Ministry of Food and Agriculture
The Republic of Ghana

No.

The Study on Upper West Integrated Agricultural Development in the Republic of Ghana

Final Report

Part III
Instruction Manuals for Agricultural Technologies and Tools

March 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

KAIHATSU MANAGEMENT CONSULTING, INC.
CTI ENGINEERING INTERNATIONAL CO., LTD.

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Guide for the Use of the Manual

The Instruction Manuals for Agricultural Technologies and Tools have been developed for the purpose of introducing appropriate agricultural technologies to the MOFA staff and farmers in the Upper West Region (UWR). The intended readers of the Manuals are therefore mainly DAOs, AEAs of MOFAUWR, and farmers.

It is expected to enhance food security and increase income of the people in the area by improving agricultural technologies. To verify potential agricultural technologies for the UWR, the Pilot Development Activities (PDAs) have been implemented through the JICA's Study on "Upper West Integrated Agricultural Development" in 2008 and 2009. Various agricultural technologies have been tested in comparison with the traditional methods at the trial plots. The findings have been reflected on the Manuals.

The Manuals are comprised of three chapters; crop production, animal production, and processing. These activities are the most important for farmers in the area to produce foods and generate incomes. All the technologies included in the Manuals are: i) require low cost and low input, ii) use locally available materials as much as possible, and iii) are applicable to the farms in the area. It is the hope of the Study Team that the Manuals are widely used and contribute to improve the livelihood of farmers.

Chapter 1
Crop Production

Instruction Manual for Agricultural Technologies

1.1 Sorghum Production

1. Land Preparation and Sowing

a) Weeding and leveling

Sorghum seeds can be sown on the ridged beds.

The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.

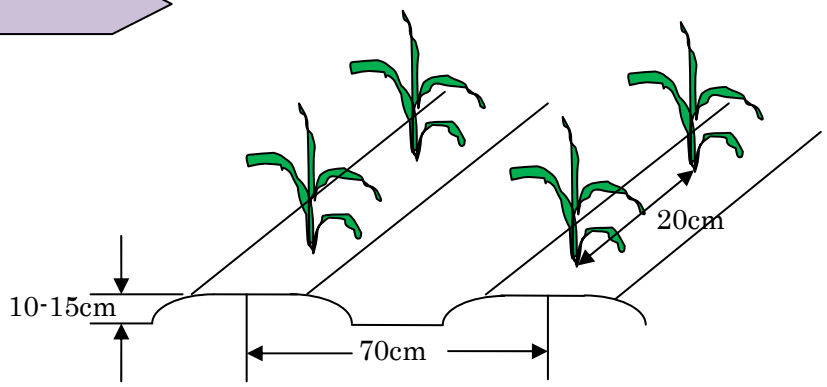
Compost must be uniformly spread all over before sowing seeds, unlike chemical fertilizer, since it takes time for decomposition to be in usable form for plants.

c) Sowing

Sowing has to be done in the early stages of rainy season. Sow 3 to 4 seeds per hill, under rain fed condition, about 2cm deep keeping interval of 20cm and 70cm between rows. Cover the seeds with the soil around.

An improved early matured variety like Kapaala/Dorado is recommended under the unsteady rain pattern in UWR.

d) Planting distance



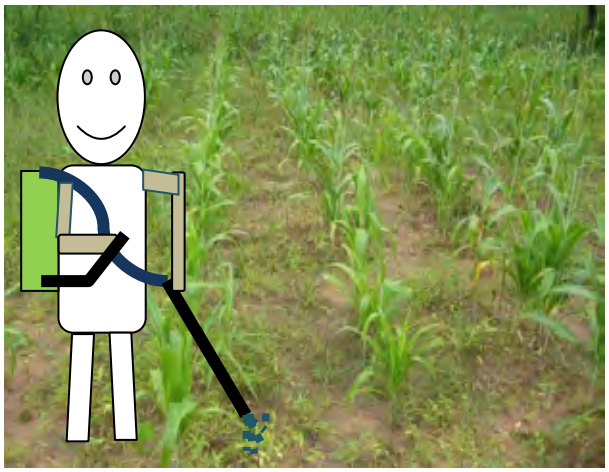
2. Crop Management

a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of sorghum.
Uproot "Striga" whenever you see it.
In case of use of chemical fertilizer, apply 130kg (about 2.5 bags)/ha of NPK:15,15,15 when the crop grows 30-40cm in hight.
Fertilizer should be applied along the planting rows or dropped little by little at the base of each planting hill, and cover it with soil.

b) Pest control

To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.
Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water, that is equivalent to one and a half (1.5) caps of "Voltic Water" for 16 liters knapsack sprayer filled with water.



3. Harvesting and Post Harvest

a) Time of harvesting

Harvest matured heads/pinnacles one by one by cutting.

b) Threshing and drying

Threshing is normally done by beating with a wooden stick on the concrete floor or tarpaulin after sufficiently drying up the grains under sunlight.
Grains are dried up again after threshing.

