

Maize Farming Techniques

Manual



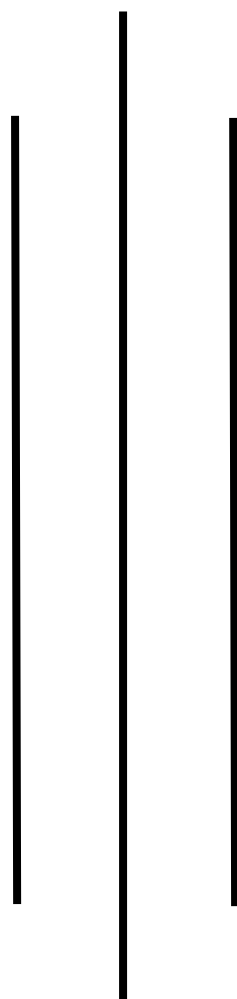
District Agriculture Development
Office, Sindhupalchok



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Government of Nepal
Ministry of Agriculture Development
Regional Agriculture Directorate, central development Region
DISTRICT AGRICULTURE DEVELOPMENT OFFICE
Sindhupalchok, Chautara

Acknowledgement

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

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

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

March, 2016

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Hikmat Kumar Shrestha
Senior Agriculture Development Officer

Government of Nepal

Ministry of Agriculture Development

Regional Agriculture Directorate, central development Region

DISTRICT AGRICULTURE DEVELOPMENT OFFICE

Gorkha

Acknowledgement

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

Receiving as a reference to the available theoretical and practical educational materials included in this Maize Farming Techniques Manual; and as it has covered all technical aspects like identification of maize variety, land preparation, maize sowing, fertilizer management, importance of different fertilizers, preparation of compost, seed germination testing method, irrigation, weeding and weed control method, identification and management of pest and disease in maize, crop harvesting method, storage method, IPM method, preparation of organic pesticide etc., it is believed to be useful to especially farmers, respective technicians as well as to other readers.

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

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Yam Kumar Shrestha

Senior Agriculture Development Officer

District Agriculture Development Office, Gorkha

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PART I: CHARACTERISTICS OF MAIZE FARMING

1. Background

Maize is second main food crops after paddy in term of production among three major food crops of Nepal. Especially in hilly area, maize is considered as the important source of food. Maize is known as a traditional cereal crop in Nepal; nevertheless, its average productivity is low in comparison to other developed countries. Major reasons behind low production are lack of proper preparation of land, use of less quality seed and lack of proper use of organic and other fertilizers. Hence, there is great potential for increasing the maize production in Nepal if proper quality seeds and improved cultivation techniques are applied.



Fig. No. 1.1 Rampur Composite variety of maize cultivation

Source: JICA Project Team

2. Climate and Soil Condition

2.1 Climates

- The suitable climate for well growth and development of maize plant is in warm weather with moderate rainfall.
- 20 °C temperatures is needed for germination and a range of 21-27 °C temperature is suitable for better growth of maize plant.
- In mid-hill region, if heavy rainfall occurs at time of tasseling stage, it causes different disease, pests to maize crop leading to fewer kernels in cobs; therefore, it is necessary to cultivate maize sowing in late March to early April due to tasseling stage start before heavy rainfall.

2.2 Soil

- Fertile, light loamy and sloppy or non-water-logged soil is good for maize cultivation.

3. Types of Maize

Generally, there are several types of maize cultivated in the world. In Nepal, the types of Dent corn and Flint corn are cultivated at this moment.

3.1. Dent Corn

Dent corn is mostly used as feed for farm animals and poultry, as it contains more gluten. Similarly, the yellow color of kernel/grains gives yellowish color tone to egg and meat.

From the production point of view, dent corn gives a good yields but it has less resistance to weevils during the storage period. Similarly, compared to other variety of maize, dent corn has fewer nutrients.



Fig. No. 2. Dent corn/maize

Source: JICA Project Team

3.2. Flint corn

Flint corn does not have dent on its kernels, has more starch which results to have more flour. Therefore, it is used for preparing porridge cake or bread. Flint corn has more nutrients, tasty while eating and it has disease resistant capacity also. Flint corn remains safe in storage from weevil for several months under natural condition.

