

Maize Seed Production Techniques

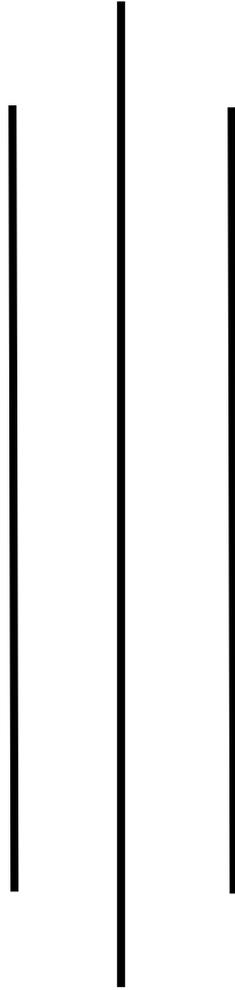
Manual



District Agriculture Development
Office, Sindhupalchok

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Government of Nepal
Ministry of Agriculture Development
Regional Agriculture Directorate, central development Region
DISTRICT AGRICULTURE DEVELOPMENT OFFICE
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Training Plays important role for the Change in behaviour 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 this 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 maize seed production techniques will support for the increment of the productivity, improving in quality maize seed production.

JICA/RRNE and Good Neighbours 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 centre. 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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PART I: DEFINITION AND IMPORTANCE OF QUALITY SEED

1. Background

Quality seed is very important thing for increasing the production. It is necessary to maintain the varietal purity of seed and control the seed borne disease for the production of high quality seed. Normally, there is lack of knowledge to farmers of mid-hill area of Nepal regarding production of pure and disease free seed in technical way, as well as seed production techniques through cooperative management. Therefore, the major objective of this maize seed production technique manual is to improve the knowledge to farmers about technical and management activities, including increment in production of quality seed of maize. The technical and managerial farming activities will also help livelihood improvement of people living in mid-hill area of Nepal.



Fig. No.1.1 Maize seed production area

Source: JICA Project Team

2. Definition of Seed

- “Seed” means a matured ovule having embryonic plant, food substance and protective cover or seeds or germ which can be used in sowing or planting to produce crop by reproducing in sexual or asexual mode. (Seed Act, 1988).
- Seed is a live embryo in dormancy mode with or without cover, which can grow as a fully developed plant under a favourable environment.

3. Features of Quality Seed

- Seed purity
 - It should have genetic purity.
 - It should have physical purity (no mix of other crop seed, weed seed & inert matter).
- It should have high germination vigour, germination rate and sprouting capacity.
- It should be free from seed born disease and pests.
- It should be good seed shape, size and weight for producing good seedlings.
- It should be healthy and shining without any spot and weakness on looking.
- It should be in equal size and weight, which should have uniformity on germination after sowing.
- It should have standard moisture level – maximum 12% (as recommended by government) in maize seed, which should clink while biting and shaking by hand.

4. Importance of Good Quality Seed

- Quality seed gives more production in comparison to normal seed.
- It also leads increment of production and income of farmers.
- Quality production from quality seed can be easily traded in the market.
- If high quality seed is produced in the mid-hill region of Nepal, the production of maize will be raised in that area.
- The variety selected from Nepal has higher adaptability and more resistant than the seed imported from foreign country.

- There are many pockets area for quality seed production in mid-hill region, which is also easily accessible to remote farmers.
- Quality seed production can also contribute to food security via increasing productivity.

PART II: METHOD OF MAIZE SEED PRODUCTION

In techniques of quality seed production, there are the following points:

- Technical Aspect: where various techniques are adopted for producing quality seeds
- Management Aspect: where the individual farmers are managed through cooperatives & groups, in order to secure sufficient quality of seeds and stable sales of the products.

A) Technical Aspects for Quality Seed Production

5. Basic Knowledge for Maize Cultivation

5.1 Various stages of maize plant

(A) Seedling stage

- It is the initial stage of maize plant with 2-4 leaves after the emergence. It takes 1-2 weeks' time after the seed plantation



Fig. No. 5.1.1 (A) Two leaf stage after germination of maize plant

(B) Growth stage of maize

- Major growth stage of maize is to certain height equal to knee-length height. It takes 35-40 days' time period. First top dressing is done in this stage. Likewise, first top dressing, and last weeding and hoeing are also done in this stage.



Fig. No. 5.1.2 (B) Growing stage of maize plant

(C) Tasseling stage

- This stage is also called stage of male flower emergence (pollen formation) or Tasseling stage. The Tassel is formed after 14th or 15th leaves in maize plant, and final top-dressing should be done during this stage for good yields.



Fig. No. 5.1.3 (C) Tasseling stage of maize plant

(D) Silking stage

- This stage is also called as cob formation stage. In this stage, Gynoecia are developed. Generally, Cob also emerges between 7th to 11th leaves.



Fig. No. 5.1.4 (D) Silking emergence stage of maize plant

(E) Milking stage of maize

- The development of blisters/ kernels starts after the completion of pollination, and silks emerge at the upper end of the cob ear. The outer husk is also green, and the blisters appear to be milky. This is the best period to eat green corn/maize



Fig. No. 5.1.5 (E) Milking stage of maize plant

Source: JICA Project Team

5.2 General schedule for maize cultivation and technical works

The general schedule for maize cultivation and technical work is indicated in the following table:

Table No. 5.2.1 Maize seed production calendar

Month	Stages of plants	Activities			Farm works
		Field inspection	Use of fertilizers	Control of diseases & pests	
Dec. - Feb.	Land preparation		<ul style="list-style-type: none"> Initial stage of applying compost / FYM Compost / FYM: 50-60 Doko (250-300 kg/ Ropani) 		<ul style="list-style-type: none"> Application of well ripen compost or FYM
3 rd Week of Mar. - 3 rd Week of Apr.	Application of fertilizer / Seed treatment by fungicides: Captan or Thiram		<p>Apply the following amount of fertilizer to the field and plough the land before sowing.</p> <ul style="list-style-type: none"> Urea: 2.6 kg./ Ropani D.A.P: 3 kg/ Ropani 		<ul style="list-style-type: none"> Seed treatment by fungicide