1.2 Cowpea Production

1. Land Preparation and Sowing

a) Weeding and leveling

Cowpea seeds can be sown on the flat or ridged beds.

The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.

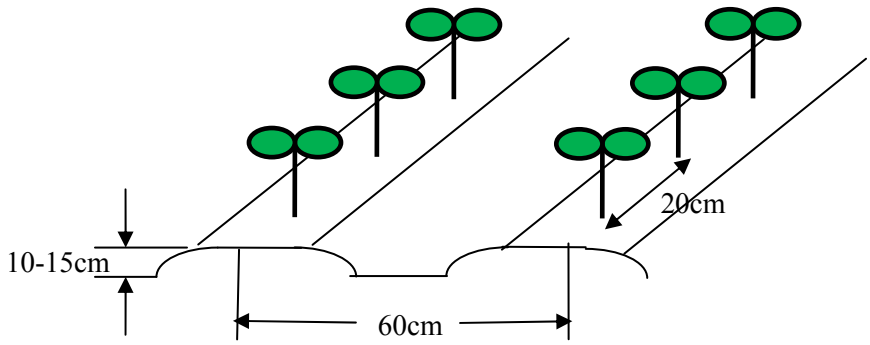
Compost must be uniformly spread all over before sowing seeds, unlike chemical fertilizer, since it takes time for decomposition to take place and release nutrients in usable form for plants uptake.

c) Sowing

Sow 2 to 3 seeds for each hill, under rain fed condition, about 2-3cm deep keeping interval of 20cm and 60cm between intra-row spacing.

Cover the seeds with the soil around.

An improved early matured variety like Songotra/Apagbaala is recommended under the unsteady rain pattern in UWR.



2. Crop Management

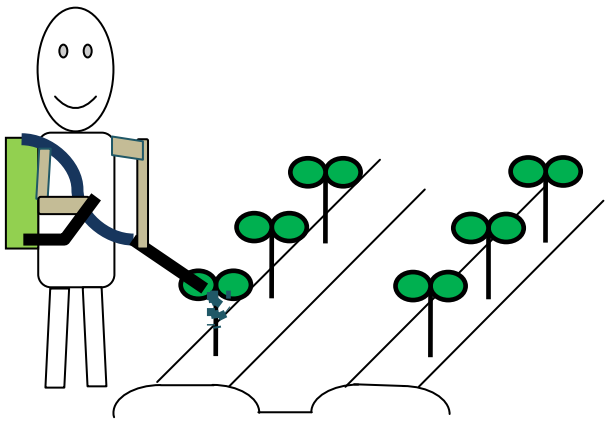
a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of cowpea.

In case of the use of chemical fertilizer, apply 130kg (about 2 and half bags) of NPK:15,15,15 per hectares as soon as possible before the initial growth of cowpea is completed.

Fertilizer should be applied along the planting rows or dropped little by little at the base of each planting hill.

b) Pest control



To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.

Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water, that is equivalent to one and a half (1.5) caps of “Voltic Water” for 16 liters knapsack sprayer filled with water.

3. Harvesting and Post Harvest

a) Time of harvesting

Harvest matured pods one by one by picking as they get brownish and dry.

b) Threshing and drying

Threshing is normally done by beating with a wooden stick on the concrete floor or tarpaulin after sufficiently drying up the peas under sunlight.

Peas are dried up again after threshing.

1.3 Soybean Production

1. Land Preparation and Sowing

a) Weeding and leveling

Soybean seeds can be sown on the flat beds. The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.

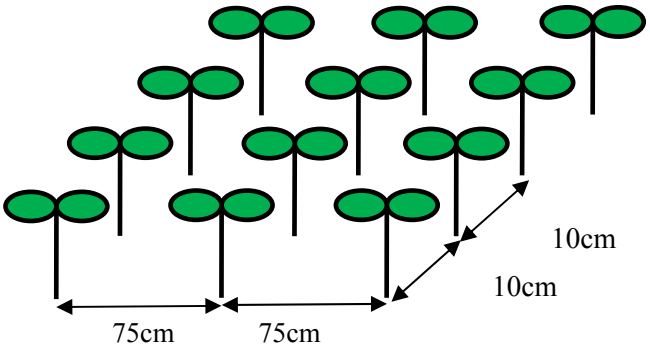
Compost must be uniformly spread all over before sowing seeds, unlike chemical fertilizer, since it takes time for decomposition to be in usable form for plants.

c) Sowing

Sow 2 to 3 seeds for each hill, under rain fed condition, about 2-3cm deep keeping interval of 10cm and 75cm between intra-row spacing.

Cover the seeds with the soil around.

An improved early matured variety like Jengumatra is recommended under the unsteady rain pattern in UWR.



2. Crop Management

a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of soybean.