In hilly area of Nepal, maize cereal crop is grown especially for human consumption. Therefore, plump flint corn variety is better for cultivation than other varieties at this moment, since it is disease resistant and can be stored for a long time and to consume.



Fig. No. 3 Flint corn

Source: JICA Project Team

4. Varieties of Maize

Table No. 4.1

Variety of maize cultivated in Nepal

SN	Variety of Maize	Grain color	Yield potential (ton/ha.)	Maturity days	Recommended areas	Varietal characteristics
1	Rampur composite	Orange Yellow	4.42	115-130	Terai, inner Terai, Hills	Tolerance to Downy Mildew, tight husk cover
2	Arun 2	Light yellow	3.0	80-90	Terai, inner Terai Hills	Dwarf plant height, non-lodging, reddish color of shelled cob
3	Manakamana1	White	3-5	120-130	Mid-hills	Tight husk cover, tolerance to Downy mildew
4	Arun 1	White	3.5-4.5	90-100	Terai, inner Terai, Hills	Dwarf in plant height, non-lodging, early maturing variety
5	Manakamana3	White	5.6	142	Mid-hills	Tight husk cover, stay

SN	Variety of Maize	Grain color	Yield potential (ton/ha.)	Maturity days	Recommended areas	Varietal characteristics
						green character
6	Manakamana4	Yellow	5.1	140-145	Mid-hills	Tolerant to banded leaf & sheath blight, thick Stover, non-lodging, stay green character
7	PoshiloMakai1	White	5.6	140-145	Mid-hills	Lysine & Tryptophan content is doubled as compared to normal varieties
8	Manakamana5	White	6.6	140-145	Mid-hills	Tolerant to banded leaf & sheath blight, thick Stover, non-lodging, stay green character

(Source: National Maize Research Program, Rampur, Chitwan)

Out of the above, Rampur composite is better for Mid- Hill area, which is described below:

Rampur Composite is a variety of flint corn recommended in the year 1975. The average height of stalk is 210-220 cm and can be harvested in 110 days of sowing. Rampur Compost is mostly cultivated in mid-hills, inner-Terai and Terai areas. The color of its kernel is orange-yellow, and it is resistant to downy mildew. The husk of this corn variety covers till tip of the cob and



Fig. No. 41.1 Variety of maize: Rampur composite (orange yellow) & manakamana-3 (white)

Source: JICA Project Team

remains safe from water; hence, this variety of flint corn has less problem downy mildew. Rampur Composite gives good yields in the Terai, inner- Terai, Mid-hills and High hills as well. Therefore, District Agriculture development office (DADO) suggests the cultivation of Rampur Composite variety in the mid-hill areas.

PARTII: TECHNICAL ASPECTS FOR QUALITY MAIZE 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 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 topdressing, and last weeding and hoeing are also done in this stage.



Fig. No. 5.1.2 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 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 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 Milking stage of maize plant

Fig. No. 5.1 Various Stages 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 works are indicated in the following table:

Table No. 5.2

Maize cropping calendar

Weeks	Stages of plants	Activities		Remarks
		Use of fertilizers	Control of diseases & pests	
				<ul style="list-style-type: none"> Remove and burn or bury residues in the field to avoid outbreaks of pests & diseases in the next cultivation
3 rd Week of 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"> White Grub 	<ul style="list-style-type: none"> Well fermented FYM or compost should be used
3 rd Week of Mar. - 3 rd Week of Apr.	Application of Fertilizer / Seed preparation	<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 		<ul style="list-style-type: none"> Seed treatment with fungicides

Weeks	Stages of plants	Activities		Remarks
		Use of fertilizers	Control of diseases & pests	
		<ul style="list-style-type: none"> • D.A.P: 3 kg/ Ropani • Potash: 2.5 kg/ Ropani 		
4 th Week of Mar. – 4 th Week of Apr.	Seed sowing			<ul style="list-style-type: none"> • 1.5 kg. seed/ Ropani
4 th Week of Apr. – 4 th Week of May	5 leaf stage of maize	<ul style="list-style-type: none"> • First top dressing Urea: 0.87 kg. / Ropani 		<ul style="list-style-type: none"> • First weeding and rouging • First rouging: ✓ Uproot Diseased and off types plants
2 nd Week of May- 2 nd Week of Jun.	Knee-height stage	<ul style="list-style-type: none"> • Second top dressing: Urea: 0.87 kg./ Ropani 	<ul style="list-style-type: none"> • Stem borer 	<ul style="list-style-type: none"> • Second weeding • Second rouging • If possible, first irrigation
4 th Week of May– 4 th Week of Jun.	Tasseling stage	<ul style="list-style-type: none"> • Third top dressing: Urea: 0.87 kg./ Ropani 	<ul style="list-style-type: none"> • Gray leaf Spot 	<ul style="list-style-type: none"> • If possible, second irrigation.

