# Potato Seed Tuber Production Techniques Manual







District Agriculture Development Office, Sindhupalchwok

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District Agriculture Development Office, Sindhupalchowk

#### 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 and ability of the farmers. To follow up and enhance more technically about the local methods, techniques, learning and experiences with current climatic requirement and technical needs are our major responsibility. Good Agricultural practices, traditional knowledge, skill and 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 and 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 Potato Seed Tuber Production Techniques Manual with very useful technical knowledge. This manual which is prepared under the JICA project on Rehabilitation and 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 potato seed tuber production techniques will support for the increment of the productivity, improving in quality potato seed tuber production.

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

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Hikmat Kumar Shrestha Senior Agriculture Development Officer

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#### PART I: DEFINITION AND IMPORTANCE OF QUALITY SEED TUBER

#### 1. Background

Potato is one of the major food crops of Nepal. The average productivity of potato tuber in Nepal is 13.13 metric ton/hectors in 2071/72 B.S. (Agriculture diary, 2073 B.S.), which is far behind from the productivity of other developed countries. For increasing the productivity, the quality seed tuber production and improved cultivation technique is the main factor. Quality seed tuber means the tuber free from seed borne diseases. Generally, suitable area for the production of high quality seed tuber in Nepal is high hill region i.e. 2000 meter above from mean sea level (MoAD, Nepal).

The seed borne diseases spread quickly, and cannot be controlled using chemicals as well. Use of healthy and disease free seed tuber following crop rotation with proper field inspection can help to minimize the seed borne disease. Hence, this manual tries to provide some idea for the production of quality seed tuber via improved techniques and cooperative seed production group management.



Fig. No. 1.1: Growing potato plants

#### 2. Features of Quality Seed Tuber

- Free from seed born disease and pests.
- Seed tuber must not be mixed with other variety.
- High sprouting vigor.
- A seed tuber weight should be 30-50 gm. for minimizing the infection by the use of cut potato.
- In visual, the seed tuber should be healthy, free of wrinkle and no disease symptoms.

#### 3. Importance of Good Quality Seed Tuber

High quality tuber seed is considered as important tool for increasing productivity. There are several advantages of use of quality seeds and they are given below:

- Quality seed tuber gives more production.
- Quality seed tuber production can contribute to food security via increasing productivity.
- There are many pocket areas for quality seed tuber production in high-hill region, which is easily accessible to remote area farmers.

#### PART II: METHOD OF POTATO SEED TUBER PRODUCTION

There are two aspects for quality seed production.

- **TECHNICAL ASPECT** where various techniques are adopted to obtain disease free potato seed tuber.
- MANAGEMENT ASPECT- where individual farmers are controlled through seed production cooperatives, in order to secure sufficient quality of seed tuber and stable sales of the products.

#### A) Technical Aspects for Quality Seed Tuber Production

#### 4. Basic Knowledge for Potato Seed Tuber Production

#### 4.1 General schedule for potato cultivation and technical works

The general schedule for potato cultivation and technical works are indicated in the following table.

# Table No. 4.1.1: Potato seed-tuber production calendar

Month	Stages of		Activit	ies	Farm works
	Plant	Use of fertilizers	Field Inspection	Control of Diseases and Pests	
3 <sup>rd</sup> Week of Dec - 1 <sup>st</sup> Week of Jan.	Land preparation	At initial stage: Compost: 50-60 Doko/ Ropani (250-300Kg/ Ropani)			<ul> <li>Apply well fermented FYM (Farm yard manure)</li> <li>First plowing</li> </ul>
2 <sup>nd</sup> Week of Jan 4 <sup>th</sup> Week of Jan.	Seed tuber preparation				<ul> <li>Selection and treatment of Seed tuber:</li> <li>The seed tuber variety should be checked before planting</li> <li>40-50 gm. (medium sized) tuber should be selected.</li> <li>In case of large sized tuber, make cuts of 40-50 gm. with the sterilized knife</li> <li>Sun-light treatment: Tuber should be kept in sun light for 3-4 weeks for getting 4-8 healthy sprouts</li> </ul>
3 <sup>rd</sup> Week of Feb - 1 <sup>st</sup> Week of Mar.	Seed tuber potato plantation	Urea: 2.8kg/ Ropani DAP: 5.5 kg/ Ropani Potash: 5 kg /			<ul> <li>In case, there is irrigation facility, better to moist the field before 2<sup>nd</sup>plowing</li> <li>Amount of seed required per Ropani is 110-140 kg</li> </ul>

Month	Stages of	Activities Farm works			Farm works
	Plant	Use of fertilizers	Field Inspection	Control of Diseases and Pests	
		Ropani			<ul> <li>Tuber plantation in space of line to line space: 70 cm., and plant-plant space: 22 cm</li> <li>2200-3200 tubers per Ropani are required</li> </ul>
1 <sup>st</sup> Week of Mar 3 <sup>rd</sup> Week of Mar.	Elongation of sprouts				
3 <sup>rd</sup> Week of Mar 1 <sup>st</sup> Week of Apr.	Elongation of Plants	1 <sup>st</sup> Top dressing Urea: 1.4 kg / Ropani Ash: 10-20 gm./plant			<ul> <li>First weeding and first earthing up (soil covering)</li> <li>Control white grub and Cut-worm by manually (hand picking)</li> <li>Control of aphid by the pesticides application</li> </ul>
2 <sup>nd</sup> Week of Apr - Last Week of Apr.	Seed tuber formation stage		First field inspection	<ul> <li>Potato tuber moth</li> <li>Aphid</li> <li>Viral disease(seed borne)</li> <li>Early blight disease(seed borne)</li> </ul>	<ul> <li>Irrigation if possible</li> <li>Uproot and remove the diseased plants from field</li> <li>Control aphid by the pesticides application</li> <li>Irrigation management (More potato</li> </ul>