			<ul style="list-style-type: none"> • Potash:2.5 kg/ Ropani 		
	Seed sowing and pressing soil				1.5 kg. seed/ Ropani
4th Week of Apr - 4th Week of May	Five leaf stage of maize (20-25 cm seedlings height)	<ul style="list-style-type: none"> • First field inspection • Uproot Diseased and off types plants 	<ul style="list-style-type: none"> • First top dressing <ul style="list-style-type: none"> ➤ Urea: 0.87 kg. / Ropani 	<ul style="list-style-type: none"> • White Grub 	<ul style="list-style-type: none"> • First weeding • First covering by soil
2nd Week of May -2nd Week of Jun.	Knee-height stage	<ul style="list-style-type: none"> • Second field inspection • Uproot Diseased & off types plants 	<ul style="list-style-type: none"> • Second top dressing: <ul style="list-style-type: none"> ➤ Urea: 0.87kg. / Ropani 	<ul style="list-style-type: none"> • Stem borer 	<ul style="list-style-type: none"> • Second weeding • Second soil covering and make drainage • First irrigation if possible
4th Week of May - 4th Week of Jun.	Tasseling stage	<ul style="list-style-type: none"> • Third field inspection • Uproot Diseased & off types plants 	<ul style="list-style-type: none"> • Third top dressing <ul style="list-style-type: none"> ➤ Urea: 0.87 kg. / Ropani 	<ul style="list-style-type: none"> • Gray leaf Spot 	
1st Week of	Silking stage			<ul style="list-style-type: none"> • Stalk rot of 	

Jun - 1st Week of Jul.				maize	
4th Week of Jun. - 4th Week of Jul.	Seed formation or Milking stage			<ul style="list-style-type: none"> • Black smut of Maize 	
3rd Week of Jul. - 3rd Week of Aug.	Seed ripening stage (cob fully formed)	<ul style="list-style-type: none"> • Fourth field inspection • Remove diseased plants and cobs 		<ul style="list-style-type: none"> • Ear rot of Maize 	
In Aug.	Harvesting stage	<ul style="list-style-type: none"> • Fifth field inspection <p>(not select the cobs infected with pest and disease for the seed purpose)</p>			<ul style="list-style-type: none"> • Harvest the maize cobs after rainfall season stop and in sunny day.

Source: JICA Project Team

5.3 Climate and soil condition

- Although warm weather condition is favourable for maize farming, it can be grown successfully in various kinds of weather conditions.
- Minimum 20 °C temperature for maize production and 21- 27 °C temperature during growth period are suitable for maize farming.
- High rainfalls during tasseling stage in mid-hill region can lead to increase soil born disease & pests. Thus, it is necessary that tasseling stage should be before starting of rainy season, which may be possible by early sowing of maize, i.e. up to second week of April.
- Water logging in maize field for 6-8 hours can decay the roots and the plant starts withering. Hence, the maize field should be well-drained during rainy season.

5.4 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 the storage. By considering this, cooperative should make the plan of selecting the land and cultivation for seed production.

5.5 Selection of land

- The quality seed production by individual farmer is very difficult, because it is necessary to maintain the isolation distance in the seed production field. Therefore, necessary quantity of seeds can be produced in a designated area for seed production involving all farmers of a particular area. That's why; land selection has to be done through cooperative.
- In this sense, land selection should be done through seed production cooperative.
- As there are high chances of pollination of maize with other variety, the isolation distance of minimum 300 meter is necessary for seed production.
- South face is suitable to produce maize seed in mid- hill region.
- In seed production land, we should follow proper sanitation & follow crop rotation.

5.6 Crop rotation for reducing disease and pest

- For the controlling of pest disease and pest, same family crop should not be continuously cultivated every year in same plot, and crop rotation should be adopted in every 3/3 years for seed production.
- If farmers cultivate maize every year in the same plot, virus & other soil borne diseases will be increased gradually.
- The crop rotation can be adopted as given below:
 - First of all, farmers should divide their field into 3 plots.
 - In the first year, cultivate the maize in 1st plot, cultivate potato in 2nd plot and if possible cultivate legume in 3rd plot.
 - In 2nd year, continue the same procedure following same time & season but rotate the crops like maize will be in 2nd plot, potato in 3rd plot and legume or vegetable will be in 1st 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 control and eradicate the disease and pest in the crop production field.
- The figure below indicates the crop rotation for the 3 years in a same plot.

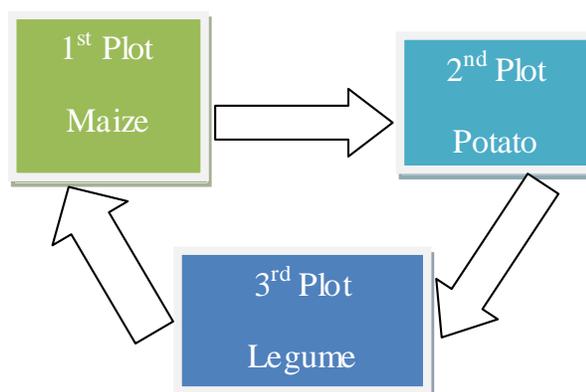


Fig. 5.2 Concept of crop rotation for Maize seed production

Source: JICA Project Team

6. Works before Cultivation of Maize

6.1 Selection of variety

- Selection of variety shall be done in coordination with seed production group / cooperative, under the support of District Agriculture Development Office (DADO).
- The recent variety having more demand and adapted to particular environment should be selected.
- The maize varieties recommended for the mid hill areas are given in the table below:

Table No. 6.1.1

Varieties of maize

S.N	Maize Quality	Production Metric ton per hectare	Harvesting day	Recommend area	Released year	Grain colour
1	Rampur Composite	4.4	110	Terai, Hill	2032	yellow
2	Arun 3	2.2	90	Terai, Hill	2039	yellow
3	Manakamana 1	4.0	125	Mid Hill	2044	white
4	Arun 1	4.0	95	Terai, Hill	2052	white
5	Manakamana 3	5.5	142	Mid Hill	2052	white
6	Manakamana 4	5.3	117	Mid Hill	2065	yellow
7	Nutritional Maize 1 (Poshilo Makai – 1)	-	142	Mid Hill	2065	white
8	Manakamana 5	-	142	Mid Hill	2066	white

Source: Agricultural Diary, 2073

6.2 Conformation of purchased foundation seed

Among receiving foundation seeds from DADO or other relevant agencies or other seed companies, the warranty tag of the foundation seed should be checked whether there is the right or not.

6.3 Germination test of foundation seed

Germination of seeds should be tested in order to identify the vigour and germination rate of seed, which helps to identify the health quality of seed, future growth of seedlings & amount of future yield etc.

If the seed has good germination vigour, higher number of seeds germinates; the required amount can be harvested.

The germination rate of seed can be identified in the following ways:

- If possible, dip the seeds in water for 24 hours before the germination test.
- Keep sand/soil in a flexible container or carton box, and remove stones from sand/soil.
- Take 200 seeds randomly from the foundation seed bag.
- Sow the 100 seed in one carton box making 10 rows with 10 seeds in each row, and repeat the same process for another 100 seeds in other carton box, for simultaneously getting more exact germination rate. During sowing, seed to seed distance should be 2.5 cm. to 3 cm and the depth should be double of the seed size, and should provide daily irrigation.
- Count seedlings up to 7 days to know the vigour of seed. If we found more than 85% germination, then only we can use those foundation seeds for cultivation.
- If germination rate of seed found less than 85%, then cooperative should request to DADO or relevant governmental authorities (from where they purchased seed) for providing another good seed lot to them.

Germination test methods of maize seed



Fig. No. 6.3.1 Making line with finger



Fig. No. 6.3.2 Sowing maize seeds in line



Fig. No. 6.3.3 Maize seeds sowed in row



Fig. No. 6.3.4 Covering seeds with soil



Fig. No. 6.3.5 Watering the planted seeds



Fig. No. 6.3.6 Sprouted maize plant

Source: JICA Project Team

6.4 Treatment of seed before sowing

- Maize seeds should be treated by fungicides for controlling damping-off of plant in initial stage.
- For seed treatment, 1.5 gm of Captan or Thiram fungicide is needed for per kg seed. 1.5 kg of maize seeds need to cultivate the maize for 1 Ropani, and 2.25 gm. of Captan or Thiram fungicides is enough to treat that much of seed.

The following cautions should be considered while treating seeds with fungicide:

- Mix the fungicides with maize seeds in an air tight pot or container with lead cover, and stir it vigorously for 8-10 minutes.
- Windy place must be avoided as it can sweep away powder.
- Children, pregnant women and old-aged people are more vulnerable to pesticides; therefore, they should not be involved while treating the seeds.
- Use mask, gloves and spectacles while treating the seeds.
- Wear the clothes that cover the whole body.
- Use only the pesticide of proper quantity.
- Wash thoroughly with water when fungicide touches your skin directly.



Fig. No 6.2 Seed treatment methods by the use of fungicide

Source: JICA Project Team

7. Land Preparation and Sowing

7.1 Field sanitation before cultivation

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.

7.2 Application of FYM (Farm yard manure)

- Around 50-60 bamboo baskets (*DOKO*) of well-fermented FYM per Ropani of land should be applied during the land preparation or first ploughing (1-2 month earlier of cultivation).
- Use 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. So, it should be better spread the manure and plough the field immediately.

7.3 First ploughing

- 1-2 month before planting, during Dec-Jan first ploughing should be done.
- Ploughing should be done after putting 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, plough the field 5-8 cm deep and second time 10-15 cm deep should be done.
- In case, there is big size of soil clods present in the field after first ploughing, the breaking of those clods should be done manually with the help of spade or other equipment before those clods become hard.

7.4 Second plowing & sowing of maize

- The field should be ploughed second time just before seed sowing in line with the application of basal dose of chemical fertilizers. Apply 2.6 kg of Urea, 3 kg of DAP, 2.5 kg of Potash per Ropani as a basal dose of fertilizer.
- Line sowing has an advantage over broadcasting as it requires less seed, facilitates easy weed control and field inspection.
- Just after sowing of seeds, we should press the soil, which will conserve the moisture and will help, for easy germination.

7.5 Sowing

(A) Time of Maize sowing and harvesting according to different region:

For the maize cultivation, 24 hours average temperature should be at least 10 ° C

Table No. 7.5.1

Time of maize sowing & harvesting in different region

Month Area	Feb/ Mar	Mar/ Apr	Apr/ May	May/ Jun	Jun/ Jul	Jul/ Aug	Aug/ Sep	Sep/ Oct	Oct/ Nov	Nov/ Dec	Dec/ Jan	Jan/ Feb
High hills		○	○	△	△	△						
Mid-hills		○	○		△	△						
Terai or low land		○	○		△	△						

○ Time of sowing

△ Time of harvesting

Source: JICA Project Team

(B) Amount of seed

In case of germination rate over than 85%, we should apply the seed rate as mentioned in the table below.