Weeks	Stages of plants	Activities		Remarks
		Use of fertilizers	Control of diseases & pests	
1 st Week of Jun. – 1 st Week of Jul.	Silking stage		<ul style="list-style-type: none"> • Stalk rot of maize 	
	Pollination stage			
4 th Week of Jun. - 4 th Week of Jul.	Seed formation or Milking stage		<ul style="list-style-type: none"> • Black smut of Maize 	
3 rd Week of Jul.- 3 rd Week of Aug.	Seed ripening stage (cob fully formed)		<ul style="list-style-type: none"> • Ear rot of Maize 	
4 th Week of Jul.- 4 th Week of Aug.	Harvesting stage			<ul style="list-style-type: none"> • Harvest the maize in sunny & dry day

Source: JICA Project Team

5.3 Selection of land

- Fertile, light loamy and sloppy (or non-water-logged) soil is good for maize cultivation.

5.4 Crop rotation for reducing disease and pest

- For the controlling of 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 years.
- 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 & 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 & 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 & pest in the crop production field.
- The figure below indicates the crop rotation for the 3 years in a same plot.

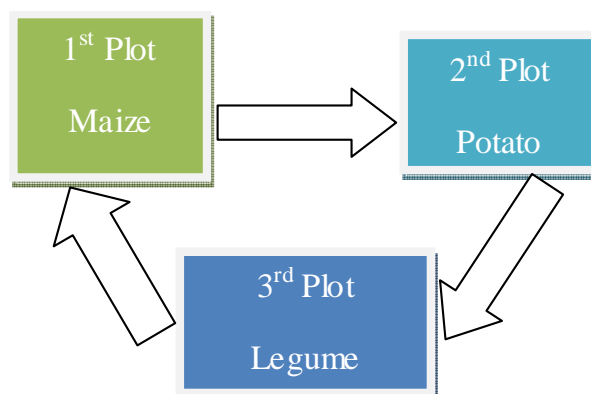


Fig. 5.4.1 Concept of crop rotation for Maize production

Source: JICA Project Team

5.5 Germination test of commercial seed from Agro-vet

- If possible, it would be better to use of certified and disease free seed to prevent seed born disease, otherwise there is risk of low production.
- Among received seeds from market, the warranty tag of the seed bag should be checked whether that is the right variety or not. After that, the germination test of the seed should be done.
- To identify the germination capacity of seeds, the following ways can be followed:
 - Keep sand/ soil in a flexible container or carton box, and remove stones from sand/ soil.
 - Take 200 seeds randomly from the 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 vigor of seed.
 - If germination rate of seed was found more than 85%, these seed can be used as seed. But, if it is less than 85% germination, either other quality seed have to be procured or sow the seed more.

Techniques of testing Germination of seed



Fig. No. 5.5.1 Making line with finger



Fig. No. 5.5.2 Sowing maize seeds in line



Fig. No. 5.5.3 Maize seeds sowed in row



Fig. No. 5.5.4 Covering seeds with soil



Fig. No. 5.5.5 Watering the planted seeds



Fig. No. 5.5.6 Sprouted maize plant

Fig No. 5.5 Procedure for maize seed germination test

Source: JICA Project Team

5.6 Treatment of seed before sowing

Maize seeds should be treated by fungicides for controlling damping-off of plant in initial stage. Processes for seed treatment are as follows:

- 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.
- Mix the fungicides with maize seeds in an air tight pot or container with lead cover, and stir it vigorously for 8-10 minutes.
- The following cautions should be considered while treating seeds with fungicide:
 - 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 soap water when fungicide touches skin directly.