Month	Stages of		Activities		Farm works
	Plant	Use of fertilizers	Field Inspection	Control of Diseases and Pests	
					can be produced if there is drainage facility while irrigation. Hence, there shall be facility of irrigation for more production. If it could be managed well, more production can be done).
1 <sup>st</sup> Week of May- 3 <sup>rd</sup> Week of May	Seed tuber growth stage(flower bud formation stage)	2 <sup>nd</sup> top dressing Urea: 1.4 kg/ Ropani Ash: 10-20 gm./plant.			• Second weeding and covering by soil
3 <sup>rd</sup> Week of May - Last Week of May	Flowering stage		Second field inspection	<ul> <li>Potato tuber moth</li> <li>Aphid</li> <li>Viral disease(seed borne)</li> <li>Bacterial wilt(soil borne)</li> </ul>	<ul> <li>Uproot and remove the diseased plants from the field</li> <li>Check the drainage well for preventing water logging in the field</li> </ul>
1 <sup>st</sup> Week of Jun - Last Week of Jun.	Seed tuber maturation stage				• Check the drainage well for preventing water logging in the field

Month	Stages of		Activit	ies	Farm works
	Plant	Use of fertilizers	Field Inspection	Control of Diseases and Pests	
2 <sup>nd</sup> Week of Aug Last Week of Aug.	Plant cutting or haulm pulling		Third field inspection	<ul> <li>Symptoms on plant:</li> <li>Wart disease (seed borne)</li> <li>Viral disease (seed borne)</li> <li>Brown rot disease (seed borne)</li> <li>Bacterial wilt(soil</li> </ul>	<ul> <li>Uproot and remove the diseased plant from field</li> <li>Haulm pulling of potato plants</li> <li>Check the drainage well for preventing water logging in the field</li> </ul>
Last Week of Aug 2 <sup>nd</sup> Week of Sep.	Harvesting and sorting stage		Fourth field inspection	<ul> <li>Symptoms on tuber</li> <li>Wart disease (seed borne)</li> <li>Brown rot disease (seed borne)</li> <li>Bacterial wilt (soil borne)</li> <li>Common scab (seed and soil borne)</li> </ul>	• Separate the disease symptoms appeared tuber

#### 4.2 Suitable environment for potato seed tuber production

- Area with cool weather during cultivation period and altitude over 2000 meter is better for the seed tuber production in Nepal because of disease and pest attack is less in that area. In the mid hill areas, the seed tubers should be planted a little earlier to end of the frost occurrence.
- Potatoes can be grown in well-drained, loose soil with plenty of organic matters of all kinds of soil.



Fig. No. 4.2.1: Potato tuber seed farming in suitable climate

Source: JICA Project Team

• For seed potato farming, 5.5 - 6 pH is considered good.

#### 4.3 Marketing plan

Before seed production, cooperative should consider how much seeds that could be sold in the market, and how much quantity of seed can be stored in their storage. By considering this, they should make the plan of selecting the land and cultivation for seed production. Likewise, while cultivating the potato seed tuber, whether the seed storage has been constructed or how to construct, should also be considered.

#### **4.4 Selection of plot**

It is important work to select appropriate plot in the potato seed tuber production method. The following things need to be considered while selecting plot for seed production:

- The site for producing seed potato should be in sunny area with fertile soil,
- The spacing distance between the plots of potato seed tuber farming and other solanum crop farming should be of minimum 30 meters,
- We should select the plot where the aphid and other insect cannot easily come out from other solanum field for controlling disease.

#### 4.5 Crop rotation for reducing disease and pest

- For controlling disease and pest, same solanum related crops should not be planted continuously in the same plot. Crop rotation should be adopted in every 3/3 years for seed tuber production.
- If farmers cultivate potato every year in the same field, virus and other soil borne diseases will be increased. Thus, potato of those areas cannot be used as seed tuber.
- The crop rotation can be adopted as given below:
  - First of all farmers should divide their seed tuber production field into 3 plots.
  - In the first year, cultivate the potato in 1st plot and cultivate Maize in 2<sup>nd</sup> plot and if possible cultivate legume or cabbage cauliflower or remain fallow in 3<sup>rd</sup> plot.
  - In2nd year continue the same procedure following same time and season but rotate the crops i.e. Potato will be in 2<sup>nd</sup> plot, Maize in 3<sup>rd</sup> plot and legume or vegetable will be in 1<sup>st</sup> plot
  - > In third year, do same as before by rotating the crop.
  - This way every three years there will be changing the crops in farmers' field, which will help to eradicate the disease and pest in the seed tuber production field.
- The figure below indicates the crop rotation for 3 different plots for the period of 3 years.



Fig. No. 4.5.1: Concept of crop rotation for Potato seed tuber production

# 5. Activities before Cultivation of Potato Seed Tuber

# **5.1 Selection of variety**

• The variety of seed potato should be selected according to the climate and the demand of the accessible market.

