurred previously. • Sanitize the field and remove, and destroy all weeds and infected plants. • Do not use the seeds from the virus disease infected field.

7. Solanaceae Vegetables and Other Fruit Vegetables Cultivation Method

The Solanaceae family vegetables include tomato, eggplant, pepper, chilly, potato etc., and other fruit vegetable is okra. The young and mature fruit of vegetable can be consumed as vegetable under this family. The vegetables of this group are rich in nutrients such as carbohydrate, minerals, vitamins, protein, etc.

Table No. 7.1: Edible parts

Name of vegetable	Young fruit	Ripe fruit	leaves	Root(rhizome)
Solanaceae vegetable				
Tomato		✓		
Brinjal	✓			
Pepper	✓	✓		
Chili	✓	✓	✓	
Fruit vegetable				
Okra	✓			

Source: JICA Project Team

7.1 Basic methods of solanaceae family cultivation

7.1.1 Land preparation and manure application

(A) Land preparation

- This types of vegetable can be cultivated in the sunny area with well-drained, any loam and sandy type soil.
- Like in other crop cultivation, the soil prepared for this crop needs to have adequate amount of organic materials.
- Land should be plowed deeply for Solanaceae crop cultivation. Crush clods, weeding and till or dig for 2-3 times for preparing soil for cultivation.

(B) Manure application

- It is beneficial to use 4-5 bamboo baskets (100- 150 kg) of compost manure, 4 *Mana* (2 kg) of ashes, mustard cake (*Peena*) and 4 *Mana* (4 kg.) Hamal Jhol-1 per *Aana* (31.25 meter square) of land at land preparation works.

7.1.2 Producing seedlings

- Nursery bed should be prepared raising 15 cm high ridge with a meter width and length as per necessity.
- Sky nursery or raised nursery bed should be made for rainy season.
- Solanaceae group vegetable seed should be sown in a 2 cm (2-3 times deeper than seed) deep hole, at the gap of minimum 3-4 cm between each hole. After sowing seed in each hole, seed should be covered loosely by soil and mulching should provide with straw or dried leaves.

Fig. No. 7.1.2.1: Farmers preparing raised nursery bed for sowing tomato seeds

Source: JICA Project Team

- Just after mulching or covering by straw or dried leaves, water should be sprayed over it in nursery seed bed.
- After 20-25 days, when seedlings become 2-3 leaves already, it will be ready for transplanting. 1-2 hours before uprooting the seedlings, the seed bed should be watered so that the seedlings come off easily without getting the roots damaging.
- If possible, it would be better to harden the seedling when it gets 2 weeks before transplanting in main field. At the time of hardening[1], the seedlings have to be transplanted with plant to plant distance 12 cm and row to row distance 15 cm.
- After two weeks of hardening, the seedlings should only be transplanted to the main bed with 60 cm spacing between plants to plant, and maintaining the row to row distance with 80 cm apart.

[1] Hardening refers to adopting the environment for seedlings by transplanting it from main nursery to next bigger nursery in distance before transplanting to the main field.

- While transplanting the seedlings, the bed should not be either too wet or to dry also.

7.1.3 Weeding and Mulching

(A) Weeding

- In case of transplanting seedlings, the surface of ground should be properly ploughed, and weeded before transplanting.
- Second weeding should be done about 20-25 days after the first weeding or transplanting.
- Third weeding should be done just before the time of compost and urine is applied to the plant. (40-45 days of transplanting).

Fig. No. 7.3.1.1: Farmer weeding around eggplant
Source: JICA Project team

- In case farmers directly sow the seeds in main field without making nursery bed, first weeding is done in 15 - 20 days after the seed germinate.
- The second and third weeding are as same as in case of transplantation case.
- The weeds cannot make much trouble to the plants after they grow to a height over 50-60 cm. Therefore, initial period of seedling growth is very sensitive time for weed control.
- We should be careful to make covering the plant by soil to the base of plant just after every weeding, which help to prevent the lodging and making good root growth.

(B) Mulching

- Mulching can be done in the plants for maintaining the moisture of soil by covering the soil near to the base of the plant by the help of sawdust, paddy or wheat straw, dry leaves of tree or compost during the dry and summer season.

Fig. No. 7.2.3.2: Mulching practice

Source: JICA Project Team

Fig. No. 7.2.3.3: Mulching in egg plant

Source: JICA Project Team

7.1.4 Watering (Irrigation)

- Waste water such as dish wash and clothes washing, bathing, will be collected through pipe to a plastic tank or bucket or small pit dug near to the kitchen garden for the irrigation of vegetables.
- In this way, the collected water can be used as per necessity to water the vegetables.
- In case of seed sowing, it is necessary to water the soil before sowing. During dry and hot season, all plants need to be watered in every 3 - 4 days in summer when soil surface become dry.
- In case of transplanting seedlings, first watering to planting place should be done well before and after transplanting seedlings. Then, plants should be watered at the interval of 3-4 days in summer.
- The kitchen garden should have proper drainage to outside for excessive water in rainy season.
- The drainage system should be managed compulsory during the rainy season. If no rainfall occurred continues, the plants should be watered.
- Sprinkler jar or plastic bottle with hand-made sprinkles can be used on its surface to water the nursery bed or plants in the kitchen garden.

7.1.5 Top dressing

- At the time of the 1st or 2nd weeding, looking at the condition of the plants, mixture of 1 part of cow's / buffalo's urine in 7-8 parts of water will be sprinkled on the plants or mixture of 1 part urine in 4-5 parts of water will be put in the soil around a plant.
- Additional compost should be given in 20-25 days after the transplantation; the surface soil should be properly raked, weeded, and covered near to the base of plant.
- The eggplant should be weeded and top dressed with additional compost in 20-25 days after the first weeding.

7.2 Specific Methods for Tomato cultivation

Tomato is a warm season vegetable, and it required warm climate. Tomato plants cannot withstand frost and high humidity. Too much high temperature and too low temperature (average temperature below 16°C & above 27°C) is not also desirable. It required low to medium rainfall.

7.2.1 Health benefit

It has a great medicinal value as well, and it contains high amount of carotenoid called lycopene.

7.2.2 Types of tomato

- Mainly, tomato plant has been categorized into three groups based on the growth of plant and nature of flowering: determinate (dwarf plant), semi-determinate (in middle type of them) and indeterminate (taller type of plant) varieties.
- They bear flower or fruit on every third node. In determinate type, the main stem of plant is stopped after 5-6 cluster setting. In the indeterminate type, the main stem of the plant grows continuously. First branch grows from the bottom of the stem, and other branches grow from other above nodes.
- It would be better the determinate and semi-determinate varieties for home garden farming, and the indeterminate types for commercial farmers.

(A) Determinate type plant

- These tomato plants have less height of approximate 1.0 m with fruiting and flowering on same time.
- Generally, determinate tomato is early maturity types.
- This type of plant has the characteristics of fruiting and flowering in the gap of every one leaf or one node, by which plant become dwarf.
- At least 2 branches from bottom should be kept on the plant for getting more yields.
- As it requires a limited amount of staking for support, it is perfectly suited in kitchen garden farming.
- Examples of dwarf variety of tomato (determinate or semi determinate) are BL 410, Pusa early, Durbarg, Surakshya, NS 2535, NS 815 etc. are cultivated in Nepal.

(B) Semi-determinate type plant

- The growth habit of ***semi-determinate tomatoes*** is somehow between the true determinate and true indeterminate tomatoes.
- Most semi-determinate varieties are technically indeterminate plants that are bushy type due to their shorter vines.
- At least 2 branches should be kept on the plant for getting more yields.

(C) Indeterminate tomato plant

- Indeterminate tomato plant requires many tall staking or threads (rope) for supporting plant.
- First side shoot grows from the bottom of the stem, and other side shoots grow from other above nodes.
- For the better yield, the tip of main stem should be cut after plant gets height of 1-1.2 meter with 5 clusters of fruits.
- In case of indeterminate type of Tomato grown, we can make from indeterminate type to semi-determinate type by cutting tip of plant.

- Examples of taller variety of tomato (indeterminate type): *Shreejana, Dalila, Bhim, Manisha,* etc. are cultivated in Nepal. These tomatoes of indeterminate group thrive on trellis.

Table No.7.2.2.1: Time of planting and harvesting

Geographical area	**Sowing seed and transplanting seedling**	**Harvesting time**
High hills	April to May	July to September
Mid-hills	1. March to April 2. June to July	1. June to September 2. September to November
Lower hills	1. August to September 2. January to February	1. October to February 2. April to July

7.2.3 Transplanting

- In determinate types, ridges are not necessary if the seedlings are transplanted during summer (March-April). In indeterminate types, ridges are necessary to cultivate until rainy season for drainage of rain water.
- In rainy season (July to August), 15 cm high ridges need to be made to transplant seedlings for prevention from rain water.
- A shade with a plastic roof is better for rainy season to cover the plants if this facility is available.
- The gap between the ridges (row –row distance) should be at least 80 cm with 60 cm spacing between the plants in each row for determinate and semi determinate varieties.
- It is better to adopt crop rotation system (change the place of plantation every year in different corner of kitchen garden).
- It is not good to cultivate Solanaceae vegetable such as Tomato, Potato, Chili and Brinjal in the same crop rotation. Because the diseases prone to tomatoes can attack all other Solanaceae crops as well.

7.2.4 Staking to tomatoes

- It gets double production for staked tomato plants in comparison plants without staking.
- Staking or bamboo branch can be given with the support of rope.
- It is necessary of staking to tomatoes cultivated in rainy season.

7.2.5 Pruning

- Pruning helps plant to receive direct sun light and air movement. It also helps in keeping the plant healthy and improves size, color and shape of fruits.
- Remove the tip of plants to increase the size of fruits.
- In a kitchen garden, the main stem of indeterminate varieties will be pruned at 4-5 leaves stage, and two side shoots should be kept on the plant. Then, other side shoot should be removed from the plant time to time if we saw more side shoots are emerging.

Fig. No. 7.2.5.1: Plant pruned keeping only the main stem
Source: JICA Project Team

- Maximum of two main stems can be kept while the old leaves at the bottom of the plant, yellow and infected leaves should be timely removed.
- Timely pruning can help in number of fruits, productivity, quality and uniformity in size of the fruits.
- Pruning work makes to increase the number of fruits in per unit.
- The pruning of unnecessary parts should be removed no sooner as it is found. Otherwise, if delayed to remove the young side shoots grown from leaves, it consumes the nutrients, which weakens the plant and results in decrease the yields.

7.2.6 Harvesting

- The harvesting time may differ following the purpose of tomato use.
- There are six different harvesting times based on the target and purpose of picking tomatoes from garden:
- Immature green
  - The tomato fruit becomes dark green in color.
  - The seeds inside the fruits are not fully grown, and they are not attached by the jelly like substance.

Fig. No. 7.2.6.1: Tomato fruit ripen in vine
Source: JICA Project Team

- Mature green
  - The tip of the fruits has been turned a little yellow-greenish color.
  - The seeds inside are wrapped with like jelly substances.
  - The tomatoes of this phase are picked for a longer transportation and storage.
- Starting of pink color/ Turning
  - 1/4 part on the top of the tomato fruit becomes pink.
  - The tomatoes at this phase are picked for local markets.
- Pink color stage
  - 3/4 parts on top of the tomato fruit becomes pink.
  - Such tomatoes are also picked for local markets.
- Dark red
  - The tomato fruit turns completely red and becomes hard at this phase.
  - The hard red tomatoes are picked for preparing ketch-up (sauces) and making pickles.
- Overripe red

- The tomatoes of this phase are deep red and very soft in texture.
- Tomatoes of this phase are picked only for harvest seed.