Fig. No. 5.6.1 Seed treatment methods by the use of fungicide

Source: JICA Project Team

5.7 Land preparation and sowing of maize

(A) Field sanitation before cultivation

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

(B) 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 plowing (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 also. So, it should be better spread the manure and plow the field immediately.

(C) First ploughing

- 1-2 month before planting, during Dec-Jan, first plowing should be done.
- Plowing 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 plowing, the breaking of those clods should be done manually with the help of spade or other equipment before those clods become hard.

(D) Second plowing and 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.

- Just after sowing of seeds, we should press the soil, which will conserve the moisture, and will help, for easy germination.



Fig. No. 5.7.1 Farmer plowing land for maize cultivation

Source: JICA Project Team



Fig. No. 5.7.2 Farmers preparing rows for maize cultivation

Source: JICA Project Team

(E) Sowing

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

For the maize cultivation, Average temperature of 24 hours should be at least 10 ° C.

Table No.5.7.1

Time of maize sowing & harvesting in different region

Month Area	Feb/ Mar	Mar/ Apr	Apr/ May	May/ June	June/ July	July/ Aug	Aug/ Sept	Sept / 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

(II) Amount of seed

In case of germination rate over than 85%, we should apply the seed rate as mentioned in the table below. If the germination rate is below 85%, the amount of seeds sown should be increased.

Table No. 5.7.2

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

(III) Methods of sowing seeds

- Seeds will be soaked for 1 night in water, and dry it slightly in 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. 5.7.3

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 is as followings:
 - 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.



Fig. No. 5.7.3 Soaked maize seeds before cultivation

Source: JICA Project Team



Fig. No. 5.7.4 Spacing between row to row and plant to plant

Source: JICA Project Team

(IV) Application of chemical fertilizer

- The half dose of Urea, full dose of DAP and full dose of Potash should be applied in line and plow 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 fertilisers, amount and timing of application**

Fertilizers/ Manures	Basic dose (per Ropani)	Top dressing (kg./ Ropani)			Time
		1 st	2 nd	3 rd	
Compost/ FYM	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

6. Activities during Growth Period

- We should regularly check the field during 15-20 days after sowing to see if any problems have been occurred in the field.

6.1 First farm work: (25-30 days after sowing)**(A) First weeding**

- Various unnecessary weeds grow in maize field. Hence firstly, after 25-30 days of sowing, we should weed the field, and take the weeds away from the field.
- Weeding will help the maize seedlings to relieve from competition with weeds.

(B) Thinning

- After 25-30 days of sowing maize or at 4-5 leaf stage, thinning should be done.
- Thinning means practice of keeping only one healthy seedling removing another 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.

(C) 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.

(D) First top dressing

- After 25-30 days of sowing, we have to apply urea immediately as first top dressing. Applying of 0.87 kg Urea per Ropani, first weeding should be done 25-30 days after sowing. We should apply quarter tea spoon of urea near (5-10 cm) to each plant, and cover it by soil.

6.2 Second farm work: (25-30 days after 1st farm work)

(A) Second weeding

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

(B) Second top dressing

After 20-25 days of first top dressing, during knee height stage, we should apply the urea as second top dressing near the plant (5-10 cm from plant) after second weeding, like first top dressing.

(C) Making ridge

- After the second weeding and top dressing, each nodal root of maize plant should be covered by soil for the prevention of lodging in plants.
- At the same time of covering, we should make the drainage way between each line of plants, which helps to prevent lodging while it rains heavily.

6.3 Third farm work: (25-30 days after second farm work)

(A) Third weeding

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

(B) Third top dressing

After 20-25 days of second top dressing, during tasseling stage, we have to apply urea near each plant (5-10 cm) as third top dressing immediately just after 3rd weeding.

(C) Making ridge

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

(D) Making drainage

In the fourth farm work, drainage should be made between each line of plants, which will help to prevent root rot problems by plant logging during heavy rain.