The potato varieties and their recommended areas are given in the table below:

Table No. 5.1.1: Potato varieties and their recommended areas

S. N.	Variety of potato	Production	Time for crop	Recommended area
		in	maturity	
		kg / Ropani		
1.	Kufrijyoti	900 - 1100	100 - 120	High hill and mid hill
2.	Janakdev	1250 - 1500	100 - 120	High hill and mid hill
3.	Khumal seto	1250	100 - 120	High hill and mid hill
4.	Khumal Laxmi	1200 - 1400	100 - 120	High hill and mid hill
5.	Dejire	800 - 1000	70 - 90	Low hill
6.	Kufri Sindhuli	750 - 950	110 - 130	Low hill
7.	Khumal rato	1000 - 1200	100 - 120	Low hill
8.	I. P. Y.	800 - 1000	100 - 120	Low hill
9.				Mid hill
	Rosita	-	-	(Mahabharata hill range)
				Tungo)

Source: Agriculture diary, 2073 B.S.

# 5.2 Procurement of certified foundation seed tuber

• While procuring the seed tuber from DADO or other seed tuber production company, it should be inspected and confirmed that it is foundation.

# 5.3 Preparation of seed tuber for planting

# (A) Dormancy period

- The newly harvested seed tuber will not sprout up-to certain period of time, which is known as dormancy period.
- The dormancy period may be range about 30 to 60 days.

# (B) Seed tuber size selection

# (a) Tuber size (weight)

- It is better to select medium sized single potatoes for seeds than the chopped ones. Single whole tuber or cut tuber should be 40 50 gm.
- Single potato tuber should be used as seed, which can avoid spread of diseases from the tools used for cutting the seed tubers.

# (b) Number of sprouts

• Each selected seed tuber should have about 4-8 sprouts so that, we can harvest more tubers as well as more medium sized tubers.

# (c) Treatment of seed tuber before planting

To control the fungal diseases on seed tuber, the tuber should be treated in the following ways:

• Seed tuber should be dipped in the solution of 2 -3 gram fungicides in one liter of water before sun-light treatment.

If cut tubers have to be used, they should follow the given treatment methods:

- When cutting, knife or sickle should be sterilized every time with hard alcohol or solution of fungicide.
- Otherwise, the cut seed tuber has wound, through which disease can easily spread to other tubers by knife.
- After cutting, seed tuber should be treated with ashes or Bordeaux mixture and placed in the shade for 2-3 days.

#### (C) Sun- light treatment for potato seed tuber

Sun-light treatment is the process of exposing the seed tubers on the sun-light for 20-30 days under the condition of 10-20 degree Celsius before the plantation for getting the healthy, strong and uniform 4-8 sprouts from each of all potato.

• The seed tuber with young 4-8 sprouts that are 0.5-1 cm long, strong, healthy and green emerged from every eye is better for plantation.



Fig. No.5.3.1: Potato tuber seeds with the proper condition of sprouts

Source: JICA Project Team

- In case of using such light treated seed tuber, the plants will grow strongly and easily during the initial stage for good seed tuber production.
- Potato plants grow fast and give stronger tubers from such sun treated seed tuber potatoes.

Single potato tuber seed	Cut potato tuber seed
Less chance of attack from disease	High chance of attack from diseases
No need to treat the seeds with ashes or	Seeds need to be treated with ashes or
Bordeaux mixture	Bordeaux mixture
No extra budget for purchasing tool and	Extra expenses on tools and time for
time for chopping	chopping

Table No. 5.3.1: Differences between the whole potatoes and the cut ones



Fig. No. 5.3.2: Single potato tuber seed Source: JICA Project Team Fig. No. 5.3.3 Cut potato tuber seed Source: JICA Project Team

# 5.4 Preparation of field

# (A) Field sanitation before plantation

In case residues of earlier crops remain in the field, the larva of the pest and disease of the previous crops stay alive in soil, and attack the new crops as well. Therefore, field should be cleaned after harvesting of any crop.

# (B) Application of FYM (Farm yard manure)

- Around 50-60 bamboo baskets of well fermented FYM for per Ropani should be applied during the land preparation or first plowing.
- Application of unfermented FYM (farm yard manure) can increase pest such as white grubs, cut worms and other worms.
- In case, heaps of FYM put in the field for long time, the nutrients in the FYM will be lost and insect may lay eggs in the heaps also. So, it should be better spread the manure and plough the field immediately after applying the FYM.

# (C) First plowing

- 1-2 month before planting, during Dec-Jan first plowing should be done.
- Plowing should be done after applying the well fermented FYM (50-60 Doko/ Ropani) as organic fertilizer on the field.

- Plough the field two times, which will make the soil loose and make easy for aeration and root growth. In the first time, it should be 5-8 cm deep plowing, and second time 10-15 cm deep plowing.
- In case, there is big size of soil clods present in the field after first plowing, the breaking of those clods should be done manually with the help of spade before those clods become hard.

# (D) Second plowing

- During second plowing time, dig the field manually by spade about 8-10 cm. making the line.
- Then apply 2.8 kg Urea, 1.4 kg DAP and 1.4 kg Potash for a Ropani in lines, and mixed well with soil and made ridge.
- The ridge should be 25-30 cm. in height and 30-35 cm. in width in each row.