Table No. 7.5.2**Necessary amount of seed based on the number of seed per kg and density of plants**

Plant density (Plant numbers/ Ropani)	Necessary amount of seed (in case of two seed sown per spot)		
	3000 seed/ kg	3500 seed/ kg	4000 seed kg
4,100	2.72 kg/ Ropani	2.34 kg/ Ropani	2.05 kg/ Ropani
3,900	2.60 kg/ Ropani	2.22 kg/ Ropani	1.95 kg/ Ropani
3,600	2.40 kg/ Ropani	2.05 kg/ Ropani	1.8 kg/ Ropani

Source: JICA Project Team

(C) Methods of sowing seeds

- Foundation seeds will be soaked for 1 night in water, and dry it slightly in the shadow before sowing.
- Field needs to have adequate moisture (when the condition of the surface of the field soil become somehow brownish, and when we take the soil on palm and tight it with fingers, it will slowly break after releasing the fingers) during sowing time for using water soaked seeds.
- 2-3 maize seeds should be sown in each spot with 3-5 cm deep in rows.
- Seeds should be sown in the spacing of 20-24 cm from seed to seed and 60-68 cm from line to line. The different range of spacing & plant number per Ropani is mentioned in the table below:

Table No. 7.5.3

Plant to plant and row to row distance & number of plants/ Ropani

Row-Row\ plant-plant	20 cm	22 cm	24 cm
60 cm	4,166 plants/ Ropani	3,787 plants/ Ropani	3,472 plants/ Ropani
64 cm	3,906 plants/ Ropani	3,551 plants/ Ropani	3,255 plants/ Ropani
68 cm	3,676 plants/ Ropani	3,342 plants/ Ropani	3,063 plants/ Ropani

Source: JICA Project Team

- **Advantage of line sowing**

- Save amount of seed for sowing
- Easy for weeding the field
- Easy for covering the plant by soil, and making good drainage way or irrigation in the field
- Easy for top dressing on the plants.



Soaked maize seeds Spacing between row to row and plant to plant before cultivation

Fig. No. 7.4.1 Maize soaking in water before germination test, and spacing between plant to plant and row to row

Source: JICA project team

(D) Application of chemical fertilizer

- The half dose of Urea, full dose of DAP and full dose of Potash should be applied in line and plough the field, then sow seeds in same line.
- The detail amount, type and time of fertilizer application is mentioned on the table below:

Table No. 7.5.4**Name of fertilizers, amount and timing of application**

Fertilizers/ Manures	Basic dose (per Ropani)	Top dressing (kg/ Ropani)			Time
		1 st	2 nd	3 rd	
Compost/F YM	50-60 bamboo basket (250-300 kg)				Land preparation(Before one or two month of sowing)
Urea	2.62 kg	0.87	0.87	0.87	Basic- sowing time 1 st - first weeding 2 nd - second weeding 3 rd - tasseling stage
DAP	3 kg				Sowing time
Potash	2.5 kg				Sowing time

Source: JICA Project Team

8. Farming Activities during Growth Period

8.1 Weeding

- Uprooting and removing the weeds from the field.
- Weeding helps to control the weeds in the field due to which plants get sufficient space, moisture, nutrients from the soil, and higher production will be obtained.
- Weeding should be done at least two times during the plant growth stage.

(A) First weeding

- Various unnecessary weeds may grow in maize field. Hence firstly, after 25-30 days of sowing, we should weed the field by the help of hand or spade, and take the weeds away from the field.

(B) Second weeding

- The weeds should also be removed on knee-height stage as second weeding after 20-25 days of first weeding

(C) Third weeding

- The weeds should be removed again on tasselling stage as third weeding after 20-25 days of second weeding.

8.2 Thinning and transplanting

(A) Thinning

- After 25-30 days of sowing maize, at 4-5 leaf stage, thinning should be done.
- Thinning means practice of keeping only one healthy seedling per spot and removing other unnecessary seedling from each spot.
- Thinning should be done just after the first weeding at the same time.
- Thinning helps to control competition for nutrition, water, and sunlight among the plants. As a result, remained one plant develops well.

(B) Transplanting

- The removed plants during thinning can be transplanted to the missing spot of field.
- In case the missing spot found, the transplanting should be done after enough watering. But, the root of the maize plant should be pulled out with soil in the root; otherwise, there might be problem of no formation of cob, or no kernel on the cob.

8.3 Making ridge

- As the first ridge, after the third weeding and top dressing, each nodal root of maize plant should be covered by soil for the prevention of lodging plants.
- The second ridge should be strengthened by gathering soil around the stem of maize plants placing the plants in middle of row to prevent lodging during heavy rain.

8.4 Top dressing

- While top-dressing, we should apply quarter tea spoon of urea for each plant at 5-10 cm away at the growth stage of plants, and cover it by soil making drainage way.
- The top dressing should be done like as first top dressing up to 3 times as mentioned below: (detail amount is mentioned in table 7.5.4)

(A) 1st Top dressing

After 25-30 days of sowing, we apply urea immediately as first top dressing, and weeds have to be removed before top dressing.

(B) 2nd Top dressing

After 20-25 days of first top dressing, during knee height stage, we should apply the urea as second top dressing, and weeds have to be removed before top dressing.

(C) 3rd top dressing

After 20-25 days of second top dressing, during tasseling stage, we have to apply urea as third top dressing, immediately just after 3rd weeding.

8.5 Irrigation: only in case of availability of irrigation facility

For the quality seed production, soil must have adequate moisture until 40-45 days from sowing. Likewise, Soil moisture should be maintained also in the tasseling and kernel developing stage. Irrigation is necessary after the first weeding and during the tassel stage if the field goes dry.

8.6 Making Drainage

After the third weeding & top dressing, each nodal root of maize plant should be covered by soil and make drainage for the prevention of lodging in plants.

8.7 Field inspection

- Field inspection will help to produce high quality seed by controlling disease and maintaining physical purity.

(A) Removing off-types plants

- Off-types plants means different than majority of plants in the field in the condition like plant height, leaf shape, leaf colour, etc., and such plants should be removed.
- Off-types plants should be removed from the field, which will help to maintain the purity of seeds.