In case of use of chemical fertilizer, apply 130kg (about 2 and half bags) of NPK:15,15,15 per hector as soon as possible before initial growth of soybean is completed.

Fertilizer should be applied along the planting rows or dropped little by little at the base of each planting hill.

b) Pest control

To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.

Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water that is equivalent to one and a half (1.5) caps of "Voltic Water" for 16 liters knapsack sprayer filled with water.

3. Harvesting and Post Harvest

a) Time of harvesting

Harvest matured pods one by one by picking as they get brownish and dry.

b) Threshing and drying

Threshing is normally done by beating with a wooden bar on the concrete floor in Ghana after sufficiently drying up the beans under sunlight.

Beans are dried up again after threshing.

1.4 Groundnut Production

1. Land Preparation and Sowing

a) Weeding and leveling

Groundnut seeds can be sown on the flat or ridged beds.

The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.

Compost must be uniformly spread all over before sowing seeds.

The effect of the compost is shown in the cover page.

c) Ridging

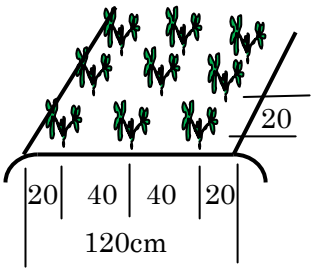
Groundnut seeds can be sown on the flat field where the maximum number of plants are accomodated if there is no risk of soil erosion and water logging.

In case of the slope field, raised ridges should be set up along the contour line while the mound like ridges is suitable in the water logging fields.

d) Sowing

Sow 2 seeds per hill, under rain fed condition, about 2-3cm deep keeping interval of 20cm and 40cm between rows spacing.
Cover the seeds with the soil around.
An improved early matured variety like "Chinese" is recommended under the unsteady rain pattern in UWR

A sample of planting space on ridge



2. Crop Management

a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of groundnut.
In case of the use of chemical fertilizer, apply 130kg (about 2 and a half bags) of NPK:15,15,15 per hectares as soon as possible before the initial growth of groundnut is completed.
Fertilizer should be applied along the planting rows or dropped little by little at the base of each plant hill.

b) Pest control

To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.

Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water that is equivalent to one and a half (1.5) caps of “Voltic Water” for 16 liters knapsack sprayer to be filled with water.

3. Harvesting and Post Harvest

a) Time of harvesting

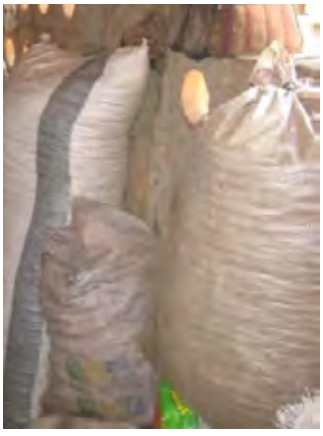
Harvest when 70-80 % of nuts are matured by uprooting with a hoe to ease the plant out of soil.

The harvested groundnut has to be dried immediately, and never heap or pack it in sacks to avoid the incidence of fungal diseases.

b) Shelling and drying

Removing shell from plant is normally done by hand, and dry them up again under sunlight before putting in sacks to store.

Shelling is done either by hand or a manual shelling machine.



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1.5 Upland Rice Production

1. Farming Calendar

a) Farming calendar

Activities	May.	Jun.	Jul.	Aug.	Sep.	Oct.
1. Field preparation						
2. Compost application						
3. Sowing						
4. Weeding & fertilizer application						
5. Harvesting						

2. Land Preparation and Sowing

a) Weeding and leveling

Upland rice seeds can be sown on the flat beds.

The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.

Compost must be uniformly spread all over before sowing seeds, unlike chemical fertilizer, since it takes time for decomposition to be in usable form for plants.

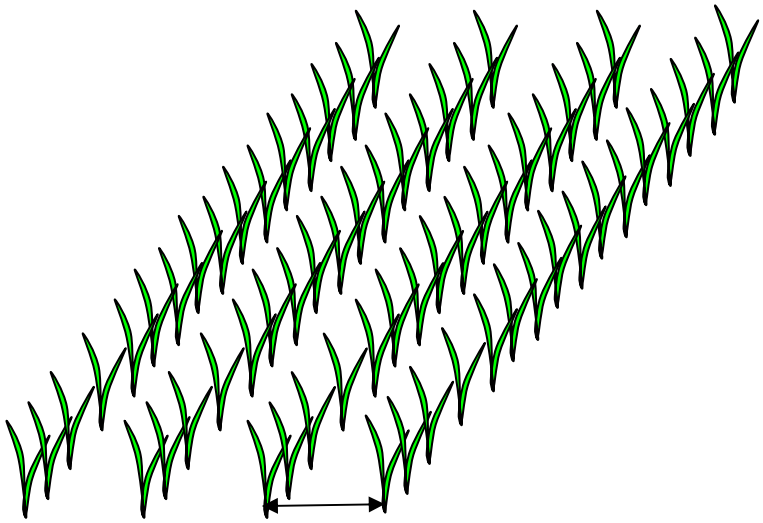
c) Sowing

Make sowing ditches straight with a wooden stick along the rope tightly stretched between the ends of rows.