The detail amount, type and time of fertilizer application is mentioned on the table below:

Table No.5.4.1: Name of fertilizers, amount and timing of application

Fertilizers/ Manures	Basic dose (per Ropani)	Top dressing (kg/ Ropani)		Time
		1 <sup>st</sup>	2 <sup>nd</sup>	
FYM	50-60 bamboo basket ( 250-300 kg)	-	-	Land preparation (Before one month of sowing)
Urea	2.8 kg/ Ropani	1.4	1.4	Basic- second plowing 1 <sup>st</sup> - elongation of plant 2 <sup>nd</sup> - flower bud setting stage
DAP	5.5 kg/ Ropani			Second plowing
Potash or Ash	5 kg/ Ropani			Second plowing

# 6. Planting

After making ridge in second plowing, on the same day or next day the potatoes are planted on middle of each ridge with 7-8 cm deep. The distance of row to row and tuber to tuber is mentioned below:

# 6.1 Planting density

- Planting density varies with planting distance. The planting space varied 22-26cm from tuber to tuber and 70-84 cm from line to line depending upon variety.
- The different range of spacing and tuber number per Ropani is mentioned in the table below:

Table No. 6.1.1: Tuber to tuber and row to re	ow distance and	d number of tubers	per Ropani
---	-----------------	--------------------	------------

Row to Row\	22 cm	24 cm	26 cm
Tuber to Tuber			
70 cm	3,246 per Ropani	2,976 per Ropani	2,747 per Ropani
74 cm	3,071 per Ropani	2,824 per Ropani	2,604 per Ropani
78 cm	2,913 per Ropani	2,673 per Ropani	2,475 per Ropani
80 cm	2841 per Ropani	2604 per Ropani	2403 per Ropani
84 cm	2717 per Ropani	2487 per Ropani	2293 per Ropani

Source: JICA Project Team

# 6.2 Planting method

- Potato seeds tuber should be planted 7-8 cm deep.
- The ridge should be 25-30 cm. in height and 30-35 cm. in width in each row.

# 7. Activities during Plant Growth Period

# 7.1 Top dressing

(A) 1<sup>st</sup> top-dressing

• We should apply one quarter tea spoon (0.5 gm.)of urea for each plant on the shoulder of ridge and cover by soil simultaneously.1<sup>st</sup> top dressing should be done 1 month after plantation (10-20 days after sprouts emerge from soil).

# (B) 2<sup>nd</sup> top-dressing

- 2<sup>nd</sup> top dressing should be done on flower bud formation stage.
- The amount of urea during second top dressing should be as same amount as mentioned in the table number 5.4.1 on the shoulder of ridge, and it should be covered by soil simultaneously as first top dressing.

# 7.2 Covering method

- Covering is the process of putting soil around each plant during the growth stage of Potato. Covering should be done for:
  - > It provides enough space inside soil and easy growth for tuber.
  - > It helps preventing the lodging of plant.
  - ➢ It helps to control of weeds.

# $(A) \mathbf{1}^{st}$ covering

- Each seed tuber should get more than 15 cm soil from ridge surface of soil by covering.
- 1<sup>st</sup> Covering should be done 10-20 days after sprouts emerge from the soil.
- (B) 2<sup>nd</sup> covering
  - Second covering should be done putting more than 15 cm soil from tuber on the surface of ridge during 2<sup>nd</sup> top dressing.

# 7.3 Irrigation

- Potatoes should be irrigated time to time in case field becomes very dry and there is irrigation facility. But, there should not be irrigation more than necessary.
- While irrigation in potato, the ridge should be wet, but it should not dipped fully, and irrigation should be done in the middle of two ridges.



Fig. No.7.3.1: Irrigation in potatoes field

Source: JICA Project Team

# (A) 1<sup>st</sup> irrigation

• In case soil is very dry during

sprouting time of potato, irrigation helps potatoes to sprout easily from the soil surface.

# (B) 2<sup>nd</sup> Irrigation

• Especially the potatoes require more water when the plants bear tubers (after 50 -60 days of plantation), 2<sup>nd</sup> irrigation should be given if possible at this period of time.

#### 7.4 Drainage

• The field should have the drainage at end which will drain the water from the furrows during 1<sup>st</sup> and 2<sup>nd</sup> irrigation and also it helps to drain rain water.

#### 7.5 Field inspection

#### (A) Target of field inspection

- Field inspection will help to produce high quality seed tuber by controlling disease.
- For the detail method of controlling major diseases and pests during field inspection is described below in title 8.





#### (a) Target insects

- Potato tuber moth: Phthorimaea operculella
- Aphid
- White fly

# (b) Target Diseases

- Target viral diseases
  - Potato leaf roll virus (PLRV)
  - Potato virus A(PVA)
  - Potato virus M(PVM)
  - Potato virus Y(PVY)
  - Acuba Mosaic Virus

# • Target bacterial diseases

- ➢ Bacterial wilt
- Potato Brown rot
- Potato common scab
- Target fungus disease
  - Potato Blight
  - ➢ Potato wart
- Major activities
  - Disease infected plants should be removed from the seed production field for controlling spreading of seed borne disease to other farmers field.
  - After uprooting and removing the diseased plants, we should decompose these away from the potato field by making hole.
  - It can be controlled the aphid from the plants by spraying 1 ml Diamethoet (30 E C) mixing in one liter water when aphid appeared in the field.

#### (B) Stage and task during field inspection

- 1<sup>st</sup> Field inspection: Tuber formation stage (45-50 days after planting)
  - > Uprooting and removing those plants with viral and bacterial disease.
  - Control Aphid
- 2<sup>nd</sup> Field inspection: Flowering stage (3 month after planting)
  - > Uprooting and removing those plants with viral and bacterial disease.
  - ➢ Control Aphid
- **3<sup>rd</sup> Field inspection:**15-20 days before harvesting
  - > Uprooting and removing those plants with viral and bacterial disease.
  - → Haulm cutting (for the detail see below in title no. 7.6)
- 4th Field inspection: Harvesting time
  - > Remove the tuber infected by any kind of disease during harvesting.