7. Irrigation: only in case of availability of irrigation facility

For better maize 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. Weed Management

- If weeding is not done in proper time, the unnecessary weeds and plants compete for nutrients, light, water and place, which obstructs in proper growth of plants and decreases yields.
- Therefore, unnecessary plants and weeds have to be removed in well manner. This results for better production by well growth and development of plant,

8.1 Major weeds in maize field

- a) Commelina grass
- b) Digiteria grass
- c) Cyperus grass
- d) Cynodon grass
- e) Ageratum grass

8.2 Methods of controlling weeds



- Plow the maize field properly earlier to cultivation.
- At time of sowing, remove weeds and cover the maize plant by soil during the time of weeding (20-25 days of sowing).
- The weeds like *Cyperus* should be uprooted together with the underground roots, and root galls should be buried or burned away from the field.
- If the field is ploughed in summer season, the weeds die due to the sun light.

9. Major Disease, Pests and Methods of Controlling Them




9.1. Major causes of disease and pest attack


- Use of not well-decomposed FYM.
- Residues of previous crops.
- Lack of proper cleaning of the field.
- The fungal disease like Downey mildew can attack, if the temperature and humidity is high.

9.2 Major pest and control methods

Pests	Symptoms of damage	Control methods
 <p>Fig. No. 9.2.1 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"> • Plowing the field, and destroy it picking up the white grub manually • 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 plowing time. • If there is highly effect of white grub, we also can use Meterhizium at second weeding time in soil.
 <p>Fig. No. 9.2.2 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>Hamal 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.

9.3 Major disease and control methods

Disease	Symptoms	Control methods
 <p>Fig. No. 9.3.1. Common Ear rot disease</p> <p>Source: JICA Project Team</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"> • Properly sanitize the field after harvesting and before sowing. • Maintain the crop rotation after 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. 9.3.2 Black smut disease</p> <p>Source: JICA Project Team</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"> • Control in the way as mentioned in above disease. • If black smut disease appears in maize field, wrap it with polithene bag without dropping on field, chop the stalk and burry it or burn it down.
 <p>Fig. No. 9.3.3 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"> • Control in the way as mentioned in above disease. • This disease is occurred after the attack borer, hence; use Carbofuran (Furadan 3%) to control the borers.

Disease	Symptoms	Control methods
 <p data-bbox="188 801 584 837">Fig. No. 9.3.4 Downy Mildew</p> <p data-bbox="188 875 560 1021">Source: Plant Protection Directorate, Hariharbhawan, Lalitpur</p>	<p data-bbox="627 264 847 300">(Fungal disease)</p> <p data-bbox="627 338 916 483">Leaves turn yellowish and streaks appear on leaves.</p>	<ul style="list-style-type: none"> <li data-bbox="938 271 1449 360">• Properly sanitize the field after harvesting & before sowing <li data-bbox="938 398 1449 544">• Maintain the crop rotation in every 3 years with other crops excluding wheat. <li data-bbox="938 582 1449 672">• Cultivate disease-resistant variety such as Rampur-composite. <li data-bbox="938 710 1449 855">• Spray fungicide Bevistine 75% W. P. 3 gram mixing in per liter of water.

10. I. P. M. Methods According to Condition of Maize Crop

10.1 Bio pesticides and botanical pesticides

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

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

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

10.2 Preparation of Bio pesticides/ Botanical pesticides

(A) Plants and herbs of "Hamal Jhol - 1" and their quantity for the management of underground insects

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

- | | |
|-----------------------------------|-------------|
| b) Mustard cake (mustard or Neem) | - 1 kg |
| c) Ash | - 500 grams |
| d) Red chili (fresh or powder) | - 50 grams |
| e) Onion | - 200 grams |
| f) Garlic | - 200 grams |
| g) Kerosene | - 20 mls |
| h) Water | - 7 liters |

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



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

Source: JICA Project Team

(B) Plants and herbs of "Hamal Jhol - 2" and their quantity for the management of insects on plants

- | | |
|----------------------------|------------|
| a) Justicia (Asuro) leaves | - 1 kg |
| b) Mug wart | - 1 kg |
| c) Crofton weed | - 1 kg |
| d) Tallow tree | - 1 kg |
| e) Screw pine | - 1 kg |
| f) Nettle | - 1 kg |
| g) Cattle urine | - 5 liter |
| h) Water | - 15 liter |

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



Fig.No.10.2.2 Farmers are preparing *Hamal Jhol- 2*

Source: JICA Project Team

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

11. Harvesting of Maize for Consumption

11.1 Time of harvesting

- Maize can be harvested according to the purpose of use. In case, maize is harvesting for food consumption, it can be started harvesting from earlier to full maturation.