7.3 Specific Methods for Brinjal (Eggplant) Cultivation

Brinjal is one of the important vegetable crops grown in sub-tropical and tropical area. Young fruits are available throughout a year in market. The young fruits are chopped and fried or cooked with potatoes or tomatoes and eaten as vegetable curry.

Fig. No. 7.3.1 Fruits of Brinjal
Source: JICA Project Team

Table No. 7.3.1: Timing of sowing and harvesting of Brinjal

Geographical Area	**Sowing Seed/ Transplanting Seedling**	**Harvesting Time**
High hills	April to May	June - September
Mid-hills	March to April	April - July
Low hills	1. February to March 2. July to August	1. May to December 2. November - April

7.3.1 Health benefits

It is a nutritious vegetable. Regular intake of this vegetable helps in controlling cholesterol in blood.

7.3.2 Transplantation

- Sowing and transplantation of seedlings are done in the spring in high and mid-hill region and the fruits are harvested in summer-rainy season.
- Egg plant is transplanted in raised bed. The raised bed is made 120 cm wide in winter, and seedling is transplanted in row to row distance of 60 cm; whereas, it should have 45 cm distance of plant to plant.

Fig. No. 7.3.2.1: Transplanting egg plant seedlings

Source: JICA Project Team

7.3.3 Weeding and irrigation

- At time of top dressing the plant in 20-25 days after the transplantation, the surface soil should be properly raked and weeded.
- The eggplant should be weeded and top dressed with additional compost in 20-25 days after the first weeding.
- After that, the plant can be weeded 1-2 times and looking at the condition of the crop, mixture of 1 part of cow's or buffalo's urine or Bio- pesticide in 8-10 parts of water can be sprinkled on the crop or mixture of 1 part urine in 4-5 parts of water can be put in the soil around a plant.

Fig. No. 7.3.3.1: Farmer weeding around eggplant

Source: JICA Project Team

- The furrows should be drained with water. The eggplants should be watered at the interval of 10 - 15 days in winter while at 5 -7 days or when the soil becomes dry in the summer season.
- Collecting the waste water from kitchen and bathroom can also be used for the vegetable in kitchen garden.

- Waste water from dish washing utensils and bathroom can be collected by digging small pit or in a plastic tank or bucket.
- The moisture of soil can be maintained using shade or compost mulch.

7.3.4 Pruning

- First pruning should be done in the month of July to August as this time there is a lot of damaging fruits by fruits fly. It is appropriate to prune plant before flowering.
- Second round of pruning in December-January after harvested all fruits.
- The pruning should be done with secateurs or sharp sickles.

Fig. No. 7.3.2.4: Farmer being instructed methods of pruning eggplant
Source: JICA Project Team

- While first and second pruning, leave total of two growing branches on the main stem.
- Remove the branch that looks like a node and grows between the main stem and branch-growing node. Remove the leaves that grow below the plant so that air can pass freely.
- Cut and remove the upper part of eggplant that withers due to pod borer during day time. It should be done when this problem is found.
- Auxiliary roots should be pruned underground making a round circle with a hoe or spade, and put compost around plant. This work needs to be done at time of second round of pruning in the month of December-January.

7.3.5 Harvesting

- Fruits should be picked when the fruit reaches the size as per the species and when it has an attractive color. All fruits should be picked in cool of the morning with the help of scissors or sickle.
- After fruit is picked, should be consumed soon. It is better to consume the eggplants within 5 days of harvesting in hot season, and within 5-7 days in winter season.

7.4 Specific Methods for Lady Finger (Okra) Cultivation

Okara is one of the important vegetable crops grown in sub-tropical and tropical area. The young fruits are chopped and fried or cooked and eaten as vegetable curry. It is also used as Salad or soup.

Lady finger is a warm season vegetable crop and requires a long warm growing season. In Nepal, it is grown in summer months and during the rainy season. It is highly sensitive to frost. Its seeds germinate poorly at ground temperature of 20 °C or less.

Table No. 7.4.1: Time for cultivation

Geographical area	**Sowing seed/ Transplanting seedling**	**Harvesting time**
High hills	May-June	July - August
Mid-hills	April - May	June - September
Low hills	March - April	May - November

7.4.1 Health Benefits

This vegetable is very famous for its high soluble and insoluble fiber content. It has Dietary fiber (9 %), Folate, Pyridoxine, Thiamine, Vitamin C, Vitamin A, Vitamin K, Copper, Calcium, Potassium, Iron, Magnesium, Manganese, Zinc and Phosphorus.

7.4.2 Sowing

Ridges are prepared for winter crop at distance of 50 cm. and 2-3 seeds are kept at 2-3 cm depth at 30 cm. distances. Lady fingers can be grown as mixed crop with Chilly.

7.4.3 Pruning

- Lady finger plant should be pruned.
- In high hills, no need to prune the plants due to warm season and short day in autumn.
- In mid-hills, the plants will be pruned at stage 50 – 60 cm plant height.

- In low hills, it will be pruned at stage 1.0 – 1.2m plant height due to long warm season in autumn.
- It helps in growing more additional branches and increasing yields. Similarly, pruning maintains too much height of plant.

7.4.4 Harvesting

Generally, the okra crop will be ready for picking in 50-60 days after sowing. The first lady finger pods can be kept for seeds. If the pods are not picked in time, its quality goes decreasing. The pods should be picked in every 2-3 days. Normally, the okra pod will be ready for picking after 5 - 7 days of flowering.

Fig. No. 7.4.4.1: Okra pod ready for picking
Source: JICA Project Team

7.5 Major pests and diseases and their management

7.5.1 Pests

(A) Fruit and stem borer

The butterfly or moth of borer lay eggs on leaves, shoots and fruits. The eggs hatches and tiny borers start feeding on leaves, young shoots and fruits of plant. Pod borers stay inside fruit and eat the flesh, and finally smaller holes appear on the surface of fruits.

Fig. No. 7.5.1.1: Eggplant infected by

Fig. No. 7.5.1.2: Shoot withered with

borer

Source: JICA Project Team

borer infestation

Source: JICA Project Team

Prevention measures

- The infested shoot or fruit should be duly picked, collected and destroyed.
- The young shoots infested with borers wither during day, and such shoots should be removed from the plant.
- The fruits infested with borers should be picked and dipped in water so that the larva inside the fruits will be dead.

(B) Aphids

These groups of insects/pests stick on the downside of leaves, and suck the plant juice and also transmit other diseases.

Prevention measures

- Spray the areas invaded by aphids with soap-water solution.
- Mixture of tobacco-water can be sprinkled.
- Spray ash dust targeting body of the aphids.
- Preserve the friendly bugs such as lady bug which feed on aphids.

(C) Grass hoppers

It is necessary to control grass hoppers since its adult grass hoppers feed on leaves and finish the plant. This insect pest can easily be identified looking at the leaves as it eats leaves from edges. The leaves eaten by grass hoppers turn yellow from its edge, and become brown-red.

Fig. No. 7.5.1.3: Leaf eaten by grass hopper
Source: JICA Project Team

Prevention measures

- For the grass hoppers, Hamal Jhol – 2 has to be applied.
- It can also be controlled by using *Neems*.

7.5.2 Diseases

(A)Damping off disease

- Germinated seedlings' stems get rotten, fallen down and die.

Prevention measures

- Every year change the place of nursery bed.
- Nursery bed should be raised and well-drained.
- The nursery bed should be treated with solution prepared by mixing fungicides Bevistin, Kyaptan or Redomil 1.5 - 2 grams with per liter water.
- One kilogram seeds should be treated with the ratio of 3 gram fungicides Kyapton, Thiram or Bevistin.
- Seed should be sowed at a distance, and if it emerges dense, dense seedlings should be removed.

Fig. No. 7.5.2.1: Fusarium wilt disease in chilly
Source: JICA Project Team

- If this disease is diagnosed, the nursery bed and the seedlings should be treated using the solution of Mancojeb (0.25%) and Carbendazim (0.05%).

(B) Fusarium wilts disease

Leaves turn yellow and wither. Plants wither to death. This Fusarium wilt disease transmits from seed and remains in soil.

Prevention measures

- Disease resistant species of tomato should be cultivated. For example, Ureka, Siriss, Senss etc.

Fig. No.7.5.2.2: Tomato plant suffering from Fusarium wilt
Source: JICA Project Team

- Crop rotation should be adopted with crops other than the tomato family.
- Seed, nursery bed soil, seedlings and the soil from the farming land should be treated with Sanjibani. After transplantation, if the plant is treated with solution prepared mixing 5 gram Sanjibani, 5 gram sugar with per liter of water for 2-3 times at the interval of 15-15 days, the damage from this disease can be reduced.
- Psudomonos organic pesticide 5 gram with per liter water can be sprayed at least twice at the interval of 10 days to reduce the damage of this disease.

8. Brassica Family Vegetables Farming Methods

- In Nepal, like the soft leaves, stems, flower bud/flowering heads, stems of Brassica family vegetables (cauliflower, cabbage, broccoli, broad leaf mustard, Chinese cabbage, etc.) are cultivated.
- Brassica family crops are cultivated in Terai, low hill, mid-hill and high hills of Nepal in winter season.
- These Brassica vegetables are mostly consumed as vegetable, pickle and salad etc.
- Similarly, it is consumed as dried and *Gundruk* - fermented dry vegetables, *Pakauda* (mixed-vegetable chop), etc.
- Brassica vegetable consists of sufficient amount of vitamins, carbohydrate, minerals, protein etc.

Table No. 8.1: Edible parts of the cauliflower

Name	leaves	flower buds/flowering head	stems
Cabbage	✓		
Cauliflower		✓	✓
Broccoli		✓	✓
Broad leaf mustard	✓		

Fig. No. 8.1: Ready to consume cauliflower

Source JICA Project Team

Fig. No. 8.2: Ready to consume cabbage

Source JICA Project Team

8.1 Basic Cultivation Methods of Brassica Family

8.1.1 Land preparation and Manure Application

(A) Land preparation

- Plough the field 2-3 times, crushes clods, and removes weeds, pebbles and residues of previous crops. First plowing should be done one month before of seed sowing or transplantation.

Fig. No. 8.1.1.1: Field being prepared for cauliflower cultivation
Source: JICA Project Team

- At time of second tillage, mix 40-50 bamboo baskets (1200-1500 kg) of well-composted farm yard manure.
- It is better to plough the site mixing ashes in soil 5-7 days earlier to seedlings transplantation.

(B) Manure application

Use 40-50 bamboo baskets (1200-1500 kg) of well decomposed FYM or compost manure in one *Ropani* of land.

8.1.2 Preparation of nursery bed

A nursery bed is in accordance with the local soil environment for seed sowing. Often it comprises not only the soil but also a specially prepared cold frame, hotbed or raised bed used to grow the seedlings in a controlled environment for the seedlings production before transplanting into a garden.

The seedlings of cauliflower and cabbage can get easily decayed or infested with diseases during rainy season; hence, seedlings are grown preparing nursery beds. The process of growing seedlings in nursery is described below:

- Cauliflower and cabbage seedlings are prepared in May-August in mid and high hills.
- For mid hills, raised or sky nursery bed will be suitable during rainy season.
- From 90 cm to 1 m. width and the length as per necessity of the nursery bed have to be filled up with soil up to 12-15 cm, and use 1 bamboo basket (30-35 kg) of manure for one nursery bed.
- Make line of 3-4 cm deep by stick and maintain spacing of 5-7 cm between each line in nursery bed.
- Sow cauliflower and cabbage seeds at spacing of 3-5 cm.
- Cover the seeds with bed soil or sand spraying some ashes, press a little and cover it with straw or mulch.
- To protect seeds from rain, prepare a shade with white plastic cover at height of 100-120 cm (3-4 feet).
- Remove the straw or mulch slowly after the seeds germination.
- Then, remove all weeds grown in the bed.