#### 7.6 Potato haulm cutting technology

- Haulm cutting is the process of cutting the plants parts above the soil surface keeping about 10 cm stem of each plant in no rainy day.
- The time of haulm cutting can be identified when the leaves change into yellowish color and the tuber size found to be 40-50 gm. by sample digging.
- Haulm cutting should be done around two weeks (10-14 days) before



Fig. No. 7.6.1: Field inspection in Potato tuber seed farming

Source: JICA Project Team

harvesting so that the potatoes tuber develop a thick enough skin and the tubers do not get damaged while harvesting.

- The tuber after haulm cutting start to thicken its skin and possible skin damage will be minimized.
- The viral infection by aphid will be minimized in the tuber due to controlling re-growth of stems and mobilization of virus from stem to tuber.

#### 8. Diseases and Pests

#### 8.1 General description on pest and disease

#### (A) Viral disease

- Generally, the virus infected potatoes cannot be identified just by visually.
- The symptoms such as mosaic leaves, folded leaves, wrinkled and yellowish leaves are caused by the virus infection, which can be observed on the plants in the field.
- If the infected virus potatoes are mixed with the non-infected seed potato, the virus spreads to others easily.
- Diseases can also spread through the seed tubers and once they appear in the crop, it is very difficult to control for long time.



Fig. No. 8.1.1: Diseased potato tuber seed Source: JICA Project Team



Fig. No. 8.1.2:Healthy potato tuber seed

#### (B) Pests

- Among the pests of the potato tuber, moth is the most destructive. This moth can cause considerable damage in the field or store within a few days.
- Similarly, the white fly, aphids found in potato plants suck sap from the plants and hinder the plants' growth, and they also spread different kinds of diseases from potato plants. Therefore, disease and pest free tuber should be selected for seed tuber.



Fig. No. 8.1.3: Pest affected potato tuber seed

Source: JICA Project Team

#### 8.2 Major symptoms diseases appearance in the potato tuber

- In leaves: Mosaic patterning, curling, yellowish, rolling, turning, causing deep spots on the edge of leaf, browning, wilting, withering etc.
- In stems: wilting and withering.
- In potatoes tuber: rotting, spots on the skin of tuber, brown dots at ring edge, surface become rough (not smooth) etc.

#### Diseases and their control

Disease	Symptoms	Control
Major viral disease		
<ol> <li>Viral disease</li> <li>✓ Potato leaf roll virus (PLRV)</li> </ol>	<ul> <li>Mosaic spots appeared on the leaves</li> </ul>	<ul> <li>✓ Use of foundation or certified seed tuber</li> </ul>
✓ Potato virus A(PVA)	<ul> <li>✓ Leaves rolled and withered</li> </ul>	<ul> <li>✓ Uproot, remove the diseased plant from</li> </ul>
<ul><li>✓ Potato virus M(PVM)</li><li>✓ Potato virus Y(PVY)</li></ul>	<ul> <li>✓ Leaves and later on stem also turn yellow</li> </ul>	field and buried it. ✓ Control of aphid by

Disease	Symptoms	Control
<ul> <li>✓ Acuba Mosaic Virus</li> <li>Major Seed borne disease</li> </ul>	<ul> <li>✓ Leaves and stems become dwarf</li> <li>✓ Yellowish green ring pattern appears in leaves</li> </ul>	spraying Malathion or Dimethoat by mixing 1 ml of this into 1 of water
2. Blight (Seed borne disease)	<ul> <li>✓ Small brown lesion develops at the tip or edge of leaf.</li> <li>✓ White fungi appear like cotton underside of the lesion.</li> <li>✓ Later on the lesion</li> </ul>	<ul> <li>✓ Cultivate the disease resistant variety of potatoes such as Khumal Rato, Khumal Seto, Janak dev, etc.</li> <li>✓ In earlier stage of disease symptoms, use</li> </ul>
Fig. No. 8.2.1: Leaf affected by blight Source: Crop Protection Directorate, Hariharbhawan, Lalitpur	<ul> <li>increases and reaches to stem and tubers.</li> <li>✓ Finally whole plant will be dried and died.</li> </ul>	<ul> <li>2-3 gram Dithene M 45 in per liter of water for 3-4 times at the interval of 7-10 days.</li> <li>✓ Uproot, remove the diseased plant from field and buried it.</li> </ul>
3. Brown rot of Potato (Seed borne disease)	<ul> <li>✓ Potato plants wither and die suddenly like in dry land.</li> <li>✓ When stem or tuber is cut into piece, brown dots are seen at ring edge of cut piece of stem or tuber.</li> </ul>	<ul> <li>✓ Use the tuber seed only from the field which is free from the diseases</li> <li>✓ Not cultivate the seed tuber in the disease infected field</li> <li>✓ Uproot, remove the</li> </ul>

Disease	Symptoms	Control
Fig. No. 8.2.2: Brown rot effectedpotato tuberSource: Crop ProtectionDirectorate, Hariharbhawan,Lalitpur		diseased plant from field and buried it.
Major Soil borne disease		
4. Bacterial wilt of potato(Soil	✓ Vascular bundle inside	$\checkmark$ In the infected field,
borne disease) The second seco	<ul> <li>the stem will be</li> <li>brownish and blocked</li> <li>which cannot absorb the</li> <li>water from root and</li> <li>leaves start to wilt.</li> <li>✓ Such brownish</li> <li>appearance seen even</li> <li>inside tubers when they</li> <li>are cut.</li> </ul>	<ul> <li>practice crop rotation in every 3-4 years with other cereal crops.</li> <li>✓ Uproot, remove the diseased plant from field and buried it.</li> <li>✓ Field condition should be well drained.</li> </ul>
wilt of Potato		
Source: Source: Crop Protection Directorate, Hariharbhawan, Lalitpur		