(B) Removing diseased plants

- Disease infected plants should be removed from the seed production field, which will control spreading of seed borne disease to other farmers field.
- The diseased plants should be taken away from the field and properly disposed by burying in the soil. Be careful, these infected plants should not be fed to the animals.

(C) First field inspection: Five leaf stage (after one month of sowing)

- Inspect the plants in the field and remove those which are too taller or too shorter in plant height among majority of plants. Similarly, plants having the different colour, shape, size, width of leaf should also be removed.
- Inspect the plants, and remove those which are different in thickness of stalk.

(D) Second field inspection

Knee-height stage (after one month of first field inspection)

- Inspect the plants, and remove those having non-uniformity in colour, size, and shape of leaf, thicker or thinner stalk plants among all plants in the field.

(E) Third field inspection

Tasselling stage (45-50 days after sowing):

- Inspect, and remove the plants which are too taller & too shorter in height.
- Inspect the field, and remove those plants with un-uniform tassel formation (too early tassel formed or too late tassel formed plants).

(F) Forth field inspection

Before harvesting (about 4 month after sowing):

- Remove the plant, and cob infected by any kind of disease to the seed, and use those for other purpose.

(G) Fifth field inspection

During harvesting time (after 4 and half month from sowing)

- Remove the disease infected cobs from the seed lot during harvesting time.



Fig. No. 8.7.1 Red spot in husk indicates fungal rot of seeds inside cob

Source: JICA Project Team

9. Major Pest & Diseases

9.1 Major pest and their control methods

Pests	Symptoms of damage	Control methods
 <p>Fig. No. 9.1.1 White Grub</p> <p>Source: Plant Protection Directorate, Hariharbhawan, Lalitpur</p>	<p>It lives in soil, and feed roots, which caused death of plant</p>	<ul style="list-style-type: none"> • Ploughing the field, and destroy it picking up the white grub manually • Irrigating sufficient water, it can also be destroyed. • Do not use unfermented FYM. • Use <i>Hamal Jhol</i> 1. • In case, there is the prevalence of white grub every year, Use 2 kg Meterhizium pesticide per Ropani mixing with soil during second ploughing time. • We also can use Meterhizium mixing with soil in second weeding in highly infected field.
 <p>Fig. No. 9.1.2 Maize stem borer</p> <p>Source: Plant Protection Directorate, Hariharbhawan, Lalitpur</p>	<p>It initially feeds leaves, and finally enters inside stalk and damages it eating the growing shoot and flesh inside.</p>	<ul style="list-style-type: none"> • Remove the borer infected maize plant from the field, and can also be fed to the animal. • Use <i>Himal Jhol</i>- 2 in maize plants mixing with equal amount of water. • Use Carbofuran pesticide 4-5 granules per plant placing them at tassel growing part of maize at knee-height stage.

9.2 Major disease and control methods

Disease	Symptoms	Control methods
 <p>Fig. No. 9.2.1 Common Ear rot disease</p> <p>Source: Plant Protection Directorate, Hariharbhawan, Lalitpur</p>	<p>(Fusarium disease)</p> <p>Ear starts turning red from the tip and spreads down rotting the whole cob.</p>	<ul style="list-style-type: none"> • Cultivate disease resistant variety. • As ear rot disease is found in wounded cob and borer affect plant, such plants should be removed as soon as possible if seen. • Properly sanitize the field after harvesting, and before sowing. • Properly seed treatment with 2 grams Bevistine fungicide for one kilogram. • Maintain the crop rotation in every 3 years with other crops. • Early sowing of maize result in the formation of cob before heavy rainfall start, which can control this disease. • Make good drainage facility in the field.
 <p>Fig. No. 9.2.2 Black smut</p>	<p>(Fungal disease)</p> <p>The tassels become black and rot. The cob is filled with blackish powdery dusts in place of kernels.</p>	<ul style="list-style-type: none"> • Apply healthy seed. • Seed treatment with 2 grams Vitavex-200 (Bevistine) fungicide for one kilogram in highly affected plot. • If black smut disease appears in maize field, wrap it with polythene bag without dropping on field, chop the stalk and burry it or burn it down. • Controlling of Maize borer by the use of Carbofuran (Furadan 3%) for

<p>disease</p> <p>Source: JICA Project Team</p>		<p>preventing infection of disease</p>
 <p>Fig. No. 9.2.3 Pythium Stalk/ Stem rot disease</p> <p>Source: JICA Project Team</p>	<p>(Bacterial disease)</p> <p>Blackening of stalk near about second node from soil surface, the stem rots, and stalk collapses. The stalk with water soaked releases offensive smell.</p>	<ul style="list-style-type: none"> • This disease is occurred after the attack borer, hence; use Carbofuran (Furadan 3%) to control the borers. • Follow other additional measures like of common ear rot disease
 <p>Fig. No. 9.2.4 Downy Mildew</p> <p>Source: Plant Protection Directorate, Hariharbhawan, Lalitpur</p>	<p>(Fungal disease)</p> <p>Leaves turn yellowish and streaks appear on leaves.</p>	<ul style="list-style-type: none"> • Properly sanitize the field after harvesting, and before sowing • Maintain the crop rotation in every 3 years with other crops. • Cultivate disease resistant variety such as Rampur-composite. • Spray fungicide Bevistine75% W. P. 3 gram mixing in per litre of water.

10. Harvesting of Maize

- Generally, the maize cob should be harvested after full mature stage.
- The harvesting time is after the heavy rainfall stops (the husk should become dry, dark brownish, and seed should also be dried on the cob of standing plant in the field).
- At time of harvesting, a black spot is seen in the bottom (side attached to the cob)of seed. This black spot suggests it is ready for harvest.
- If the cob hangs a little bit more than before, it is time for harvest.
- Harvesting of cob should be done only after stopping the heavy rain. And, also the harvesting should be done in sunny day.