Fig. No. 8.1.2.1: Preparing sky nursery bed

Source: JICA Project Team

Fig. No. 8.1.2.2: Prepared sky nursery bed

Source: JICA Project Team

Fig. No. 8.1.2.3: Sowing seeds in row in sky nursery bed

Source: JICA Project Team

Fig. No. 8.1.2.4: Seedlings in nursery bed ready for transplantation

Source: JICA Project Team

8.1.3 Watering (Irrigation)

- Watering should be done before and after transplantation to the planted pits.
- Watering should be done daily or on alternate days for 7-10 days after transplantation.
- Cauliflower and cabbage plant should be irrigated as per the need afterwards, and excessive water should be properly drained.

Fig. No. 8.1.3.1 Watering to young plants

Source: JICA Project Team

8.1.4 Weeding

- Field should be kept weed free for at least first 45-60 days. It is the critical period for weed controlling.
- First weeding is given at 20-25 days, and second at 40-45 days after transplantation. Normally, one time weeding in rain fed areas, and two times weeding in irrigated areas are necessary.
- The weeds should be removed around each plant and kitchen garden should be kept clean.

Fig. No. 8.1.4.1: Weeding in cauliflower

Source: JICA Project Team

8.1.5 Top dressing

- The cauliflower plant should be top dressed around plant with additional manure, and mixture of water and urine of buffalos and cows at times.
- Use urine of buffalos/ cows as manure in soil mixing 1 part of urine in 5-6 parts of water. This mixture solution can be applied around the plant (8-10 cm away), on leaves or roots in the evening time in the gap of 15-15 days after the plant bears 3-4 leaves (put 1 tea glass (167 ml) urine with 5 tea glass water in 1 liter mineral water bottle, and spray this mixture solution for two cauliflower plants by half/half bottle in each plant)
- Similarly, *Hamal Jhol 1* and *2* can also be used mixing with 8-10 parts of water with 1 part of *Hamal Jhol* 1 and 2 in leaves and roots in every 15 days respectively as manure and pesticide.(put 3/4 tea glass(125 ml) *Hamal Jhol*-1 or 2 with 5 Tea Glass water in 1 liter mineral water bottle, and spray this mixture solution for two cauliflower plants by half/half bottle in each plant)

8.1.6. Mix cropping of cauliflower, cabbage with coriander or mustard

Mix cropping is also known as inter-cropping or co-cultivation. It is a type of cropping system that involves planting two or more crops simultaneously in the same field. In general, the theory is that planting two or more than two crops in same field

at same cultivation period will allow the crops to work together. Possible benefits of mixed cropping are as followings:

- It helps to balance nutrients in the soil.
- It helps to eliminate the weeds and pest problems in the field.
- It helps to minimize the crops from the effect of unfavorable climate condition (wet, dry, hot, cold) to suppress plant diseases, to increase overall productivity and to utilize the land up to its full capacity.

Fig. No. 8.1.6.1: Mixing crop cauliflower with mustard
Source: JICA Project Team

- If cauliflower and mustard are grown together, mustard can be used as short-term crop and can harvest earlier, on cauliflower can be harvested later.
- Mustard can work as trap crop, which can somehow minimize the pests attack in the cauliflower because pest goes to attack the mustard, and cauliflower remains safe.

8.2 Specific Methods for Cauliflower Cultivation

Cauliflower can be categorized in three types based on its maturity days after transplanting. They are as followings:

- Early maturity (crop ready for harvest in 40-45 days in warm area)
- Medium maturity (crop ready for harvest in 60-75 days in Mid hills)
- Late maturity (crop ready for harvest in 80-140 days in Mid hills)

In Nepal, generally, medium and late maturity varieties are cultivated.

Table No. 8.2.1: Variety and its characteristics

Variety	Maturity (days after transplanting)	Sowing	Harvesting	Area	Hybrid/ Open Pollination (OP)[2]
Jyaapu	Mid 80 - 110	August	Nov.- Dec.	Low/Mid hills	OP
Snow crown	Early 90-95	May-July	Aug.-Sep.	Low/Mid hills	Hybrid
White top	Early 90-100	May-July	Aug.-Sep	Mid/High hills	Hybrid
Kathmandu local	Late 100-110	July-August	Nov.- Dec.	Mid/High hills	OP
Kibogiant	Late 120-140	July-August	Dec. – Jan.	Mid/High hills	OP

Table No.8.2.2: Planting distances in different season

Variety	Spacing Distance	
	between row to row	between plant to plant
Early maturity	55 - 65 cm	45 - 55 cm
Medium maturity	55 - 65 cm	55 - 65 cm
Late maturity	70 - 80 cm	55 - 65 cm

[2] OP: it means true breed or self- pollination

8.2.1 Health benefits

Cauliflower is very low in calories but high in vitamins. In fact, cauliflower contains many types of vitamin and mineral needed for human body.

Fig. No. 8.2.1.1 Well-grown plants

Source: JICA Project Team

Fig. No. 8.2.1.2: Cauliflower ready for harvest

Source: JICA Project Team

8.2.2 Climate and soil

(A) Climate

- Cauliflower can be cultivated in various types of weather such as in cool, warm and hot weather conditions.
- Tropical type of cauliflower can be cultivated in rainy season in Nepal.

Fig. No. 8.2.2.1: Turned red-purple due to extreme cold temperature

Source: JICA Project Team

(B) Soil

- Cauliflower can be cultivated in various types of soil; however, the soil with high organic matters is suitable for good yields.
- The field that receives warm sunshine, fertile soil, facility of irrigation and drainage, and not cultivated cauliflower for two years is better for cauliflower cultivation.

8.2.3 Time for cultivation and harvesting of Cauliflower

- Cauliflower can be cultivated throughout a year in low hills, mid-hills and high-hills region of Nepal. The majority of the farmers are using sowing, transplanting and harvesting of cauliflower as mentioned below in table:

Table No. 8.2.3.1: Major cropping type and suitable areas with varieties

Areas	Variety	Sowing time	Time for transplantation	Harvesting time
Low hills	Early maturity Medium maturity Late maturity	June - July September - October October - November	July - August October - November November - December	October-November January - February February - March
Mid-hills	Early maturity Med-maturity Late maturity	March - April July - August September - October	April - May August - September October - November	June - July December - January March - April
High Hills	Medium maturity Late maturity	March - June February - April	April - July March - May	August - October July - November

8.2.4 Transplanting

- 25-30 days after sowing seeds in raised and sky nursery bed, the seedlings are ready for transplantation.
- It should be watered in nursery bed one hour earlier of uprooting seedlings. It leads to less damage on roots of seedlings.

- Transplant the seedlings in the evening time, and field should be watered one day earlier to transplant the seedlings if the soil is dry. And, it should also be watered to the plants after transplantation.

Fig. No. 8.2.4.1: Transplanting cauliflower seedlings
Source: JICA Project Team

- While transplanting the seedlings, root should be covered by soil only up to those parts, which part was covered by soil in nursery bed. While doing so, if there is condition of lodging seedlings, it can be staked with small sticks.
- Watering to the plants should be done every day for one week.

8.2.5 Harvesting

- We want to pick the cauliflower once the head is full and big size, but the best time to cut cauliflower is when the diameter of head becomes 15-20 cm.
- Generally, when the head reaches about the size of 5-7 cm in diameter, simply pull up about three or four large leaves and tie them loosely around the cauliflower head for better quality cauliflower production.
- The mature head should be firm, compact, and white. When it is ready to harvest the cauliflower head, cut it from the main stem with a few of the outer leaves attached with head to protect the head from injury and prolong its overall quality. It should be sure to handle the head carefully as it can be injured.
- Best time for harvesting cauliflower is in the morning time after the dues go dry or in the evening time when it turns cool. The harvested cauliflower should not be kept in sunlight.
- Once it is harvested, it’s usually recommended that the head should be soaked in salt water (1 tea spoon salt to 1 litter water) for about 20-30 minutes. This will help to ooze out pesticides that are present in head.

Fig. No. 8.2.5.1: Harvesting cauliflower by farmer

Source: JICA Project Team

Fig. No. 8.2.5.2: Cauliflower harvested with outer leaves

Source: JICA Project Team

8.2.6 Techniques to produce cauliflower seeds

Generally, a mature Cauliflower plant gives flowers, if it is left without harvesting and given proper care. Traditionally, the seeds can be produced by keeping the plant in the field without picking head. After the drying grains from flower, it can be used as seed. However; to produce the quality seed of cauliflower, the following methods can be applied.

Fig. No. 8.2.6.1: Traditional seed production from flower of cauliflower

Source: JICA Project Team

<u>The following methods can be followed to produce quality seeds of Cauliflower.</u>

Step- 1: Selection of plant

- Select medium type cauliflower variety with white curds without any diseases and remove the old leaf of plant.

Step- 2: Sterilization

- Knife / sickle, fore-shape should be disinfected by washing or dipping with hard alcohol or spirit. Hand should be properly washed with clean water.

Step- 3: Selection of curd and removing the central portion of the curd

- Select curds and remove the central part (1/3 part of head) of it with a sharper sickle. It is better to do this in the evening time.

Step-4: Cleaning curds

- After removing the core portion of the curd, the wounds will be cleaned gently with cotton, dipping it in alcohol.

Step- 5: Protection from fungus infection

- As the wound of the cauliflower can be attacked by fungal, the white ash should be applied on the wound in the same day.

Step-6: Nursing

- While nursing, provide well-composted farm yard manure and fertilizer around cauliflower plant, and water in it at every 1 week interval.
- Also, remove old leaves from the plant, which minimize the disease and pest attack in the plant.

Step-7: Supplementary pollination

- To increase the pollination, gently shake the plant at flowering time, which helps in good pollination.

Step-8: Removing unnecessary flowers and providing stake

- After the cauliflower plant bears sufficient amount of seeds, the unnecessary part of flowers should be cut off. It helps in proper development of seeds in plant.
- At this time, provide wooden stake to the cauliflower plant in garden.

Step-9: Seed harvesting

- After seeds are ripened, the pods get dry.
- Pick the pods when they are dry well.
- After picking the pod, it should be dried for 1-2 days, and get seeds from pods. Then, let the seeds dry for 2-3 days in sunlight and store them reducing seed moisture level up to 7-8%.

Step-10: Storing

- The seed germination can be maintained up to 5 years if produced is stored well.
- We have to store these seeds in a plastic bottle with tight lead cover and store in a room with less than 50% humidity, and moisture level in seed should not exceed 6%.

As mentioned above to produce the seed of cauliflower, the methods of cutting curds of cauliflower and treatment have been given below in figures:

Fig. No. 8.2.6.2: Sterilization of knife in strong alcohol or spirit

Fig. No. 8.2.6.3: Removed the one third parts of the curds of cauliflower

Fig. No. 8.2.6.4: Cleaning the wound by cotton dipped in strong alcohol

Fig. No. 8.2.6.5: Sprayed white ash to protect from fungal attack

Source: JICA Project Team

8.3 Specific Methods for Cabbage Cultivation

Cabbage is the second important crop in winter season of Nepal. The hardy head made up of leaves is edible part of cabbage. Cabbage can be consumed freshly as salad, can consume as curry after cooking, making *Parautha* or in processed form.