Disease	Symptoms	Control
5.Wart or Black wart(Soil borne disease)	<ul> <li>✓ This disease appears in all parts of potato plants except in the roots and it mostly affects the tubers.</li> <li>✓ The galls will be appeared in the tuber and sometime tuber may be become large and finally, potatoes turn black and rot.</li> </ul>	<ul> <li>✓ Use the tuber seed only from the field which is free from the diseases</li> <li>✓ Not cultivate the seed tuber in the disease infected field</li> <li>✓ Remove the diseased and buried inside hole away from the field.</li> </ul>
Fig. No. 8.2.4: Potato tuber with potato wart disease Source: Source: Crop Protection Directorate, Hariharbhawan, Lalitpur		

# 8.3Pests in seed potatoes and their control

# Pests and their control

Pests	Damaging Symptoms	Control
1. Potato tuber mothImage: Solution of the section of the sect	<ul> <li>✓ The larvae make tunnel like folding and eat on the leaves</li> <li>✓ The larvae also feed to the tuber making hole during storage period.</li> <li>✓ In the storage, Larva converts as adult pupa and the pupa start to eat living in the potato tuber in winter season.</li> </ul>	<ul> <li>✓ Put a trap in the tuber storage room.</li> <li>✓ When potato tuber moth found in field, spread 2 ml Dorsban pesticide with per liter of water.</li> <li>✓ Cleaning storage and spraying solution of 2 ml Dorsban pesticide with per liter of water.</li> </ul>
Lalitpur         2. Cut worm         Image: Constraint of the second seco	✓ The larvae of this pest feed on stem and leave in night time.	<ul> <li>Spray 1kg of Dorsban granule per Ropani near each plant during the time of vegetative growth stage.</li> <li>The weeding and field sanitation should be done for controlling pest in the field.</li> </ul>

Pests	Damaging Symptoms	Control
Lalitpur		
<b>3.</b> White grubs         Fig. No. 8.3.3: White grubs in potato         Source: Crop Protection         Directorate, Hariharbhawan,         L alitpur	<ul> <li>✓ White grub is the larvae of Anomala rufocuprea</li> <li>✓ The grubs cut and feed the root. And, slowly the potato plants wither and die.</li> <li>✓ Adult pupa can over wintering in the soil.</li> </ul>	<ul> <li>✓ Put Dorsban granule 1kg per Ropani for land during the second plowing time just before planting tuber.</li> </ul>
<ul> <li>4. Aphid</li> <li>Weight and the second state of the seco</li></ul>	<ul> <li>✓ Aphid suck sap through leaves and the leaves go dry and die.</li> <li>✓ Heavily aphid infected leaves can wilt or turn yellow.</li> <li>✓ Aphid can carry virus to the plant.</li> </ul>	<ul> <li>✓ Use yellow sticky trap at least 5 traps per Ropani above 30 cm from top of plant in the field</li> <li>✓ Spray 1 ml Diamethoet 30 E C mixing in one liter water when aphids appear.</li> </ul>

Pests	Damaging Symptoms	Control	
<ul> <li>5. White fly</li> <li>5. White fly</li> <li>Fig. No. 8.3.5: White fly in potato</li> <li>Source: Crop Protection</li> <li>Directorate, Hariharbhawan,</li> <li>Lalitpur</li> </ul>	<ul> <li>✓ These flies suck sap through leaves and the leaves go dry and die.</li> <li>✓ Heavily white fly infected leaves can wilt or turn yellow.</li> <li>✓ White fly can carry virus to the plant.</li> </ul>	<ul> <li>✓ Use yellow sticky trap at least 5 traps per Ropani above 30 cm from top of plant in the field</li> <li>✓ Sprays 1 ml Diamethoet 30 E C mixing in one liter water when white fly appear.</li> <li>✓ Use pesticide or soap solution to control white flies.</li> </ul>	
6. Termite         Image: Constraint of the second state of the secon	<ul> <li>✓ Termite feed potato parts such as stem, roots and tubers.</li> <li>✓ Heavily termite infected stem and roots, and slowly the potato plants wither and die.</li> </ul>	<ul> <li>✓ Put Dorsban granule 1 kg per Ropani of land during the second plowing time just before planting tuber.</li> </ul>	

#### 9. Harvesting of Potato

#### 9.1 Harvesting time

- After haulm cutting, the harvesting of tubers should be finished within 10-15 days. After than 15 days, there will be increased the chance of disease infection and tuber goes rotten.
- In case of Potato tuber harvesting in rainy days, tuber can be rotten easily. Therefore, a sunny day should be selected for harvesting.

#### 9.2 Harvesting method

- Dig up the potatoes around the each remaining cut stem on the field. In case of damaged seed tuber potato while harvesting, those tubers should be used for food.
- After harvesting, the damaged, diseased, green skinned and small potato tuber as well as plant residues should not be remained in the field for sanitation of field.

#### **10.** The Works after Harvesting Potatoes

#### **10.1 Selection and grading**

- Select the healthy seed tuber which is without any disease and insects attack, cuts and wounds, wrinkled or crumpled.
- Select medium size potatoes (basically about the size of chicken egg: 40-50grams)
- Very big, very small healthy potatoes can be separated for seed purpose.
- In case there are several sizes of tubers, select and packed same sized tubers in the bag.



Fig. No. 10.1.1: Selecting and grading the potato tuber seed

# 10.2 Treatment of seed tuber

- Seed tuber should be dipped in the solution of 2 3 ml. Malathien and Captan or Thiram or Mancozeb 2 3 grams (half spoon) in a liter of water for 5 minutes
- Treated seed tubers should be dried for 2-3 hours under shade.