Ditches are to be made about 2cm deep keeping interval of 50cm to 60cm between intra-row spacing.

Sow in drill in the amount of 50kg/ha along the ditches under rain fed condition.

An improved early matured variety like Wap is recommended under the unsteady rain pattern in UWR.



d) Compaction by stepping

After sowing seeds, cover the seeds with the soil around and step down to press the seeds for better contact with the soil.

3. Crop Management

a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of rice plants.

In case of use of chemical fertilizer, apply 130kg (about 2 and a half bags) of NPK:15,15,15 per hector as soon as possible before the initial growth of rice plants is completed.

Fertilizer should be applied along the planting rows.

b) Pest control

To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.

Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water that is equivalent to one and a half (1.5) caps of “Voltic Water” for 16 liters knapsack sprayer filled with water.

4. Harvesting

a) Harvesting time

Harvest panicles using a sickle when the majority of the grains turn brownish. Harvesting should be done when the weather is fine, considering the later processes such as drying and threshing.

b) Threshing and drying

Threshing is normally done by beating with a wooden bar on a tarpouline sheet or a concrete floor in Ghana after sufficiently drying up the grains under sunlight.

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1.6 Lowland Rice Production

1. Land Preparation and Sowing

a) Weeding and leveling

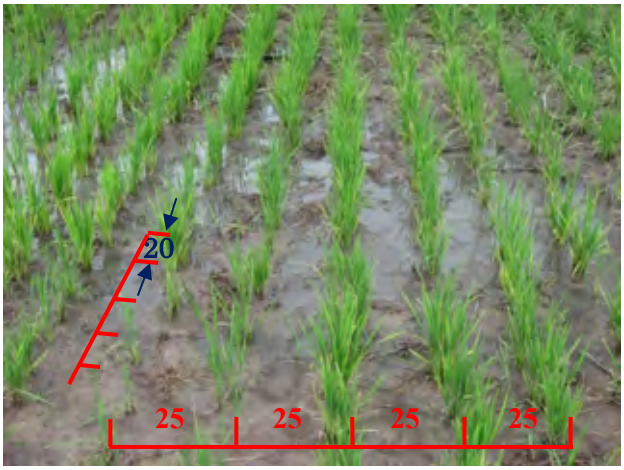
Lowland rice has to be sown in valley bottom fields where submerged shallowly.
The field must be well leveled after weeding and plowing by hoe.

b) Compost application

If compost is available, spread it all over the planting field in the dose of 20t/ha prior to sowing seeds.
Compost must be uniformly spread all over before sowing seeds, unlike chemical fertilizer, since it takes time for decomposition to be in usable form for plants.

c) Sowing

Sow 5- 6 seeds per hill about 1cm deep keeping interval of 20cm and 25cm between rows.
Cover the seeds with the soil around.
An improved early matured variety like "Digan" is recommended.



2. Crop Management

a) Weeding and fertilizer application

Weeding must be done to eliminate competition for the growth of rice.

In case of use of chemical fertilizer, apply 130kg (about 2.5 bags)/ha of NPK:15,15,15 when the crop grows 30-40cm in hight.

Fertilizer should be applied by broadcasting evenly all over the field.

b) Pest control

To prevent from insect pest, spray chemical on the entire plants once or twice in the planting period.

Any commercial insecticides available can be used by diluting into 1000 to 2000 times with water, that means 2-3 Voltic caps per 16 liters sprayer.

3. Harvesting and Post Harvest

a) Time of harvesting

Harvest matured heads/pinnacles one by one by cutting.

b) Threshing and drying

Threshing is normally done by beating with a wooden stick on the concrete floor after sufficiently drying the grains under sun.
The grains are dried up again after threshing.

For the rice for domestic use within the limited period, dry the grain remains on panicles ,then heap up for store.

A heap of well dried rice panicles

1.7 Tomato Production

1. Preparation of Nursery

a) Fertilizer application

Find a sunny and flat place for nursery.

Apply NPK compound fertilizer in the amount of 200g/m^2 to the nursery and mix it well with the soil dug up 10cm in the depth.

b) Nursery bed

Make flat bed for nursery at about 10–20cm high and 100cm wide by hoe.

c) Improved variety

Rio Grande is the only improved variety available in UWR.

The variety bears firmer fruits than the local variety and is more suitable to handle and transport.

2. Sowing

a) Sowing

Make 5 sowing ditches/m^2 of about 1 to 1.5cm in the depth at 20cm interval on the bed. Sow seeds in the drilled ditches uniformly.