Fig. No. 10.1. Pre-maturation stage i.e. not proper time of harvesting for seed production

Source: JICA Project Team



Fig. No. 10.2 Full-maturation stage i.e. proper time of harvesting for Maize seed production

Source: JICA Project Team

11. Post-harvest Processing and Storage

After harvest, maize seeds should be further sorted in order to have a good quality. The following process should be followed:

11.1 Selection of maize after harvest

- Select cobs of equal size with thick husks.
- Remove rotten cob and the cob which are not completely covered with husk
- Remove the cobs with too big and too small kernels (seeds).
- Remove the kernels from the top and bottom part of a cob for selecting uniform kernels as seed.
- Removed cobs or kernels (grain) should be used for food consumption, but not for seed.



Fig. No. 11.1.1 Methods of selecting Maize cobs for seed

Source: JICA Project Team

11.2 Works after selecting seeds

(A) Cleaning seeds by farmers

- Seed cleaning is very necessary for the quality seed production.
- While cleaning, remove weed seeds, dust, wrinkled seeds and seeds of other crops.

Winnowing fans

- The hand operated and power operated winnowing fans can be used for the purpose of cleaning threshed seeds.
- Generally, winnowing fans are available from agriculture machinery shops in urban areas.

(B) Drying of seeds

- Seeds are dried out to for lowering the moisture level to keep the longevity of the seed.
- Excessive moisture in the seed may loss its viability soon and also may be attacked by fungus.
- Properly dried seeds can be stored for long time. Hence, the seeds are dried out for several times in the sun before storage. If the seeds are sufficiently dried, the kernels will make a clinking sound when crushed.

11.3 Storing seeds in storage

- The storage structure most protects the maize seeds from extreme heat or cold, and moisture which cause microbial and fungal growth. The storage also should protect the seeds from pests and rodents which eat or damage the seeds.
- Seeds should be very carefully handled, and stored without contamination from other variety and other crop seeds.
- Seed storage refers act of keeping the seeds safe during the storage time until the seeds are sown or marketed.

(A) Moisture management

- If the moisture in seed is more than 12 % at the time of storage, the level of both heat and water increases due to intensified respiration in seeds. In this condition, the risk of fungus attack increases and reduces the quality of seeds.
- Likewise, the moisture plays important role in increasing the infestation and invasion of disease and pests in seeds. Therefore, the seeds should be stored only after controlling the moisture in seeds. The following measures can be adopted to manage moisture in seeds:
 - The seeds should be stored only after drying in the sun for 4 – 5 times.
 - The experience seed producer farmer can also identify the moister of seed.

Table No. 11.3.1**Moisture contents and storage duration**

Moisture contents of seeds	Storage duration
10-12%	For 8-12 months
< 9%	For more than 1 year

Source: JICA Project Team

(B) Storage management

- There should be only one door or opening (not more doors or windows) in the seed storage to maintain the temperature, to protect from the rodents, and robbery.
- While storing seeds in sack or metal container, such sacks or containers should be kept above the floor on a raised plank and without leaning the wall to protect from moisture of wall.
- The major objective of storage structure is to protect the maize seeds from extreme heat or cold and moisture, as well as protect from microbial & fungal growth, pests and rodents.

(C) Pest and rodents control in storage

- The store should be cleaned properly before storing the seeds and after the seed are sold out.
- Fumigants pesticide like Aluminium phosphate or Methyl bromide can be used at the rate of 3 tablets for per ton (1000 kg) of stored seed for fumigation of the storage to control from the moths, mites and other storage pests.
- Fumigation by pesticides in the storage is done by keeping the fumigants in the centre of storage and let fumigation inside by closing all doors and windows for at least 24 hours during storage or before storage period.
- The place for storage should be safe from pests and mice.
- Use mouse trap in the storage to protect seeds from mice attack.

- Inspect the storage regularly to ensure occurrence of pests.
- Do not keep door open of storage for a long time for controlling birds, rodents & insect attack.
- For weevil, one Selphas tablet can be used for 100 kg seeds by wrapping in cotton cloth and placing it in the centre of the normal sack / metal bin filled with seed. It is not mandatory in case of hermetic or super grain bag.

(D) Packing material and method

- Seed should be packed and stored on sunny day after well drying in sun for 4-5 times.
- To store the seeds, the seeds should be properly dried before the monsoon begins and stored in metal bin, hermetic bag or plastic sack. The bag or sack should be fastened air tight in order to protect seeds from possible moisture.
- Super-grain bag refers to the bag in which insects cannot enter that easily and it is air tight. Even if the insects enter into the bag, the insects and fungus die due to treatments done for such bag.
- The following ways can be followed to use super-grain bags:
 - Squeeze the air out of the bag after placing the seeds inside the bag.
 - Keeps the bag fastening properly after the air inside is squeezed out.
 - The pests can be controlled without using any chemical pesticides in this way.

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; and therefore, it is encouraged that seed production should be done through seed production cooperatives.