- Cabbage is of two types based on its size and maturity:
  - Round cabbage: It is smaller in size. Generally, it can be ready for harvest in 55-70 days after transplantation.
  - Semi-flat cabbage: It is a little bigger in size and ready to harvest in 75-80 days after transplantation.
- Similarly, description of some varieties of cabbage under open pollination condition being cultivated in Nepal is given below.
  - **Copenhagen Market:** This variety of cabbage can be harvested in 70-80 days after transplantation. Normally, the heads are green, round, half-compressed or fully compressed and of 0.6-1.0 kg weight.
  - **Golden Acre:** This variety of cabbage can be harvested in 65-75 days after transplantation. Generally, plant grows smaller weight of heads about 0.8-1.2 kg.

Fig. No. 8.3.1: Well flourished cabbage

Source: JICA Project Team

  - **Green Coronet:** This round variety of cabbage can be harvested in 60-75 days after transplantation. Weight of cabbage heads is usually 0.8 -3.0 kg.

8.3.1 Health benefits

Cabbage is an excellent source of vitamin “K”, vitamin “C” and vitamin “B-6”. It is also a very good source of manganese, dietary fiber, Potassium, Vitamin “B-1”, Folate and Copper.

8.3.2 Climate and Soil

(A) Climate

- Cabbage grows best in regions where there is cool growing season with temperatures between 7°C and 24°C.
- Cabbage can tolerate frost and temperatures as low as -7°C.
- Some varieties have a tolerance high temperature, and can give yields maximum in 25 ºC temperature.

(B) Soil

- Cabbage can be cultivated in various types of soil. However, soil rich in organic substances is more suitable.

8.3.3 Planting distance

Table No. 8.3.3.1: Planting distance based on variety

S. N.	Variety of Cabbage	Distance	
		Spacing between line to line	Spacing between plant to plant
1.	Copenhagen Market	40 - 45 cm	40 - 45cm
2.	Golden Acre	50 - 55 cm	40 - 45cm
3.	Green Coronet	60 - 75 cm	40 – 50 cm

8.3.4 Time for sowing and harvesting

Table No. 8.3.4.1: Time for sowing and harvesting

Areas	Sowing	Transplantation	Harvesting
Low hills	July - December	August - January	November - April
Mid-hills	August - September	September - October	January - February
High Hills	January - July	February - August	May - November

8.3.5 Transplanting

- Raised or sky nursery beds are prepared to grow seedlings of cabbage.
- At stage of 5-6 leaves in the nursery bed after 30-35 days of sowing seeds, the seedlings are ready for transplantation.
- It should be watered in nursery bed one hour earlier of uprooting seedlings. It leads to less damage on roots of seedlings.

Fig. No. 8.3.5.1: Seedlings of cabbage in sky nursery bed
Source: JICA Project Team

- Transplant the seedlings in the evening time, and field should be watered one day earlier to transplant the seedlings if the soil is dry. And, it should also be watered to the plants after transplantation.
- While transplanting the seedlings, root should be covered by soil only up to those parts, which part was covered by soil in nursery bed. While doing so, if there is condition of lodging seedlings, it can be staked with small sticks.
- Watering to the plants should be done every day for one week.

8.3.6 Harvesting

- Normally, we can also pick the cabbage two times from one plant from early cultivated cabbage plants. During the first harvesting, cut the cabbage head out of the plant, leaving the outer leaves and root in the soil. The second new head also formed from the plant after 1st harvesting. Later on that also can be used for consumption.
- Cabbage head should be carefully harvested together with some leaves and kept under a shade until consumption.

Fig. No. 8.3.6.1: Farmer picking mature cabbage with sharp sickle
Source: JICA Project Team

8.4 Major pests and diseases in cauliflower and cabbage

8.4.1 Major pests and their control

Pests	Types of damage	Management
 Fig. No. 8.4.1.1: Cut worms Source: Crop Protection Directorate, Harihar Bhawan	• Plant falls, withers and dies.	• Do not use raw cow dung. • Spray Hamal Jhol 1 properly targeting roots and soil around plant. • Mix 1 kg of Malathion powder for 1one Ropani land.
 Fig. No. 8.4.1.2:Red ant Source: JICA Project Team	• Plant falls, withers and dies.	• Spray Hamal Jhol 1 properly targeting roots and soil around plant. • Treat soil with mixing 1 kg of Malathion powder for 1 one Ropani land, or prepare Dyclorovas (Nuvan) or, Dustban pesticide 1 ml in 1.5 liter of water, and spray it to the infested plant reaching its roots.
 Fig. No. 8.4.1.3: Cabbage butterfly Source: Crop Protection Directorate, Harihar Bhawan	• Initially the larvae stick together and later on move separately when they grow, and feed on leaves, stem and young head of cauliflower or cabbage. Leaves are noticed with many holes. Whole leaves are eaten if there are more larvae.	• Spray properly Hamal Jhol 2 on the leaves. • Use *Neem* based pesticides. • Spray the solution of Carbile (Sevin) or Dyclorovas (Nuvan) 1 ml with per liter of water.

Pests	Types of damage	Management
 Fig. No. 8.4.1.4: Tobacco caterpillar Source: Crop Protection Directorate, HariharBhawan	• Holes appear on leaves in initial infestation. When invasion increases it eats up all leaves rendering the plant leafless.	• Spray properly Hamal Jhol 2 on the leaves. • Use *Neem* based pesticides. • Spray the solution of Carbile (Sevin) or Dyclorovas (Nuvan) 1 ml with per liter of water.
 Fig. No. 8.4.1.5: Diamond back moth Source: Crop Protection Directorate, Harihar Bhawan	• Larva sick on underside of leaves and feed on them, and leaves turn like green net. When invasion of larva increases, leaves die and plant cannot grow.	• Spray properly Hamal Jhol 2 on the leaves. • Use *Neem* based pesticides. • Use Spodo- lure trap or spray solution of Fenvalarate or Carbile (Sevin) or Dyclorovas (Nuvan) 1 ml with per liter of water.
 Fig. No. 8.4.1.6 :Aphids Source: Crop Protection Directorate, Harihar Bhawan	• These aphids suck sap from leaves and young stem, which makes plant sick and cannot grow.	• Spray soap-water solution on aphid affected areas. • Spray tobacco-water solution. • Spray ashes reaching bodies of aphids. • Spray Hamal Jhol 2 properly on aphids. • Preserve friendly pests (lady bug) and it feeds on aphids).

Pests	Types of damage	Management
 Fig. No. 8.4.1.7: Flea beetle Source: Crop Protection Directorate, Harihar Bhawan	• Larva survives in soil and eats the roots of plants. Adult flea beetle feed on leaves making smaller holes.	• Spray properly Hamal Jhol 2 reaching on the leaves. • Use *Neem* based pesticides. • Spray the solution of Malathian 2 ml or Dyclorovas (Nuvan) 1 ml with per liter of water.

8.4.2 Major diseases and their control

Diseases	Symptoms	Management
 Fig. No. 8.4.2.1: Damping off Source: Crop Protection Directorate, Harihar Bhawan	• Young shoots in nursery bed decay and die.	• Treat seeds with 2 gram of Bevistin (Carbendagim) for per kg seeds. • Do not sow seeds thickly. • Manage drainage system for excessive water. • Spray the nursery bed with solution of Dythene M – 45 (Mankojeb) or Bevistin (Carbendagim) 2-3 gram and per liter of water after symptoms of damping off are seen in seedlings.

 Fig. No. 8.4.2.2: Alterneria leaf spot Source: JICA Project Team	• Grey blotches appear on leaves and stem. • It spreads to all leaves, stems and heads.	• Use disease resistant variety of crop and healthy seeds. • Treat seeds with Captan, Thiram. • Keep the field neat and clean. • Make proper use of irrigation and manure fertilizer. • Apply Hekzaconal fungicide.
 Fig. No. 8.4.2.3: Sclerotinia rot Source: JICA Project Team	• The stem above soil rots, and appears white fungus or the plant withers while flowering. • The color of shoot turns white grey, and black stones appear inside stem.	• Use only the healthy seeds. • Keep the field neat and clean. • Plough the land deeply. • Apply Myankozeb fungicide.
 Fig. No. 8.4.2.4: Downy mildew Source: JICA Project Team	• The underside of leaves is covered with white to grayish, ash like fungus. Similarly, seedlings grow smaller and turn discolored.	• Adopt crop rotation (no cultivation of cabbage variety in the same site for 6 years) • Treat the seeds (Kyapton, Thiram). • Keep the field clean. • Uproot and burry the diseased plants. • Apply the fungicide called Myankozeb or Metalyakzel.

 Fig. No. 8.4.2.5: Club root Source: JICA Project Team	• Plant turns yellow and stops growing. • The roots are deformed when uprooted. • Lower part of roots becomes extremely big since roots become thick, large, and swollen.	• Adopt crop rotation. • Use agro-lime. • Apply 20 kg of Nebizan powder per *Ropani* of land. • Dip roots of seedlings in solution of 5 gram of Nebizan in 1 liter of water for 30 minutes.

9. Green Leafy Vegetables

The green leaf, shoots, stem of the vegetable crops under this leafy vegetable group are consumed. Broad leaf mustard, *Chamsur*, Lettuce, *Methi*, Latte, Bethe, swish chard, etc. vegetable crops is under leafy vegetable group. The leafy vegetables are especially rich in vitamin "A", including protein, minerals and other nutrients.

9.1 Specific Methods for Broad Leaf Mustard Cultivation

Broad leaf mustard is the most popular and widely consumed leafy green vegetable in Nepal. It stands first among all leafy green vegetables and its young leaves are consumed as vegetable. Well-grown, green and young leaves of broad leaf mustard are consumed cooking them lightly. The broad leaf mustard leaves are also chopped in smaller pieces, dried or fermented *(Gundruk),* and can also be consumed during the off season. In direct sowing in kitchen garden, after 30-40 days young thinning leaves can be harvested for daily cooking.

9.1.1 Health benefits

This mustard leaves are rich in calcium, iron, phosphorus, protein, fiber, and other nutrients such as vitamin "A", "B", "C "and "E".

9.1.2 Climate and Soil

(A) Climate

According to the variety, mustard generally grows best in cool temperature, and humid air. It does not give good yields with high temperature and dry season. Hence, it is winter crop in Terai and mid-hills. Even in high-hills where snow and frost falls this mustard is cultivated in summer.

(B) Soil

Mustard can be cultivated in various types of soil. But, it grows best in loamy soil with adequate amount of organic matters.

9.1.3 Variety

Short description of varieties of mustard recommended for cultivation in Nepal is given below.

Table No. 9.1.3.1: Variety of broad leaf mustard cultivated in Nepal

Name of mustard	**Maturity days (after transplanting)**	**Leave type**	**Color of leave**
Khumal broad leaf Mustard	50 – 60 days	Round broad with wrinkled leaves	Dark green with short stem
Marpha broad leaf	55 - 65 days	Hairless, wrinkled	Light green, short leaf stem
Khumal red leaf	60 – 70 days	Hairless, wrinkled. Stem & leaf are slightly curved	Light green mixed with purple-red

Name of mustard	**Sowing time**	**Harvesting time**	**Area**
Khumal broad leaf Mustard	1. Feb. – May 2. Sep. – Feb.	1. May – Aug. 2. Nov - March	Mid/high hills
Marpha broad leaf	1. Feb. – May 2. Sep. – Feb.	1. May – Aug. 2. Nov. – Mar.	Terai, mid/high hills

Khumal red leaf	1. Feb. – May 2. Sep. – Feb.	1. May – Aug. 2. Nov. – Mar.	Terai, mid/high hills

Source: JICA Project Team

(a) Khumal broad leaf mustard

Khumal broad leaf variety of mustard is more popular than other varieties. Leaves of this variety are round broad with wrinkled surface, dark green with short stem. It is an early maturity variety. It can tolerate the rain; therefore, it is suitable for rainy season.