Cover the sowing ditches with light soil sieved by fine mesh for quick germination.

b) Covering

After watering gently, cover the soil thinly with palm leaves or any dry grass for promoting germination and preventing dryness.

3. Raising Seedling

a) Removal of the cover

Remove the cover from the soil when seeds germinate and gradually refrain from watering. Watering is preferred to be done every morning.

b) Optimal time for transplanting

Check out the optimal time to transplant.
Optimal time is when there are 3-4 true leaves and about 20-25 days after the sowing date.

4. Land Preparation

a) Compost application

Manuring is preferred. Put it as much as possible.

It should be applied one week before transplanting.

Example:

Prepare 10m x 10m land for 200 plants.

Till to the depth of 20cm from surface soil and mix.

b) Ridging

Make ridges in height of 15cm and width of 1m by hoe.

Open a space between ridges wide enough to walk.

5. Transplanting

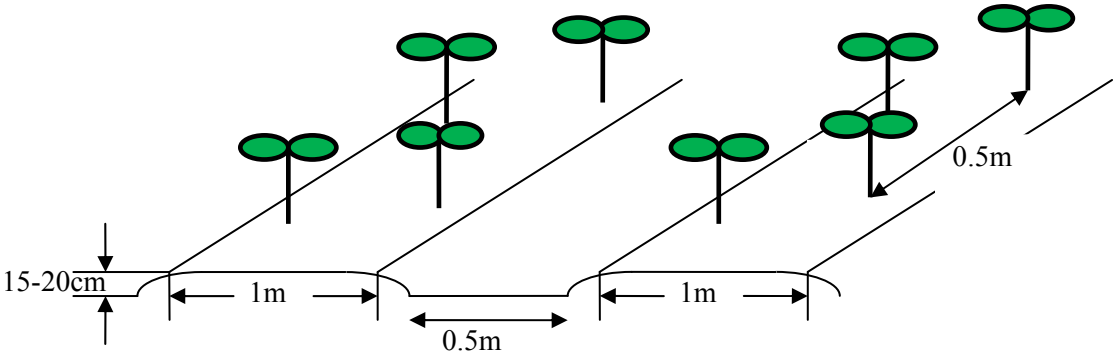
a) Cutting inter-row space

Cut inter-row spaces by knife every two days starting a week before transplanting to stimulate the growth of new roots.

b) Uprooting

After watering substantially, uproot them from the bottom of the roots by hand.
Be careful not to injure the roots.

c) Planting density



d) Transplanting

Dig planting holes and put seedlings in the holes.
The planting depth is to coordinate soil surface and root of the seed leaf.
Push the soil softly by hand. Root taking will be done within 3 days.

e) Fertilizer application

Apply 4kg/10a on K_2O base of NPK compound fertilizer around the plants.
The fertilizer has to be incorporated with the soil.
Example:
Fertilizer type: NPK 15-15-15
Amount: 27Kg/10a
Apply a hand grip of fertilizer for each plant.

6. Crop Management

a) Mulching

Cover the soil with rice straw or similar one to retain water and to prevent from weeds.
Water sufficiently every day.