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

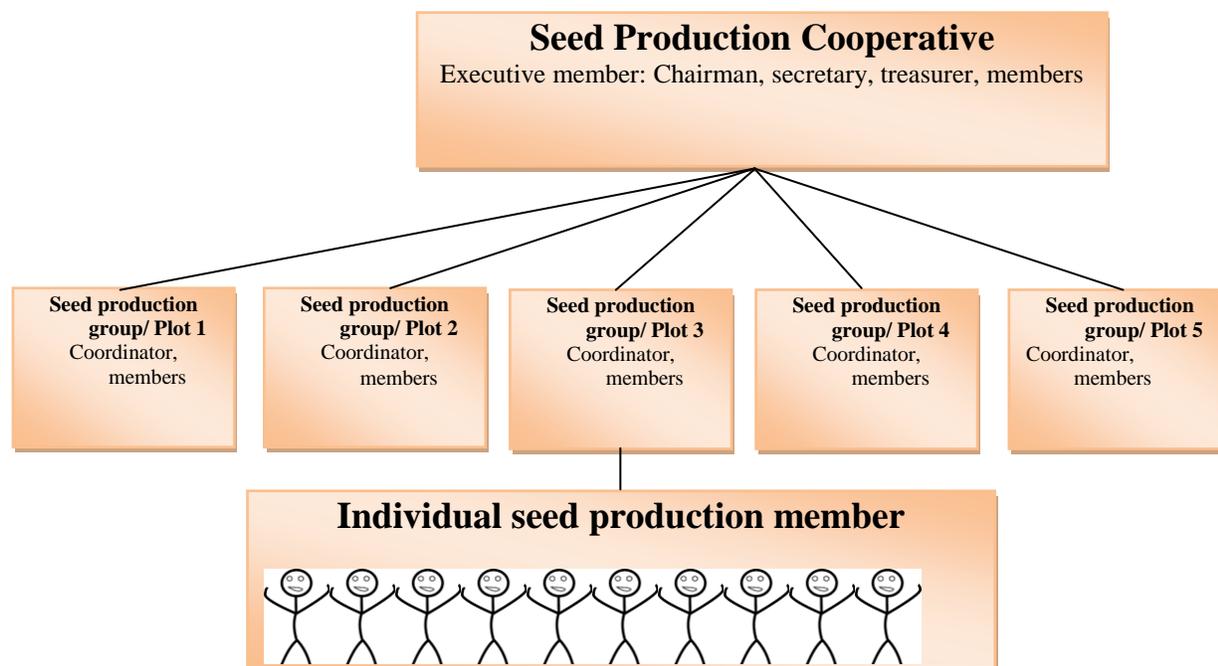


Fig. 13.1 Structure of Suggested Seed Production Cooperative

Source: JICA Project Team

14. Major Actions to Be Taken by 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 planned 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;

- i) 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.
- ii) Trustworthy farmers and separate fields with isolation distance should be selected by coordinating with the concerned farmers to produce quality seed by cooperative.
- iii) Separation of plots for food crop and seed crop can be done on the basis of trail/roads, water channel or forest, etc.
- iv) 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 crossed with other variety while harvesting and storing. Even for cultivating food crop around seed production area, same variety of crop should 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.

Table 14.2.1**Frequency and contents of field inspection by Cooperative and Group**

Responsible sides for seed production	Inspection Time	Inspection Work
Seed production Cooperative	At least twice a month	Inspect of proper spacing, crossing with other varieties, outbreak of disease and pest, weeds and height situation etc., and provide necessary advices to farmers accordingly for controlling measures, and keeping records of it.
Seed production sub-group	At least fourth a month	Weeds, equal height, outbreak of disease and pest, and provide necessary advices to farmers and cooperative accordingly for controlling measures, and keeping records of it.

(E) Coordination with DADO / Regional Seed Production Laboratory or other related governmental authorities for field inspection

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

Table 14.2.2

Timing of Official Field Inspection

Crop name	Field inspection Time					Activities
	First	Second	Third	Fourth	Fifth	
Maize	Before initiation of tassel	After complete formation of tassels	Pollination stage	After cobs formation	During harvesting of cobs	<u>Uproot and Remove:</u> disease plants off-types plants: plant height, leaf colour & shape, early and late tassel formed plants, Remove diseased cob during harvesting

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

The acceptable standards for official field inspection are as follows:

Table 14.2.3

Minimum standard of Certified Seed Crop to be checked during Official Field Inspection

Name of Crop	Minimum Isolation distance (in meter)	Maximum Off-type plants percentage	Maximum diseased plant in percentage	Restricted disease
Maize	200	2.0	-	Black smut

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

14.3 Collection of produced seeds and storage

(A) Germination test

- After harvesting the seeds about 2 to 3 months, conduct germination test as indicated in **“6.3 Germination test of foundation seed”**.
- The coordinator of each group shall collect samples from individual farmer, and conduct germination test based on the procedures indicated in **“6.3 Germination test of foundation seed”**.
- If the result of the germination test is below 85%, the seeds will be returned to the respective farmer. The farmer shall once again clean the seeds and submit it to the coordinator. This process shall be continued until the germination rate becomes 85% or above. If the germination rate does not reach 85% after several times of cleaning, the coordinator shall reject the seeds, and the farmer shall use them for self-consumption or sales as food-crop.
- It should also be noted that germination of seeds is affected by low temperature. Therefore, when conducting germination test, temperature of the container should be 25-30 °c.
- This process should be conducted with extra care; because if the reliability of the germination test at this point is low, it will affect the seed quality of the entire lot, which will lead to lower the income of the whole seed production group.
- After confirming that the seeds have germination rate of 85% or above, the coordinator shall submit the record of final germination tests for each farmer to the cooperative. The record shall consist of; name of farmer, type and variety of crop, period of germination test, and germination rate.

(B) Collection of produced seeds and storage

- After receiving the final result of the germination tests from the group coordinator, the cooperative shall collect the seeds from the group.
- The certificate provided by regional lab is mandatory before marketing of seeds.

- The seeds collected from the individual subgroups shall be managed as one “lot”, which should not be mixed with seeds from other sub-groups.
- The seeds should be mixed together with same lot in clean and open space. But, it should be ensured that the place is clean before and after mixing the seed to each other, so that it should be protected to mix with dust and other seeds.
- After mixing, the seeds shall be packed in super grain bags or tight metal bins with one Selphas tablet for 100kg seeds wrapped in cotton cloth in the centre of the bag/bin. An identical tag indicating the lot number, name of crop, variety of seed, production year and date of packing shall be placed in a visible location on each bag/bin.
- The bags/bins shall be stored as described in “11.3 Storing seed in storage” with due attention that it will not be mixed with seeds from other lots.