Fig. No. 9.1.3.1: Khumal broad leaf

Source: JICA Project Team

(b) Marpha broad leaf

This variety of mustard is recommended to cultivate in *Terai*, mid-hills, and high-hills. Leaves of this variety are light green, hairless, with wrinkled surface, and 40 - 50 cm long and 20 - 30 cm wide. It has shorter leaf stem, and is a late maturity variety. It can be harvested in 55 - 65 days after transplantation.

Fig. No. 9.1.3.2: Marpha broad leaf mustard

Source: JICA Project Team

(c) Khumal red leaf

This Khumal red leaf mustard was improved in *Terai*, mid-hills and high-hills. Leaf of this variety is light green mixed with purple-red colour, hairless, wrinkled and it is 25-30 cm long and 20-25 cm wide. And, leaf and stem are slightly curved. It is late maturity variety, shoot grows very late than in Marpha and Khumal broad leaf varieties of mustard. Fresh leaf can be harvested in 60 - 70 days after the transplantation.

Fig. No. 9.1.3.3: Khumal red mustard variety

Source: JICA Project Team

9.1.4 Land preparation and Manure Application

(A) Land preparation

A clean and well pulverized soil with good tilt is needed for better germination of seed. The land should be well prepared first by plowing deep with soil turning plough.

(B) Manure application

30-35 bamboo baskets (900-1000 kg) of well decomposed FYM or compost manure should be applied in the soil, and well ploughed the field during land preparation time.

9.1.5 Sowing

Mustard seed can be cultivated in two ways:

(A) Directly sowing in soil (Either as mix cropping or single crop)

- If mustard seed are sown mixing with broad leaf mustard seeds, mustard will be ready for harvest in 20-25 days, and it can be picked.
- Sowing or transplanting broad leaf mustard seeds either single or mixing the seed space should be at 45 cm between each seed.
- If only broad leaf mustard seed are sown, thinning, weeding and irrigation should be done when seedling gets 4-5 leaf stage.

(B) Making seedlings in nursery bed and transplantation

In this method, the seedlings are grown in nursery bed. After the site selection, the land should be cleaned. Size of the nursery bed should be 1meter wide with convenient length, plough it well. Likewise, stones and crop residues lying underneath should be removed while making nursery bed. It should be made 15 – 20 cm raised bed for rainy season; whereas sunken nursery bed for winter season. Seedlings preparation in nursery bed is as followings:

- Prepare a nursery bed of 1 m wide and of desired length, and soil should be prepared adding one bamboo basket of well decomposed FYM or compost manure.
- Draw the line of 2 fingers (2-3 cm) depth in the bed.
- Drop two seed at the space of 6 cm between the rows, and at 4 cm spacing from seed to seed.
- Cover the seeds by soil, ashes and sand, and then press the place of sowing lightly and mulch the nursery bed with straw or dried leaves.
- After the seed start germination, slowly remove the mulch and germinated weeds.
- After 3-4 weeks of sowing, the seedlings can be ready for transplantation and transplanting should be done in the evening.
- While thinning the plants of broad leaf mustard, it should be done without any damage to other plants. Thinning should be done after watering in the field in cool weather.

9.1.6 Transplanting

- While transplanting the seedlings, there should be some moisture in the soil. If the soil is dry, there should be irrigation one day before for seedling transplantation.
- Seedlings are transplanted at 30 cm distance from plant to plant and at 45 cm distance between rows to row.

- While transplanting seedlings, ¼th bottom part of main root should be cut or pinched up, which will not let the flowering earlier, and allows the leaves harvesting for a longer duration.
- While transplanting seedlings, above part from roots should not be covered by soil.
- If it is watered right after seedling transplantation, seedling grows up well and faster.

Fig. No. 9.1.6.1: 1/4th of main root is pinched up before transplanting.

Source: JICA Project Team

Fig. No. 9.1.6.2: Broad leaf mustard seedlings transplanted from nursery to garden

Source: JICA Project Team

9.1.7 Time for sowing, transplanting, and harvesting

Table No. 9.1.7.1: Time for sowing, transplanting, and harvesting

Area	**Sowing time**	**Transplanting time**	**Harvesting time**
Low hills	August - November	October - December	November - April
Mid-hills	July, August - November	August - December	September - May
High-hills	March - June	April - July	June - April

9.1.8 Weeding

First weeding should be done after 3-4 weeks of transplantation, and second weeding should be in 15 days after the first weeding. In case of direct sowing, the first weeding should be done after one month, and second weeding should be done in 15 days after first weeding. While weeding the garden, top dress the plant with water and urine solution after removing weeds. After top dressing, it is better to cover around base of each plant by the soil properly.

Fig. 9.1.8.1: Farmer weeding the broad leaf mustard

Source: JICA Project Team

9.1.9 Top dressing

- The leafy vegetables should be top dressed around plant as additional manure with mixture of water and urine of buffalos and cows at times.
- Apply urine of buffalos/ cows as manure in soil mixing 1 part of urine in 5-6 parts of water. This mixture solution can be applied around the plant (8-10 cm away), on leaves or roots in the evening time in the gap of 15-15 days after the plant bears 3-4 leaves.
- Similarly, *Hamal Jhol 1* and *2* can be used mixing with 8-10 parts of water with 1 part of Hamal Jhol 1 & 2 in leaves and roots in every 15 days respectively as manure and pesticide.

9.1.10 Watering (irrigation)

- A little more moisture is required in soil for the farm of broad leaf mustard. So, keep watering in the field to retain moisture in soil as per necessity, but avoid water logging. Watering is not necessary in rainy season; while good drainage should be managed at that time.

9.1.11 Harvesting

- The green leaf of the broad leaf will be ready for harvest in 20-25 days after the transplantation. It needs to keep picking the grown up fresh leaves, and remove

the diseased and old leaves. The stem or roots of mustard plant should not be affected while picking the fresh leaves. About 1200-1500 kg of fresh mustard green can be harvested in a Ropani of land.

9.1.12 Seed production techniques

- Seeds of Khumal broad leaf variety can be easily collected in mid-hills and low-hills; while seeds of Marpha variety can be produced in high-hills.
- For the seed production, late flowering and vigorous plant need to be selected.
- The leaves should not be harvested from the selected plant for seed production. The side shoot comes up automatically in that plant, and the seed forms. After the maturity of those seed, it should be harvested and dry in sun. It should be stored in plastic pet bottle after well drying in sun and it can be used as seed for next year.

Fig. No. 9.1.12.1: Flowering broad leaf muster for seed production

Source: JICA Project Team

9.1.13 Major diseases and pest in broad leaf mustard, and their control

(A) Major disease and their control

Diseases	Symptoms	Control
 Fig. No. 9.1.13.1: Alternaria leaf spot Source: Crop Protection Directorate, Harihar Bhawan	• Small dark spots appear on leaves at initial stage. • Slowly, the dark spots turn as lesions. • Center part of the lesions become bright color; whereas, there is brittle and crake in side of leaf.	• Treat the seeds with Dithane M-45 or Thiram 2-3 gram for per kg seeds. • Spray solution of Blaitox-50 or Dithane M-45, 2-3 gram with per liter of water in the gap of 10-15 days.

 Fig. No. 9.1.13.2: White Rust Diseases Source: Crop Protection Directorate, Harihar Bhawan	• Initially, white spots appear underside of leaves. Slowly, spots turn to lesions. The spots are filled with white fungus powder.	• Solution of Dithane M-45, 2-3 gram with per liter of water in the gap of 12-15 days should be sprayed.
 Fig. No. 9.1.13.3: Club root Source: JICA Project Team	• Plant growth stops, turns yellow. • When the plant is uprooted, it can be observed that roots are clubbed. • Roots become thick, big and large and the tip of the root becomes unusually bigger.	• Adopt crop rotation; maintain alkali at 7.2 using agro-lime. • Spray Nebijin powder 20 kg for per *Ropani* of land while preparing soil for cultivation. • Dip the roots of seedlings in solution of 5 gram Nebijin and 1 liter of water for 30 minutes before the transplantation.

(B) Major disease and their control

 Fig. No. 9.1.13.4: Aphid Source: JICA Project Team	• These pests suck sap from leaves and young stem, which makes the plant diseased and cannot grow.	• Spray soap and water solution on aphid affected areas, • Spray tobacco and water solution. • Spray ashes reaching body of the aphids. • Spray Hamal Jhol 2 properly. • Preserve friendly pest such as lady bug that feeds on aphids.

9.2 Specific Methods for Kangkong (Water spinach) Cultivation

Kangkong is grown especially in the South-east Asian region as a vegetable. Kangkong has light green ovate (oval shaped leaves), and its stems are hollow, so they also can float on the water. Both leaves and stems are edible and can be consumed like as spinach. Under sub-tropical conditions, Kangkong can be harvested in rainy season, and it can be harvested again, as the leaves can grow again after harvesting.

9.2.1 Health benefits

Kangkong leaves are very nutritious, being rich in vitamins and minerals. It is naturally rich in dietary fiber, protein, calcium, iron, vitamin “A” and vitamin “C”.

9.2.2 Climate and Soil Condition

(A) Climate

It is a semi aquatic plant, a creeper that grows in or near the water on moist soils. Kangkong is not adapted to climates with mean temperatures below 10 ℃. The optimal temperature required for Kangkong is around 20 ºC – 30 ºC. Flowering occurs under short-day conditions and starts from mid-summer onwards. Kangkong is perennial in warm climates, but an annual under cooler growing conditions. It can tolerate very high rainfall, but not frost.

(B) Soil condition

Kangkong can be cultivated well under moist condition. Soil should be wet and more micro nutrient, and pH level around 6 – 7. To make soil muddy moist, there should be regular irrigation.

9.2.3 Land preparation and Manure Application

(A) Land preparation

The field of cultivating Kangkong should be properly cleaned and ploughed, and we can sow the seeds in the ploughed field at about 30-40 cm distance between each seed. We can also prepare like sunken nursery bed, and put the seeds in each trench in the kitchen garden near by the water source.

(B) Manure Application

If the Kangkong is grown on field, manure application is not mandatory, but incase grown in pot or container, we should add the Nitrogenous fertilizer as top dressing in every week by cattle urine or urea.

9.2.4 Sowing

In moist soil condition, the seed should be sown in the bed of 60-100 cm wide. Seeds can be sown either directly or nursery-grown seedlings can be transplanted into the main beds. Seeds should be no more than 2 years old, and can be soaked for 24 hours before sowing to promote well germination. Soil temperature requirement for germination is 20 °C.

9.2.5 Harvesting

A first harvesting period of Kangkong is usually 4 to 6 weeks after planting, depending upon the temperature and growing conditions. While harvesting, cut or pinch only a few leaves or entire plant with leaves and stems leaving only 8-9 cm stem of each plant in the bed. Plant will re-grow again through this way of harvesting. Both stems and leaves of Kangkong can be consumed. Kangkong which is growing on the field, one should be careful that it’s an invasive plant and grows aggressively in broad range. Therefore Kangkong should be harvested before flowering, so that it can’t form seeds.

9.3 Specific Method for Coriander Cultivation

Coriander is very famous in the Nepalese kitchen. It can be consumed with vegetable, pickle, pulse, meat items. Its soft leaf is used of pickles. It is a soft plant growing up to 50 cm in height. The leaves are in different shape. Coriander can be cultivated twice in mid-hills areas. It is cultivated from November to January in winter season and from July to August in rainy season.