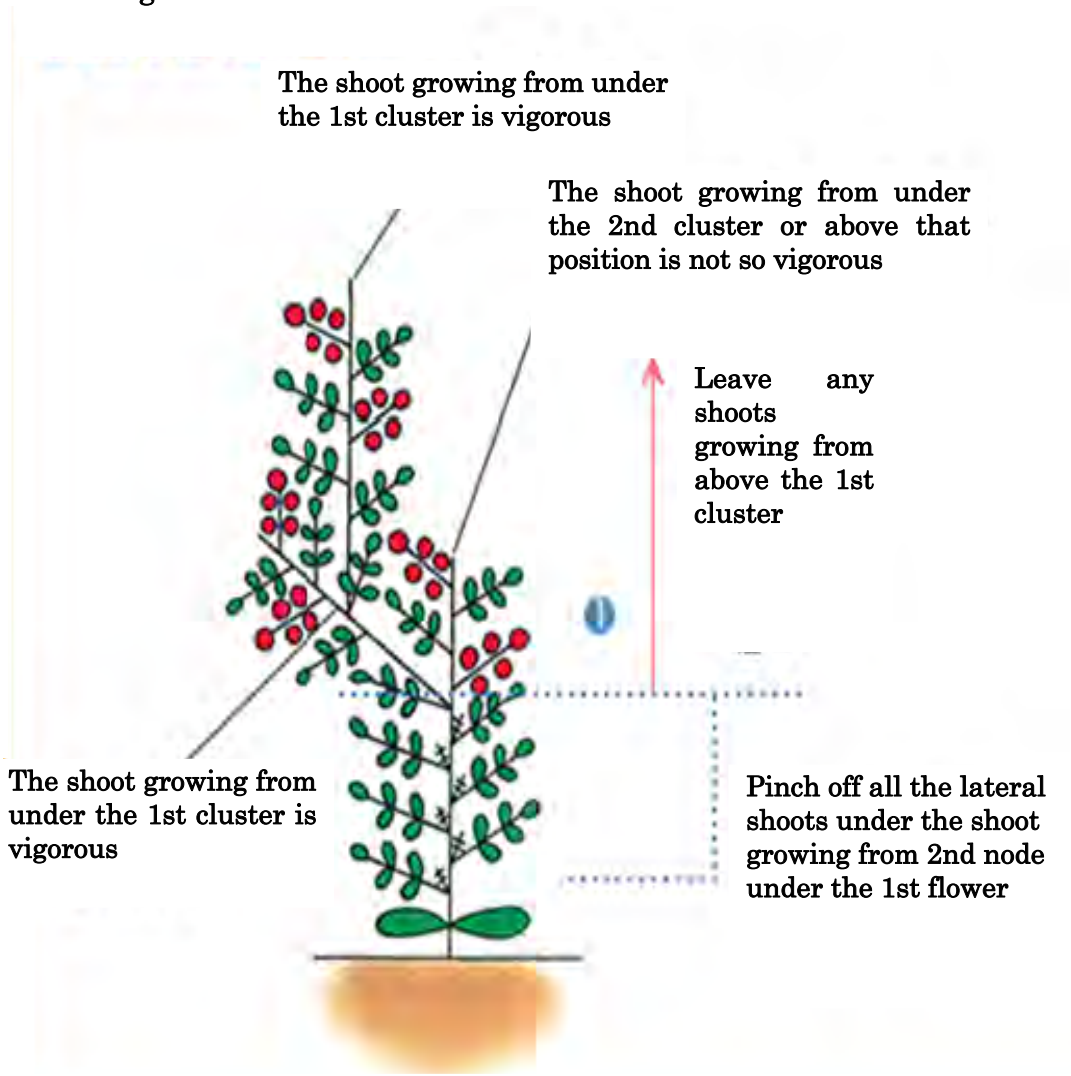
b) Top dressing

Top dress around or between plants every 2 weeks after the first fruits set.
Example:
Fertilizer type: NPK 15-15-15
Apply a pinch of fertilizer per plant and cover with the soil.
- First top dressing.
- Second top dressing
- Third top dressing

c) Pinching

Pinch lateral shoots except the primary stems and 2 of the most vigorous secondary stems.

Pruning of tomato



7. Pest Control

Disease and insect

Disease and insects should be controlled thoroughly in the nursery to avoid them widely spread to the field.
However, little damage occurs after transplanting.

For the insect control, the following measures should be taken.

Grasshopper

Applicable insecticide:
Organic phosphorus compound such as Malathion, Endosulfan and Cyflane.

Aphid

Application method:
Spray immediately after any insects appear on the plants especially at the nursery, by diluting with 2000 to 3000 times of water.

Caution:
Spray several times for the complete control. Keep 3 days for the 2nd spraying after the 1st spraying.

As for disease, “Alternaria” (Early Blight) is one of the most serious diseases on tomato occurring especially in dry season.
Symptom occurs from the lower part of foliage with brown spots on leaves, and gradually expands to entire leaves to wilting.
For prevention and control, spraying Dithene or some other major fungicide is effective.

Alternaria (Early Blight)

8. Harvesting

a) Harvesting

Harvest by hand pick when the fruits matured to red color.

The first fruit is recommended to be removed when it is in small size to maintain the plant vigor.

1.8 Eggplant Production

1. Preparation of Nursery

a) Fertilizer application

Find a sunny and flat place for nursery.
Apply NPK compound fertilizer in the amount of 200g/m^2 to the nursery and mix it well with the soil dug up 10cm in the depth.

b) Nursery bed

Make flat bed for nursery about 10–20cm high and 100cm wide by hoe.

c) Improved variety

An improved variety like Black Beauty is recommendable for market sales.

2. Sowing

a) Sowing

Make 5 sowing ditches/m^2 about 1 to 1.5cm in the depth at 20cm interval on the bed. Sow seeds in the drilled ditches uniformly.
Cover the sowing ditches with light soil sieved by fine mesh for quick germination.

b) Covering

After watering gently, cover the soil thinly with palm leaves or any dry grass for promoting germination and preventing dryness.

3. Raising Seedling

a) Removal of the cover

Remove the cover from the soil when seeds germinate, and gradually refrain from watering. Watering is preferred to be done every morning.

b) Optimal time for transplanting

Check out the optimal time to transplant.
Optimal time is when there are 3-4 true leaves and about 20-25 days after the sowing date.

4. Land Preparation

a) Compost application

Manuring is preferred.

Put it as much as possible.

It should be applied one week before transplanting.

Example:

Prepare 10m x 10m land for 200 plants.

Till to the depth of 20cm from the surface soil and mix.

b) Ridging

Make ridges in height of 15cm and width of 1m by hoe.