# 10.3 Drying of seed tubers

- Freshly harvested potatoes hold plenty of water, and in case the water level in tubers is not reduced the potatoes can rot during storage.
- After grading, seed potatoes should be placed in shade for 7 10 days with well ventilation because the high moisture level in the fresh potato can cause the rot.

# **10.4 Storing**

# (A) Storing room

- The store room should be cleaned before the storage for the prevention of pest and disease infestation.
- Seed tuber should be stored inside dark room with cool condition (0-10 <sup>0</sup>C) in room for preventing tubers from sprouting and greening.

# (B) Storing method

# Storing in rack (Multi-layered shelves)

- In case potatoes bag piled up during the storage in room, the tubers will rot easily due to touching, pressing and no air circulation.
- Main reason of using rack of multilayered shelves frame is for space advantage, easy care and inspection of tubers preventing from rotten.
- Seed tubers shall not overlap in the shelves during storing.
- The rack of multilayer shelves can be made by wood or bamboo.

# (C) Dimension of shelves frame

- Breadth : 1 meter
- Length : as per the need
- Height of frame : 1.5 meter
- No. of shelves : 4 5 layers (height between the layers is 6 cm)

# 11. Packaging

- Use new sack for packing seed potatoes for the prevention of disease and pest infection.
- Pack seed tubers in separate sacks according to the tuber sizes and the sacks size should be same.



Fig. No. 11.1: Packing of potatoes seed in sack

#### **B)** Management Aspects for Quality Seed Production

#### 12. Necessity of Management by Seed Production Cooperative

Production of seeds for commercial sales needs to be done in a certain scale in order to meet the demands of the buyers and to be able to provide stable supply. When a part of the production is affected by diseases or pests, this must be substituted by seeds produced in other plots; otherwise, the buyers will not be able to rely on the producers for stable supply. This may be quite difficult for a single farmer to manage. Therefore, it is encouraged to produce seed through Seed Production Cooperatives. In this way, cooperative should produce the seed regularly in certain amount.

#### 13. Structure and Roles of Seed Production Cooperative

The prime objective of the seed production cooperatives shall be marketing and sales of the produced seeds, as well as its overall quality control. That's why, the cooperative should also function as a liaison body with external organizations such as DADO and Regional Seed Production Laboratory in order to request for technical support or official seed laboratory testing. Furthermore, the cooperative can also work on developing the capacity of its member farmers in order to further enhance the production and quality of seeds.

The major responsibilities of the cooperative in seed production are expected as follows:

- To bear the risk and accountability of produced seed and seed production work.
- To formulate rules and regulations, approve and implement them for quality seed production.
- To keep records of seed production works, and inform the group / members as per the need.
- To expand seed production selecting possible area for quality seed production.
- To supervise the routine works such as use of manure and pesticides, weeding and irrigation management, harvest time, drying out, cleaning, storing and treatment for seeds according to the advice from Technical/ District Agriculture Development Office.
- To observe crop, hold meetings and exchange information and initiate process to address the problems.

- To promote technical skill and knowledge of seed production.
- To coordinate and collaborate with District Agriculture Development Office, District Cooperative Association, and various other seed production organizations.
- To facilitate in laboratory testing, processing, storing, packaging, certification and marketing of the produced seeds.
- To work as a mediator among the District Agriculture Development Office/ Seed trader and seed production sub-group.
- To extend the seed production extending the potential seed production area.

Furthermore, seed production groups shall be formulated by dividing the member farmers by the location of their farmlands, in order to effectively manage the seed quality. Each group shall also select one coordinator to link the group members with the cooperative. The major roles and responsibilities of the group coordinator shall be as follows:

- To maintain regular communication, coordination and cooperation with cooperative.
- To work as a mediator between farmers and cooperative.
- To inspect crops time to time coordinating among inter-groups.
- To report problems seen in seed production to the cooperative, and take necessary initiative for solution.
- To treat all members equally.
- To inform all members about any information received from the cooperative or any other bodies or organizations.
- To participate or make arrangement for other members to participate in seminars in turn.
- To utilize received support or materials for the benefits of all, manage them properly or get them managed.
- To take mutual and consensual decisions, or help to that end.
- To get committed for producing quality seeds.

The organizational structure of the suggested seed production cooperative is indicated in the following figure



Fig. 13.1 Structure of suggested Seed Production Cooperative

Source: JICA Project Team

#### 14. Major Actions to be taken by the Seed Production Cooperative

The followings indicate the major actions to be taken by the seed production cooperative.

#### 14.1 Land and Variety Selection

The variety and amount of seed have to be planed and produced in consultation with DADO, in consideration of market demand.

- (A)Cooperative needs to select appropriate seed variety based on the climatic and geographical conditions in coordination with the respective District Agriculture Development Office.
- (B) The cooperative shall not change the seed variety every year in the production area to avoid contamination with other previous variety.

- (C) land plot has to be selected through discussion with member farmers and respective DADO in consideration of the following points;
  - (a) If seeds of different variety have to be produced under a single cooperative, the production area should be divided into separate plots to minimize chances of getting mixed different seed varieties, while producing quality seeds.
  - (b) Trustworthy farmers and separate fields with isolation distance should be selected by coordinating with the concerned farmers to produce quality seed by cooperative.
  - (c) Separation of plots for food crop and seed crop can be done on the basis of trail/ roads, water cannel or forest, etc.
  - (d) In case, seed crop and food crop are to be grown at the same area at the same period, the crop variety should be same.