(C) Coordination for official germination test

- The cooperative shall collect samples from each lot, and submit them to DADO or Regional Seed Production Laboratory for official lab testing.
- The standards for certified seeds are as indicated in the following table.

(D) Standard for seed certification

Table 14.3.1

Acceptable and unacceptable standard in seed inspection for certified seed

Crop name	Min. Physical Purity (%)	Max. next mater (%)	Max. other crop seed(grains per Kg)	Max. seeds of restricted weeds (grain per kg)	Max. identifiable other variety seeds (grains per Kg)	Min. germination rate (%)	Max. Moisture percentage (%)
Maize	98	2	10	0	20	85	12

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

After receiving the results of the official germination test, the result should be recorded together with the amount of seed collected in each lot. Furthermore, the following information should be additionally indicated on the bag/bin of seed for each lot.

- Purity Percentage
- Germinating percentage
- Month of seed testing

14.4 Packaging

- After receiving the 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.

14.5 Warranty tag

- In the form received from Agriculture Development Office required details should be carefully filled up on the basis of laboratory testing certificate.
 - Name of Crop
 - Name of variety
 - Tag number
 - Lot number
 - Production Year
 - Physical Purity Percentage
 - Moisture percentage
 - Germinating percentage
 - Seed weight
 - Date of seed testing
 - Name of cooperative
 - Address of cooperative

- Treated chemical name
- Validity period of seed laboratory testing results provided by seed testing laboratories is only up to six months from the time of testing, and retesting is required if entrepreneurs want to sell that seed after six month duration. (Seed Act, 1988)
- Warranty tag should be kept inside plastic, and it should be stitched placing visible in middle part of the open end of the bag.
- While stitching bag together with the form, details of the form should be visible.



Fig. No. 14.6.1 Sample tag

Source: JICA Project Team



Fig. No. 14.6.2 Stitched sample tag in seed bag

Source: JICA Project Team

14.6 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.

14.7 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 Centres 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 form 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 faeces	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

(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.
- 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.



Fig. No. 4.1 Taking out Farm Yard Manure

Source: JICA Project Team



Fig. No. 4.2 FYM with roofing

Source: JICA Project Team

And, let it remain for next 2 months 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 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 °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

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.

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)

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 50-60 °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 to 15-20 cm (1 to 1.5 hand span).
- We can also use dried leaves, green fodder, dung, water (2-3 litre of water in each layer), lime powder (100-200 gm. in each layer), E. M. liquid (Mixture of 1 litre E.M. and 10-15 litre water, and spray nearly 1 litre 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

Source: JICA project team



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

Source: JICA Project Team

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 labour 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, hay 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.

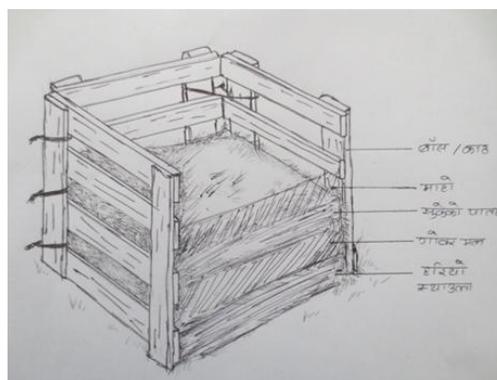


Fig. No. 12.2.1 Wooden or bamboo frame for making compost by heap method

Source: JICA Project Team

(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 & 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.

References

- राष्ट्रिय बीउविजन समिति , २००९ । *नेपालका उन्मोचित थुप्रै बालीका जातहरु* । राष्ट्रिय बीउ विजन समिति , हरिहरभवन ।
- राष्ट्रिय बीउ विजन नीति, २०५६ । हरिहरभवन, काठमाण्डौ ।
- मानन्धर, पौड्याल, चौधरी र दंगाल । धान बीउ उत्पादन प्रविधि । नेपाल कृषि अनुसन्धान परिषद् । तरहरा, सुन्सरी ।
- मानन्धर, चौधरी, पौड्याल, देगाल र उपाध्याय । *मकै बीउ उत्पादन प्रविधि* । नेपाल कृषि अनुसन्धान परिषद् क्षेत्रीय अनुसन्धान परिषद्, तरहरा, सुन्सरी ।
- Joyce A. et al., n.d. *Protien Composition of Dent, waxy and high amylose corns* (Retrieved from www.aaccnet.org/publication/backissues/1967/documents/chem44-160.pdf).
- Karki, TB et al., 2014. *Studies on the conservation agriculture based practices under maize (zea mays L) based system in the hills of Nepal* . International Journal of Applied Science and bio-technology, vol- 2 (2).
- पौड्याल, अधिकारी । *नेपालमा मकैको उत्पादनमा समस्या र अनुसन्धानको प्राथमिकता* । काठमाण्डौ: राष्ट्रिय कृषि अनुसन्धान केन्द्र ।
- पोखरेल, सापकोटा । *सामुदायिक मकै बीउ प्रविधि (पहाडी र हिमाली क्षेत्रमा)* । बाली विज्ञान महाशाखा ।
- कृषि सूचना तथा संचार केन्द्र । बीउ विजन उत्पादन तथा तालिम पुस्तिका । हरिहरभवन, काठमाण्डौ ।
- कृषि सूचना तथा संचार केन्द्र, २०७३ । *कृषि डायरी* । हरिहरभवन , काठमाण्डौ ।
- SQCC, 2014. Notified varieties of crops in Nepal. Seed quality control centre (SQCC), Ministry of Agriculture Development (MoAD), Pulchowk, Lalitpur.
- SQCC, 2045 B.S. Seed Acts- 1988. Seed Quality Control Centre (SQCC), Hariharbhawan, Kathmandu.