Fig. No. 9.3.1: Farmer cultivating coriander

Source: JICA Project Team

9.3.1 Health benefits

As coriander has medicinal importance, it is used as spices. It is practicing that its leaves are cooked with vegetables. Coriander leaves are rich in vitamins, minerals and it has more fiber amount which helps in maintaining digestive system if taken regularly.

9.3.2 Climate and Soil

(A) Climate

Coriander generally called "*Dhania*" belongs to the Apiaceae family. It is mainly grown in Terai and Mid-hills during winter, in summer to autumn in high hills. Coriander crop requires a cool climate during the growth stage and warm dry climate for its maturity.

(B) Soil

Coriander can be cultivated in various types of soil. But, it best grows in loamy soil with adequate amount of organic matters.

9.3.3 Variety

Short description of the open pollination varieties of coriander is given below:

(A) Lotus

- It is recommended for Terai and Mid-hills areas.

(B) Surabhi

- The plant grows to the height of 20 - 25 cm.
- It can be harvested in 35-40 days after germination of plants.
- This variety is recommended for Terai, Mid-hills and High hills.

9.3.4 Land preparation and Manure Application

(A) Land preparation

Plough the land deeply 2-3 times, crush the clods and flatten the surface by removing the weeds. The land should be ploughed by crushing the clods, removing weeds, pebbles, plastics, and residues of previous crops,

(B) Manure Application

Use about 25 - 30 bamboo basket (750-900 kg) well decomposed FYM or compost for a Ropani of land while preparing soil for coriander cultivation.

9.3.5 Sowing

The spacing between the rows should be 20-25 cm and seeds are sown at the gap of 10-15 cm. Coriander can also be cultivated together with other crops, or it can be cultivated on the side of any other vegetable crops (Mustard, onion, etc.), which helps in repeal of pest by its smell.

Fig. No. 9.3.5.1: Coriander grown on the side of other vegetable crops
Source: JICA Project Team

9.3.6 Weeding and watering (irrigation)

- Weeding should be done after the coriander plant bears 3-4 leaves, and remove the weeds.
- Watering should be done in coriander for maintaining moisture in soil so that the coriander plants grow well. Coriander requires more moisture during its life cycle.

- It is better to watering immediately after sowing the seeds, and then watering at the interval of 5 to 7 days or as per the necessity.
- Moisture can be maintained by using mulching like dry leaves, straw etc.
- Mulching can also help to protect the crops from the direct sun-light, and damaging by heavy rainfall.

Fig. No. 9.3.6.1: Farmer weeding the coriander

Source: JICA Project Team

9.3.7 Harvesting

- Coriander leaves can be picked as per the requirement.
- After the coriander leaves get matured, only the leaves can be picked or it can be consumed by uprooting the plants also.
- Coriander plant can be kept fresh for 4-5 days, if the roots of the coriander plant are dipped in water after uprooting from the garden.

9.3.8 Seed production techniques

- Coriander seed can also be produced in the kitchen garden by farmers. For this, suitable coriander plant should be selected, and there should not be leaf harvesting.
- The selected coriander plant bears flowers at after completion of its vegetative stage and produce seeds.
- Harvested plants with seed are dried in the sunlight for 1-2 days to bring the moisture levels down to 18%. This dried plant is then thrashed to remove the seeds. Then, seed are further dried in the shade to bring the moisture levels down to 9%.
- The seed should be stored in plastic bottles with tight lead cover for next sowing time.

Fig. No. 9.3.8.1: Coriander plant left for producing seeds

Fig. No. 9.3.8.2: Coriander plant left for seeds bearing flowers

Source: JICA Project team

9.3.9 Major diseases and pest in coriander, and their control

Coriander crop is not infested by much disease like other crops. But, if moisture in soil is more, that rots the roots. Therefore, there should be proper system of drainage.

Pests	Types of damage	Control
 Fig. No. 9.3.9.1: Aphids Source: JICA Project Team	• These pests suck sap from leaves and young stem, which makes the plant diseased and cannot grow.	• Spray soap and water solution on aphid affected areas, • Spray tobacco and water solution. • Spray ashes reaching body of the aphids. • Spray Hamal Jhol 2 properly. • Preserve friendly pest such as lady bug that feeds on aphids.

10. Roots Vegetables

Most of all the root crops have similar situation requirements, and grow best in cool weather condition. Major vegetables in this group are carrot, radish, beetroot, turnip and tubers. The root crops are commonly used by cooking roots. But some of the vegetables leaves also consumed by cooking.

Table No. 10.1: Edible parts of root crops

Name of Crops	**Edible part**	
	Root	**Leaves**
Carrot	✓	
Radish	✓	✓
Turnip	✓	✓
Beet root	✓	

As root vegetables grown in organic matter rich soil, it is full of nutrients and is excellent sources of fiber. These are also the source of vitamin “A”, “B”, and “C”, and also are the antioxidants.

10.1 Basic cultivation methods of roots vegetable

10.1.1 Climate and Soil

(A) Climate

- Generally, root crops are cultivated in Terai and mid-hills during winter season; while it is cultivated in high-hills during the summer season.
- For germination of seed, it requires slightly cool weather and soil should be moist.
- In carrot case, the seed can be produced in a cold climate area of Nepal.

(B) Soil

- Root crops cannot grow well in acidic soils.
- Root crops grow best in deep, loose and loamy soil. It gives faster yield in sandy type of soil.

10.1.2 Land Preparation and Manure Application

(A) Land preparation

- Land preparation is very important factor for well growth of root crops. They grow best in a deep, loose soil that retains moisture as well as have good drainage capacity.
- Land surface should be flattened and water should not be logged in.
- Land should be prepared by plowing land 4-5 times, and the surface should be flattened. Specially, root crops require more loose and deep soil for the well growth of root inside soil. Therefore, clods should be crushed, and fine plowing should be done during land preparation.

(B) Manure application

- Apply 40 – 50 bamboo baskets (1200-1500 kg) of well-decomposed farm yard manure (FYM) or compost in soil for per a Ropani of land.

10.1.3 Weeding

- Weeds are grown together with plant in the field. To control them, weeding is necessary for loosening the soil also.
- It is better to cover by soil around the base of each plant just after weeding to make good root growth.

10.1.4 Thinning

- The objective in thinning is to leave the remaining seedlings undisturbed from small and unnecessary plants.
- The thinning have to be done while there is moisture in soil or after irrigation of one hour.
- Root crops must be thinned about 30-40 days after sowing seeds.
- Long-rooted vegetables such as carrots and red radish should never be transplanted; otherwise, as they develop, the roots will fork.

10.1.5 Top dressing

- While top dressing, manure or mixture of urine and water can be applied surrounding the base of plants. Use urine of buffalos/ cows as manure in soil mixing 1 part of urine in 5-6 parts of water. This mixture solution can be applied around the plant (8-10 cm away), on leaves or roots in the evening time in the gap of 15-15 days after the plant bears 3-4 leaves. (put 1 tea glass(167 ml) urine with 5 tea glass water in 1 liter mineral water bottle, and spray this mixture solution for two plants, half bottle for each plant)
- Similarly, *Hamal Jhol 1* and *2* can be used mixing with 8-10 parts of water with 1 part of *Hamal Jhol* 1 & 2 in leaves and roots in every 15 days respectively as manure and pesticide. (Put 3/4 tea glass (125 ml) Hamal jhol-1 or 2 with 5 tea glass water in 1 liter mineral water bottle, and spray this mixture solution for two plants by half/half bottle in each plant).

10.1.6 Watering (irrigation)

- Root crops need moist soil constantly by rainfall or irrigation during the time of initial growing period, which helps to promote good root development.
- If the soil is too dry, there should be irrigation once in a week.
- Generally, it is necessary to water the root vegetables, when moisture decreases in soil.
- More watering and water logging also become the problem for root crops. If water level become so high, root vegetables bears more leaves, root does not grow well and maturation also be delayed.

10.2 Specific methods for radish cultivation

- Majorly, there are white and red types of radish are being cultivated in Nepal.
- Red radish contains more amounts of carbohydrate and minerals compared to white radish.
- Radish contains 90 per cent of water, and has generally all kinds of nutrients.

10.2.1 Health benefits

- Radish is rich in vitamin “B” and “C”. It is an excellent source of potassium, calcium, iron, copper, sulfur, phosphorous and fiber, while it is very low in calories, and free from fat and cholesterol.
- Radish leaves contain almost six times more vitamin “C” and calcium than its root.

10.2.2 Variety

Some of the most common varieties of radish in Nepal are as follows:

- **Mino Early:** Its root is white and grows thinner towards its tip. It can be consumed in 60 – 65 days after sowing seed. This variety is recommended in Terai, Mid-Hill and High Hill.
- **Pyuthane Rato:** Pyuthane red is a local variety of radish in Nepal. It is late-crop variety and can be harvested late. The root will be ready for harvest in 70 – 80 days after sowing seeds. It is mostly grown in hilly areas.
- **Forty Days:** This variety of radish can be grown in warmer season and it is early maturity variety to be harvested in short time. It will be ready for harvest in 35 – 45 days after sowing seeds. This variety has been recommended for mid-hill areas.
- **Tokinishi:** This is late maturity variety of radish grown in hot areas and harvested late. It will ready for harvest in 55 – 60 days after sowing the seeds. It has been recommended for mid-hills areas. This can be sown from December to February

10.2.3 Seed rate and sowing distance

- According to the variety of radish, spacing between the plants to plant should be 25 – 30 cm and 45 – 50cm between the rows.
- It is better to sow 2-3 seeds 2 cm deeply by making line.
- About 0.5 kg of seeds is required for a Ropani of land.

10.2.4 Time for sowing and harvesting

- Cultivation time of radish differs according to its variety. Although early maturity variety of radish is cultivated little earlier; while the late maturity verity of radish

is cultivated late, generally radish crop can be cultivated and harvested as given below:

Table No. 10.2.4.1: Sowing and harvesting time of different varieties

Name of varieties	**Maturity days(after sowing)**	**Time of sowing**	**Time of harvesting**	**Area**
Mini early	50-60 days	Aug. – Sep. Mar. – Apr.	Oct. - Nov. May-June	Low/high hills Mid/high hills
Miyashige	60-70 days	Sep.-Oct	Nov-Dec.	Mid/high hills
Pyuthane Rato	70-80 days	Sept.-Oct.	Nov.-Dec.	Mid/high hills
Forty days	35-45 days	June-Oct.	Aug.- Dec.	Mid/high hills
Tokinashi	55-60 days	Jan.-Feb. Feb.-Mar.	Feb.-Mar. April-May	Low hills Mid hills

10.2.5 Harvesting

- When it is used as vegetable, radishes can be harvested approximately 60 days after sowing.
- After radish is ready for harvest (before its inner fiber turns hard), the roots should be uprooted without breaking and cracking them. And, it can be used washing them properly with some young fresh leaves.

10.2.6 Seed production techniques

- Generally, in the traditional method, if the radish is left and provided with required manure and fertilizer, a shoot will grow and set pods. The pods have seed, which become mature, go dry and the seeds can be used as sowing seeds for the next year.
- Another improved method of producing quality seed of radish is that it should be uprooted with no hard fiber inside, and leave 5-7 younger leaves but remove all older leaves.
- Then, cut off the lower part without older leaves leaving 6-7 cm upper part of root by sharp weapons (knife, sickle).

Fig. No. 10.2.6.1. Flowering radish left for producing seeds in traditional method

Source: JICA Project Team

- Then, replant the radish at the gap of 25-30 cm exposing 2-3 cm upper part of it in the soil, prepared adding adequate amount of farm yard manure with plenty of moisture in the land, but it should be free from water logging.
- New shoot and pod grow in the radish replanted this way, which can be used as seeds after they ripe and go dry.