#### 14.2 Quality Control and Record Keeping

#### (A) Record keeping

- To ensure the seed quality, it is very important to record the process of seed production management (field inspection form) of production area, every stage of crop development, and keep all records of produced seeds including laboratory certificates.
- Also, keep complete records of seed produced by all farmer members after the harvest.

#### (B) Preserve seed from mixing and infection

• Preserve seed from getting adulterated with other variety while harvesting and storing. Even for cultivating food crop around seed production area, same variety of crop can be cultivated. However, such crops would be better to cultivate at the difference of 1 month.

#### (C) Prediction of disease and pest attack

• Predicting the possible attack from disease and pest at the early stage of crops, in consultation with the District Agriculture Development office or related

governmental offices, the outbreak of disease and pest attack can be easily and effectively controlled using necessary pesticide at the right time.

#### **(D)** Regular inspection of field

• It is very important for the farmers, seed production group and cooperative to pay attention and keep records of genetic quality of crop, condition of weeds, and infection from disease and pests, etc., during regular field inspection and management of crop. The frequency and contents of regular inspection are indicated in the following table.

Responsible sides	Inspection Time	Inspection Work	
for seed production			
Seed production	At least twice a	Execution of proper spacing,	
Cooperative	month	adulteration with other varieties,	
		outbreak of disease and pest, etc.	
		Inspection and removal of weeds, crops	
		that are not of equal height, checking	
		outbreak of disease and pest, necessary	
		treatment advices to farmers,	
		cooperative/ groups, and keeping	
		records of it.	
Seed production sub-	At least fourth a	Weeds, equal height, outbreak of disease	
group	month	and pest, necessary treatment advices to	
		farmers, cooperative/ groups, and	
		keeping records of it.	

Table No. 14.2.1: Frequency and contents of field inspection by cooperative and group

# (E) Coordination with DADO/ Regional seed laboratory or other related governmental authorities for field inspection

Coordination shall be made with DADO/ Regional seed laboratory or other related governmental authorities to conduct official field inspections as indicated in the following:

Field inspection Time				Activities	
First	Second	Third	Fourth	Fifth	
Plant elongation	Tuber formation time	Harvesting	After harvesting		<ul> <li>✓ Uproot and remove diseased plants</li> <li>✓ Control aphid</li> <li>✓ Discard diseased and pest infected</li> </ul>
					tuber from seed

Table No. 14.2.2: Timing of official field inspection

Source: Seed production and management training booklet, 2069 B.S., www.sqcc.gov.np

# The acceptable standards for official field inspection are as follows:

Table No. 14.2.3: Minimum standard of certified seed crop to be checked during official field

inspection

Minimum isolation distance (in meter)	Maximum off-type plants percentage	Maximum diseased plant in percentage	Restricted disease
5-10	0.20	0.50	-

Source: Seed production & management training booklet, 2069 B.S., www.sqcc.gov.np

# 14.3 Packaging

After receiving certificate, seeds should be kept in clean and attractive bags.
 According to consumers' choice, seeds can be packed in plastic bags or sacks of different sizes and sent to the market.

# 14.4. Advertisement and Sales

- Promotion can be done disseminating information about quality seeds through the local medias such as local newspapers, Radio, etc. which help in the sale of seeds in the local market itself.
- Marketing for seeds can be done in collaboration with District Agriculture Development Office and Private companies for selling seeds or signing an agreement with them.
- After Marketing of seeds, the benefit shall be distributed to the individual farmers after retaining a certain amount for logistic costs for the seed production group / cooperative. The amount to be retained shall be decided and agreed by the members prior to the handing over to the seed production group / cooperative.

# 15. Skilled Human Resource Development under Seed Production Group and Cooperatives for the Quality Seed Production

In order to further enhance the amount and quality of seeds produced by its members, the cooperative shall further coordinate with DADO and its Service Centers to receive technical information and trainings for its core members including the coordinators of each group. The knowledge gained shall be further disseminated to all members through the coordinators.



# 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.

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

Table No. 2.1 Composition of FYM

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

#### (A) 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 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.

# (B) 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



Fig. No. 4.2 FYM with roofing Source: JICA Project Team

without collecting the manures over that for further decomposing.

- 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.

#### (C) 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 flesh 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 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 flesh 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 °C 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

Fig. No. 6.1.2 Cattle urine collection through drain

Source: JICA Project Team

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.



Some photographs of wrong and good practices



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)

# **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 50-60 °C 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

#### (A) **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.

#### **(B)** 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.

#### (C) 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 °C), 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 °C, 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.

#### (D) 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. 12.1.1 Digging a pit for preparing Compost Manure

Fig. No. 12.1.2 Taking out soil from pit



Fig. No. 12.1.3 Pit ready for putting compost making materials





Fig. No. 12.1.4 Putting raw materials for compost making



Fig. No. 12.1.5 Pressing the raw materials with staking in the middle part to prepare manure

Fig. No. 12.1.6 Spraying the water for compost making



Fig. No 12.1.7 Covering with plastic to decompose the materials for compost manure



Fig. No. 12.1.8 Observing well decomposed compost manure





Fig. No. 12.1.9 Observing the condition of manure while turn-over of compost

Fig. No 12.1.10 Farmer applying well decomposed compost manure in rows

# 12.2 Heap method

# (A) 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.

# (B) 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.

# (C) 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. 12.2.1 Wooden or bamboo frame for making compost by heap method

# (D) 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 °C, 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 °C), 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.

# (E) The timing of turn-over

• Compost manure should be turned over when its temperature becomes near 60 °C, 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 and 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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