11.2 Storage: Method of maize storage for food consumption

- Maize cob can be tied in bundles, and placed by hanging under the roof of house with proper sun-light facilitation or making bunch (*Thankro*) outside of house if many, but it should not be wet with rain.



Fig.No.11.1 farmers harvesting maize for consumption

Source: JICA Project Team



Fig. No. Maize stored making bundle under the roof

Source: JICA Project Team

11.3 Self-seed production method

(A) Time of harvesting

- The harvesting time starts after the heavy rainfall stop. When the husk becomes dry or dark brownish color, seed should also be dried on the cob of standing plant in the field, the maize should be harvested.
- Harvesting should be done in dry or no rainfall day.
- 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.



Fig. No. 11.3.1 Pre-maturation stage i.e. not proper time of harvesting for seed production

Source: JICA Project Team



Fig. No. 11.3.2 Full-maturation stage i.e. proper time of harvesting for Maize seed production

Source: JICA Project Team

(B) Selection of site for seed harvesting

- The plants should be selected from the center of the field for getting the cobs as seed purpose due to less chance of out-crossing.

(C) Selection of plants

- Select medium sized plant that is neither short nor tall should be selected.
- The stalk should be healthy, and not infested with any pests and diseases.
- The cobs which are slightly bent (bend forming 45° angle) in plant should be selected.
- First of all, the cobs should be harvested for seed, and then other cobs.

(D) Selection of cobs

- 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 & too small kernels (seeds).
- Remove the kernels from the top and bottom part of a cob for selecting uniform kernels as seed.



Fig. No. 11.3.3 Methods of selecting Maize cobs for seed

Source: JICA Project Team

(E) Method of storage maize for seed purpose

- Select the cob from hanging bundles and dry seeds for 2-3 times, and put in the plastic bottles for safe storage of seeds.
- We can use two or three 2 liter plastic bottles for seed storing 600-700 gm. seeds can be stored per 2 liter plastic bottles.
- One gram (half spoon) of *Bojho* powder or *Neem* powder or mug wart powder, etc. can be used in 1 bottle seeds for pest control.



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 feces	1.35	1.94	1.05

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

2.2 Healthy for plants

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

2.3 Good means of breakdown of organic matter

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

3. Material Required for Making FYM

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

4. The Place for Making FYM

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

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

- First storage place
- Second storage place

(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.



Fig. No. 4.1 Taking out Farm Yard Manure

Source: JICA Project Team

(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 without collecting the manures over that for further decomposing.
- The size of second storage place can be varied according to the land availability



Fig. No. 4.2 FYM with roofing

Source: JICA Project Team

- 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 collected by pipe
Source: JICA Project Team



Fig. No. 6.1.2 Urine collected through drain
Source: JICA Project Team

6.2 Advantage of collecting urine

- The urine can be collected separately, and used as fertilizer since it has three times more nitrogen than in dung.
- Urine also can be used to control the disease and pests in crops. This can be sprayed in 5 to 7 days gap by mixing 1 part of urine with 4-5 parts of water.
- It also helps to reduce the application of chemical fertilizer and pesticide, which leads to reducing production cost.
- Separate collection of urine will help to sanitize and dry animal shed.
- The urine can be used together with water as fertilizer.

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

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



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

Source: JICA Project Team



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

Source: JICA Project Team



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

Source: JICA Project Team

PART 2: Compost Manure

8. Introduction

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

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 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, 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.

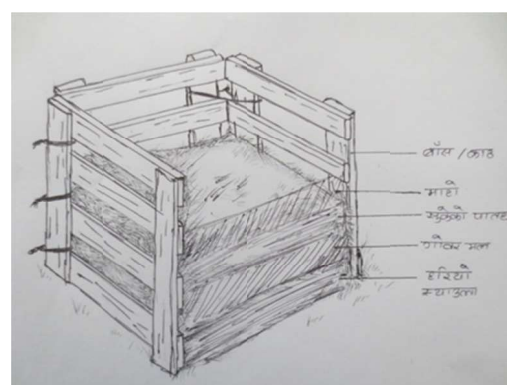


Fig. No. 12.2.1 Wooden or bamboo frame for making compost by heap method

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.

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