Open a space between ridges wide enough to walk.

5. Transplanting

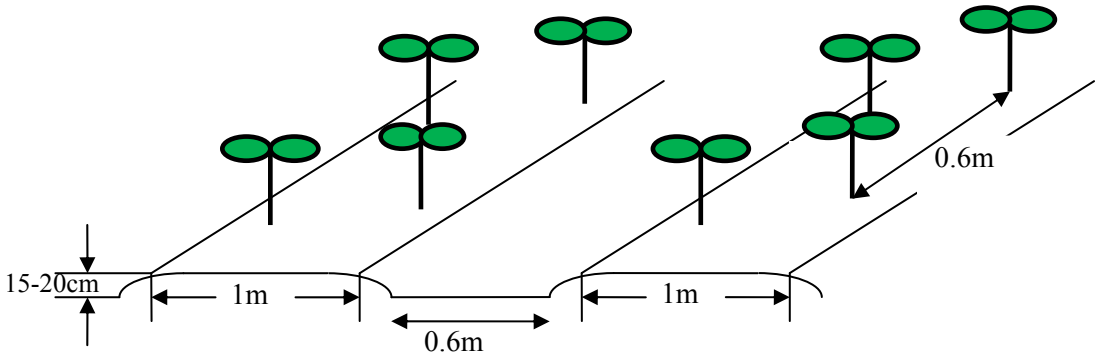
a) Cutting inter-row space

Cut inter-row spaces by knife every two days starting a week before transplanting to stimulate the growth of new roots.

b) Uprooting

After watering substantially, uproot them from the bottom of the roots by hand.
Be careful not to injure the roots.

c) Planting density



d) Transplanting

Dig planting holes and put seedlings in the holes.
The planting depth is to coordinate soil surface and root of the seed leaf.
Push the soil softly by hand.
Root taking will be done within 3 days.

e) Fertilizer application

Apply 4kg/10a on K_2O base of NPK compound fertilizer around the plants.

The fertilizer has to be incorporated with the soil.

Example:

Fertilizer type: NPK 15-15-15

Amount: 27Kg/10a

Apply a hand grip of fertilizer for each plant.

6. Crop Management

a) Mulching

Cover the soil with rice straw or similar one to retain water and to prevent weeds.

Water sufficiently every day.

b) Top dressing

Top dress around or between plants every 2 weeks after the first fruits set.

Example:

Fertilizer type: NPK 15-15-15

Apply a pinch of fertilizer per plant and cover with the soil.

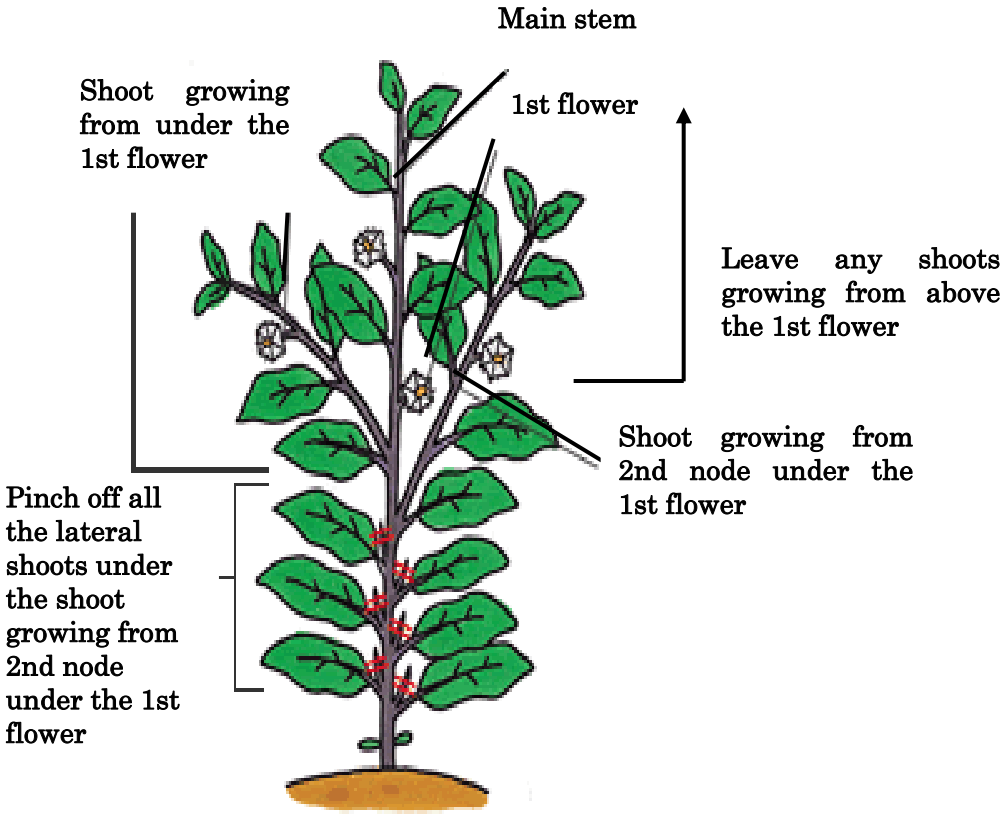
(1) First top dressing.