Fig. No. 10.2.6.2: Radish with no hard inner fiber and older leaves

Fig. No. 10.2.6.3: Cutting off 7 finger size from upper part

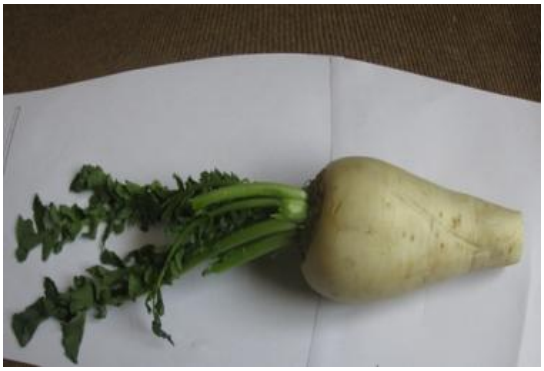


Fig. No. 10.2.6.4: Cut off 6-7 finger size from upper part

Fig. No. 10.2.6.5: Radish replanted in fertile soil exposing 2-3 cm upper part

Source: JICA Project Team

10.3 Specific Methods for Carrot Cultivation

Carrot is also a type of root crop cultivated in cool season. Seeds of carrot may germinate at low temperatures, but the germination period is shorter at higher temperatures if the soil temperature is at least 10 ºC. It is a popular vegetable crop, and can be consumed as salad or curry. It can also be consumed as Pickle, *Haluwa* (fried food), juice, etc.

Fig. No. 10.3.1 Carrot plants grown well

Source: JICA Project Team

10.3.1 Health benefits

Carrots are rich in beta-carotene, which is converted into vitamin “A” in the liver. This Vitamin is important for strengthening the eye vision power, and it will prevent peoples from night blindness.

10.3.2 Variety

Mostly New Kuroda variety is cultivated in autumn to winter of Nepal; however different varieties are cultivated. It is a hybrid variety of carrot. It grows to height of 12 – 15 cm. It will be ready for harvest in about 100 days after sowing the seed. This variety has been recommended for Terai and mid-hills areas.

Fig. No. 10.3.2.1: Carrot of New Kuroda variety

Source: JICA Project Team

10.3.3 Sowing

- It is better to sow the seeds in 2 cm deep spacing 25 – 30 cm between each row, mixing with 3-4 parts of the sand, as its seed is very small.
- It takes normally 10 to 15 days for seeds germination. If the seeds are soaked in water before sowing of one day, seeds can germinate even in 10 – 12 days.
- It is better to keep moisture after sowing, and watering in daily for a week for seed germination based on the moist present in the soil, and there should have mulching the seedbed with straw for 10 to 12 days until germination.

10.3.4 Thinning

- The objective in thinning is to leave the remaining seedlings undisturbed.
- The first thinning should be done at stage of two to three true leaves with two fingers spacing plant to plant.
- The second thinning should be done at stage 5 cm, leaves of carrot should also be thinned at this time. At this time, the spacing of root should be 7 – 10 cm apart.

Fig. No. 10.3.4.1: Thinning the carrot by farmer

Source: JICA Project Team

10.3.5 Seed sowing and harvesting time

Table No. 10.3.5.1: Seed sowing and harvesting time

Name of variety	Maturity days (after sowing)	Sowing time	Harvesting time	Recommended Area
New Kuroda	110 – 120 days	Sep. - Jan.	Dec. - April	Low hills
	100 days	May – Aug.	Aug. – Nov.	Mid/high hills

10.3.6 Harvesting

- Carrots picked at the peak of maturity (near to full maturation) give a sweet flavor and soft texture.
- Carrots take minimum 30 days for the formation of carrot from the root. Full-sized carrots form in about 80 to 100 days.
- The carrot variety is different on its maturation days, its size and can harvest in different time of maturation.
- We can harvest carrots gradually as they grow, but it should be waited too long duration for better result.
- After the fully maturity, the carrot has to be harvested. It will prevent to loss from damaging.

Carrot should be harvested when soil is moist. (This can be identified by touching the soil by finger and pressing). Then, it can be pulled out from soil, remove the older leaves, and wash with water. Carrot can be stored for maximum of 7 days in normal temperature.

10.4 Major diseases and pests in root crops

Normally, roots crops have less attack of diseases and pests compared to other crops. Pest attack is not so much; however, the major diseases and their control measures are given below:

Disease	Causes of disease	Symptoms	Management
 Fig. No. 10.4.1: Black rot of radish Source: Crop Protection Directorate, Harihar Bhawan	• Fungus and excessive rainfall	• No growth of roots. • Black spots appear in radish. • Infestation of disease to increase from smaller roots. • Finally, entire root of radish is covered with black spots.	• Crop rotation system should be adopted in the soil where root crops such as radish, turnip, etc. are grown since the germs of this disease remain alive in soil for a quite long time.
 Fig. No. 10.4.2: Alterneria blight Source: Crop Protection Directorate, Harihar Bhawan	Cold	• Small grey blotch appear on leaves. • Finally, the leaves die and it looks as if dead due to frost bite.	• To control this disease, protect the seeds from cold or treat the seeds with Thiram / Capstan.

 Fig. No. 10.4.3: Powdery mildew Source: Crop Protection Directorate, Harihar Bhawan	• Fungus	• Smaller lesions appear on leaves. • Underside of the leaves, grey or purple color appears.	• Use Sulphur powder to control this disease. Spray the solution of 1 spoon of sulphur powder in 1 liter of water on leaves.

11. Methods of Integrated Pest Management (IPM) in Vegetable Farming

11.1 Botanical and bio-pesticides

Different types of pesticides are in use to control the damage made by different pest and disease. The principle of natural enemy has been already being practiced in Nepal as well among different pesticides. The botanical / bio-pesticides means the pesticide prepared from natural ingredients for controlling pests.

The advantages of Bio pesticides / Botanical pesticides are as follows:

- Use of bio pesticide is safer for users, as it has less harm in human health.
- It is environment friendly and sustainable method of crop conservation.
- It helps in protection of friendly insects (Predators).

11.2 Preparation of Bio pesticides / Botanical pesticides

11.2.1 Plants and herbs of *"Hamal Jhol - 1"* and their quantity for the management of underground insects

a) Leaves, shoots of marigold flower/mug wart/*Asuro (justicia)*/Neem- 500 grams

b) Mustard cake (mustard or Neem) - 1 kg

c) Ash - 500 grams

d) Red chili (fresh or powder) - 50 grams

e) Onion - 200 grams

f) Garlic - 200 grams

g) Kerosene - 20 ml

h) Water - 7 liters

Crush or chop the above mentioned materials to pieces, and mix in water. These bio-pesticide / botanical pesticides can be stored for three days if it is kept in air-tight container, or it should be sprayed within 24 hours. The kerosene should be mixed at time of spray.

Fig. No.10.2.1. Farmers preparing materials for making Hamal Jhol

Source: JICA Project Team

11.2.2 Plants and herbs of *"HamalJhol - 2"* and their quantity for the management of insects on plants

a) Justicia (*Asuro*) leaves - 1 kg

b) Mug wart - 1 kg

c) Crofton weed - 1 kg

d) Tallow tree - 1 kg

e) Screw pine - 1 kg

f) Nettle - 1 kg

g) Cattle urine - 5 liter

h) Water - 15 liter

Chop the materials mentioned above into small pieces. Pour about 15 liters of water in a plastic drum, and dip the materials into the drum with water. Then, mix 5 liters of cattle urine and keep the drum air tight. Keep the drum out in the sun during day, and it can also be kept back in room at night. If the colour of the pesticide is dark brown and smells pungent when the lid of drum is opened, the pesticide is ready for spray. Then, the bio pesticide can be sprayed mixing 1 part of it to 3 - 4 parts of water filtering it through cotton cloth. It may take 20-35 days to be ready for spray according to the month and weather.

Hamal Jhol-2 should be prepared at least 15 – 20 days earlier of cultivation so that the bio pesticide can be used at crop developing stage or at time when there is more pests attack on crop. If Hamal Jhol is urgently to be used, the above mentioned materials can be boiled in water, then cooled down and used immediately.

Fig. No.11.2.2 Farmers are preparing *Hamal Jhol– 2*

Source: JICA Project Team

Compost

PART 1: Farm Yard Manure (FYM)

1. Introduction

Generally Nepalese farmers have the practice of collecting FYM from their livestock shed as an organic fertilizer for their crop fields.

Farm Yard Manure is the manure prepared in decomposed from by collecting dung and urine of farm animals along with wastes feeds, fodder, and the bedding materials. FYM is the main organic manure used in Nepal.

However, Nepalese farmers have the practice of applying immature (un-decomposed) FYM in their field. Immature manure FYM can cause the generation of harmful gas ammonia and wilting, and disturb for well germination of seeds. And, also the immature (un-decomposed) manure does not improve soil conditioning capacity of increasing water holding and fertilizer holding ability. Weed seeds can also survive inside manure and as a result, weeds problems occur in the field.

Well decomposed FYM can solve many crop growth problems in the fields.

2. Advantages of Well Decomposed Farm Yard Manure (FYM)

2.1 Improvement of soil productivity

- Application of well decomposed FYM in soil act as a soil conditioner which is capable of improving moisture holding, fertilizers holding and air passing capacity; as well as it helps the capacity of drainage to soil in good balance. This type of soil is very useful for good growth and development of plants.
- By the application of well decomposed FYM, some portions of nutrients are available directly to the plants, and remaining nutrients in soil is released to plants for long time.
- The materials that soak urine should be used as bedding materials in animal shed which can help to minimize the loss of urine. Otherwise, we can also make the urine collecting place separately with plastic or cemented structure, and use urine as fertilizers.
- By using well decomposed FYM in field, fewer amounts of chemical fertilizers are also enough for crop, which can also save the money.

Table No. 2.1 Composition of FYM

Materials	Nitrogen (%)	Phosphorus (%)	Potash (%)
Paddy straw	0.42	0.20	0.45
Cow dung	0.71	0.70	0.74
Pig feces	1.35	1.94	1.05

Source: Ministry of Agriculture, Forestry and Fisheries, Japan 2000

2.2 Healthy for plants

- Well decomposed FYM is free from weed seeds; plant pathogenic Fungi, bacteria & parasites.
- Around temperatures of 55°C to 65°C during decomposition, many microorganisms, plant pathogenic fungi, bacteria and parasites are destroyed.

2.3 Good means of breakdown of organic matter

- FYM is the good means of breakdown of organic matter in simpler form
- During decomposition of FYM, high temperature inside is accelerated, which helps to breakdown of structural molecules of bedding materials (straw, weed, grasses of feed, etc.) into simpler nutrient form which can be easily uptake by plant after its application.

3. Material Required for Making FYM

- Animal excreta: Dung, Urine
- Bedding materials: Straw, saw dust, dry leaves etc.

4. The Place for Making FYM

Place for collecting and making decomposed FYM should be as followings:

- The nearer place to animal shed
- Elevated & well drained place
- Place of easy care and observation
- It is recommended two places for the preparation of well decomposed FYM manure. Therefore total two place should be selected as mentioned below:

- First storage place
- Second storage place

4.1 First storage place

- Every day animal dung, urine and bedding materials should be collected on the surface near the animal shed.
- Usually pits of 8 meters length x 2 meters wide x 1 meter depth dimensions should be prepared nearby the animal shed, but the dimension may varies according to the land availability and number of animals.

Fig. No. 4.1.1 Taking out Farm Yard Manure

Source: JICA Project Team

- After putting the manure (Dung together with bedding materials) from animals shed in first place up to 2 months, let it remain further up to 2 months without putting other manures over it. And at that time of collecting the manure to be done in the second storage place.

4.2 Second storage place for preparation of decomposed FYM

- After 2 months of manure collection in first place, use second place to collect manures from animal shed.
- Collect the manure in second place daily up to 2 months as first one. And, let it remain for next 2 months without collecting the manures over that for further decomposing.

Fig. No. 4.2.1 FYM with roofing

Source: JICA Project Team

- The size of second storage place can be varied according to the land availability

- If possible, storage place for collecting manure should be walled and roofed with stone, wood, or hay, which protects manure from direct sunlight and rain. It is important to protect manure from sunlight and rain to protect micronutrients; otherwise the micronutrients in the manure will be lost.

4.3 Actual Procedure for collecting and using FYM

- The fresh dung together with bedding materials should be collected daily from animal sheds to the first storage place up to 2 months properly, and let it remains for next 2 month by covering it with dry leaves, straw or plastic sheet.
- After fulfilling the manure in first storage place, the manures should be collected daily to the next storage place.
- Put the manure in next storage up to 2 months and cover it like as in first place, and let it remains for next two months.
- The manure already becomes fermented in first place up to two months, when we are collecting dung in second place. So, we can apply the manure from first place to the field, and the first place will become empty and we can collect the dung again on first place. This cycle continue on every two month period on first and second places. This way, we can get well fermented FYM.

5. Condition Required for Well Decomposition of FYM

Well decomposition of manure is required for making good FYM. For making well decomposed manure, the following things should be considered well during its preparation:

- After piled up the fresh FYM, moisture content of the FYM should be managed 50-65%. It can be known by squeezing the manure in palm of hand, if it is wet. If moisture is less, water should be sprayed, and if moisture is high, the manures should be dried in shadow by removing cover for 1-2 days.
- The fresh FYM temperature rises up to 70 degrees Celsius within 2 to 3 weeks (1 week in summer) after deposition, which is not good for well decomposition of FYM. Therefore, we should be careful for turning over at every 60 ºC for two to three times. It can be known by putting hand inside the manure and feel hot.

- The manure has to be covered with a plastic sheet or straw or dried leaves or mud to protect rain and direct sunlight.
- FYM will be ready to use from first place after 2 months of filling it.

6. Collection of Animal Urine and Its Advantages

6.1 Collection of urine

- Urine can also be collected and preserved for separate use or for mixing in manure by following method:
  - The floor of cattle shed should be cemented to collect urine.
  - To collect the urine, cemented tank should be constructed at first, and then urine could be collected in plastic tank.
  - By making a pit in a corner of the shed, urine can also be collected

Fig. No. 6.1.1 Cattle urine collection through pipe from shed

Source: JICA Project Team

Fig. No. 6.1.2 Cattle urine collection through drain

Source: JICA Project Team

6.2 Advantage of collecting urine

- The urine can be collected separately, and used as fertilizer since it has three times more nitrogen than in dung.
- Urine also can be used to control the disease and pests in crops. This can be sprayed in 5 to 7 days gap by mixing 1 part of urine with 4-5 parts of water.

- It also helps to reduce the application of chemical fertilizer and pesticide, which leads to reducing production cost.
- Separate collection of urine will help to sanitize and dry animal shed.
- The urine can be used together with water as fertilizer.

7. Things to Be Considered While Making Farm Yard Manure (FYM)

- The FYM should not be dried under the sun to decrease its weight, which will cause the loss of nutrients.
- The FYM should not be left on field in small heaps for long time as the nutrients will be lost.
- Instead of leaving the FYM in individual heaps, it would be better 4 to 5 bamboo baskets of manure collection in one heap, and covered with straw, dried leaves, plastic, etc., which will help to protect the nutrients.

Fig. No. 7.1 Manure dried in the sun (Bad practice)

Source: JICA Project Team

Fig. No. 7.2 Small heap of manure in the field (Bad practice)

Source: JICA Project Team

Fig. No 7.3 Collection of 4-5 bamboo baskets of FYM in one place, and covered by dried leaves (Good practice)

Source: JICA project team

PART 2: Compost Manure

8. Introduction

- Compost manure can be prepared as alternative to FYM.
- Compost making is the best option for the farmers who don't rear the animals or cattle's with them.
- Compost manure is decomposed mixture of straws, grasses, fodder, ash, leaves and other parts of trees, farm waste, kitchen waste and similar material, together with dung if possible.
- Compost manure is generally prepared in pit or heap by making different layers of raw materials covering with mud or plastic. One wooden stake or bamboo is put in the middle for well development of bacteria and to be decomposed.
- The temperature inside the manure should be felt hot. While we put our hand inside the manures, the temperature is up to 50-60ºC at that time.

- Emulsifying concentrate (E. M.) should be sprayed in each layer of the grasses or straw or other raw materials during the preparation of manure for quick decomposition of the manure.

9. The Advantages of the Compost Manure

- It provides necessary nutrients to the soil for improving its fertility.
- Increases the water absorbing capacity of soil.
- Improves the physical, chemical and biological quality of soil.
- Increase air aeration and water movement in the soil.
- Manure can be kept in soil for long time.
- Increases the microbial activity in the soil; due to which soil become soft, and increase fertility status in the soil.
- Compost manure can be prepared in own accessible places, so that it will be easy for carrying manure in the field.

10. The Materials Required for Making Compost Manure

- Waste straws and grasses.
- Weeds, leaves fallen from trees.
- Roots and stems of young plants.
- Dung and urine of animals.
- Organic kitchen product (vegetable, food wastes)
- Limestone, ash, urea, etc.

11. The Place for Making Compost Manure

- The near place from farm.
- Elevated & well drained place
- Place of easy care and observation.

12. Methods of Preparing Compost Manure

12.1 Methods of preparing compost in pit

12.1.1 Digging pit

- It is better to dig a pit on winter season than in summer season due to which the chance of drying out of material is less.
- The length of the pit should be as per need, but depth should not be more than one meter.

12.1.2 Filling pit

- The collected raw materials for making compost manure should be kept arranging in layers inside the pit.
- Wooden stick or a bamboo should be put in the middle of the pit during filling materials inside the pit.
- Spraying water in each layer of compost during its preparation will help for making good compost manure.
- It is better to make each layer up to15-20 cm (1 to 1.5 hand span).
- We can also use dried leaves, green fodder, dung, water (2-3 liter of water in each layer), lime powder (100-200 gm. in each layer), E. M. liquid (Mixture of 1 liter E.M. and 10-15 liter water, and spray nearly 1 liter in each layer) and forest soil (2-3 kg. in each layer) between each layer which help to decompose the manure well.
- E.M. liquid, Dung, Urine, lime powder is not mandatory, but it is better to apply for producing well decomposed FYM.
- Lime powder preserves the manure from its acidity and increases the bacterial activities. Likewise, forest soil increases the bacterial numbers.
- The use of dung and urine between the raw materials will increase the quality of the compost.
- The raw materials should be forcefully pressed inside the pit so that it decays soon.

12.1.3 Using bamboo or wood stake for manure ventilation:

- During the winter and dry summer, the compost should be prepared by pit method due to which the moisture can be preserved inside the pit.
- In case the temperature inside the compost become so much hot (over than 70 ºC), bacteria cannot be survived and that will damage the compost, which will give the less quality of compost. Therefore, to maintain the temperature only up to 60 ºC, bamboo or wooden stake should be put during the time of compost preparation.
- The bamboo or wooden stake should be swing or stirred round by hand in every week for maintaining the temperature and passing air inside the manure, which will give well decomposed compost manure after 3-4 month.

12.1.4 Covering by mud or plastic

- After filling up the materials the pit should be covered with mud.
- Covering the pit with mud stops the spread of bad smell and preserves manure from rain, direct sun-light and from nutrient loss.

Methods of producing compost by digging pit have been presented as followings:

Fig. No. 12.1.4.1 Digging a pit for preparing Compost Manure

Source: JICA project team

Fig. No. 12.1.4.2 Taking out soil from pit

Source: JICA project team

Fig. No. 12.1.4.3 Pit ready for putting compost making materials

Source: JICA project team

Fig. No. 12.1.4.4 Putting raw materials for compost making

Source: JICA project team

Fig. No. 12.1.4.5 Pressing the raw materials with staking in the middle part to prepare manure

Source: JICA project team

Fig. No. 12.1.4.6 Spraying the water for compost making

Source: JICA project team

Fig. No 12.1.4.7 Covering with plastic to decompose the materials for compost manure

Source: JICA project team

Fig. No. 12.1.4.8 Observing well decomposed compost manure

Source: JICA project team

Fig. No. 12.1.4.9 Observing the condition of manure while turn-over of compost

Source: JICA project team

Fig. No 12.1.4.10 Farmer applying well decomposed compost manure in rows

Source: JICA project team

12.2 Heap method

12.2.1 Methods of making compost in heap

- Compost manure also can be produced by making heap on earth surface without digging a pit. The heap method of compost making is done in rainy season due to which the manure cannot be damaged by excessive moisture.

- It is better to make a heap in slightly elevated, and drainage facilitated site.
- This method of making compost is better in the area where shortage of labor and time.

12.2.2 Methods of making heaps on earth surface to produce compost manure

The following methods should be applied for making the compost by heap method:

- Put fodder, weeds, grasses, straws, hey and leaves on earth surface in different layer by making heap.
- Make the different layers of straw, leaves, branches, fodders or grasses by putting dung or lime or soil in between each layer, and spray water together with E.M. liquid.
- The materials in heap should be tightly pressed so that it gets decomposed earlier.

12.2.3 Use of wooden or Bamboo frame for making compost on heap

- Heaps of material can be put inside the wooden frame or covering around by wooden stakes or bamboo stakes.
- The wooden or bamboo frame can be made as per desire, but the height should be 1-1.3 meter height.

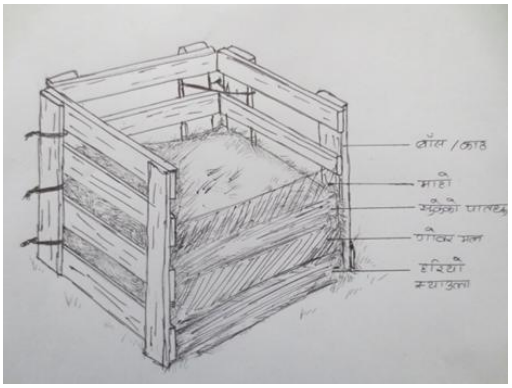


Fig. No. 12.2.3.1 Wooden or bamboo frame for making compost by heap method
Source: JICA project team

12.2.4 Turn-over in heap method for compost making

- Generally, the turn-over of compost should be done when the temperature inside the compost is 60-65 ºC, which is identified by feeling very hot while we put hand up to 20 cm inside the compost.
- In case the temperature inside the compost become so much hot (over than 70 ºC), bacteria cannot be survived, and that will damage the compost, which will give the less quality compost. Therefore turn-over should be done on-time.

- Making another frame near the main frame will help to exchange the manure for controlling the excessive heat inside the compost, and for turnover of compost for obtaining well decomposed manure.

12.2.5 The timing of turn-over

- Compost manure should be turned over when its temperature becomes near 60 ºC, which can be identified by putting your hand inside, and feels very hot. Thus, temperature should be checked every week.

13. Identifying the Well Decomposed Compost & FYM

- The manure is decayed and appears black.
- The used materials loses its original form, and cannot be distinguished
- The manure does not stick in hand.
- The bad smell of manure is less.

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