(2) Second top dressing

(3) Third top dressing

c) Pinching

Pinch lateral shoots except the primary stems and 2 of the most vigorous secondary stems.



7. Pest Control

Disease and insect

Disease and insects should be controlled thoroughly in the nursery to avoid them widely spread to the field.
However, little damage occurs after transplanting.

For the insect control, the following measures should be taken.

Applicable insecticide:
Organic phosphorus compound such as Malathion, Endosulfan and Cyflane.

Application method:
Spray immediately after any insects appear on the plants especially at the nursery, by diluting with 2000 to 3000 times of water.

Caution:
Spray several times for the complete control.
Keep 3 days for the 2nd spraying after the 1st spraying.

Grasshopper

Beatle

Aphid

8. Harvesting

a) Harvesting

Harvest by knife when the fruits matured.
The first fruit is recommended to be removed when it is in small size to maintain the plant vigor.

1.9 Green Pepper Production

1. Preparation of Nursery

a) Fertilizer application

Find a sunny and flat place for nursery.
Apply NPK compound fertilizer in the amount of 200g/m^2 to the nursery and mix it well with the soil dug up 10cm in the depth.

b) Nursery bed

Make flat bed for nursery about 10–20cm high and 100cm wide by hoe.

c) Improved variety

An improved variety like California Wonder/Yolo Wonder is recommendable for market sales.

2. Sowing

a) Sowing and covering

Make 5 sowing ditches/m^2 about 1 to 1.5cm in the depth at 20cm interval on the bed. Sow seeds in the drilled ditches uniformly.
Cover the sowing ditches with light soil sieved by fine mesh for quick germination.

b) Covering

After watering gently, cover the nursery soil thinly with palm leaves or any dry grass for promoting germination and preventing dryness.

3. Raising Seedling

a) Removal of the cover

Remove the cover from the soil when seeds germinate and gradually refrain from watering. Watering is preferred to be done every morning.

b) Optimal time for transplanting

Check out the optimal time to transplant.
Optimal time is when there are 3-4 true leaves and about 20-25 days after the sowing date.

4. Land Preparation

a) Compost application

Manuring is preferred. Put it as much as possible.

It should be applied one week before transplanting.

Example:

Prepare 10m x 10m land for 200 plants.

Till to the depth of 20cm from surface soil and mix.

b) Ridging

Make ridges in height of 15cm and width of 1m by hoe.

Open a space between ridges wide enough to walk.

5. Transplanting

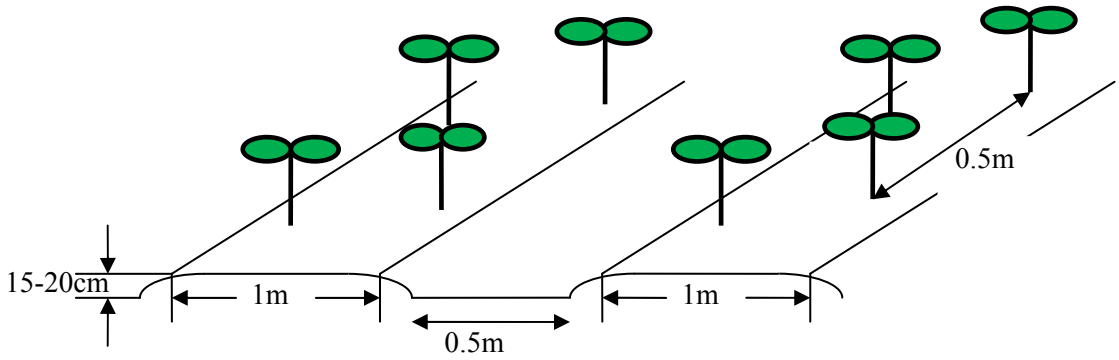
a) Cutting inter-row space

Cut inter-row spaces by knife every two days starting a week before transplanting to stimulate the growth of new roots.

b) Uprooting

After watering substantially, uproot them from the bottom of the roots by hand.
Be careful not to injure the roots.

c) Planting density



d) Transplanting

Dig planting holes and put seedlings in the holes.
The planting depth is to coordinate soil surface and root of the seed leaf.
Push the soil softly by hand. Root taking will be done within 3 days.

e) Fertilizer application

Apply 4kg/10a on K_2O base of NPK compound fertilizer along the plants.
The fertilizer has to be covered with the soil.
Example:
Fertilizer type: NPK 15-15-15
Amount: 27Kg/10a
Apply a hand grip of fertilizer per plant.

6. Crop Management

a) Mulching

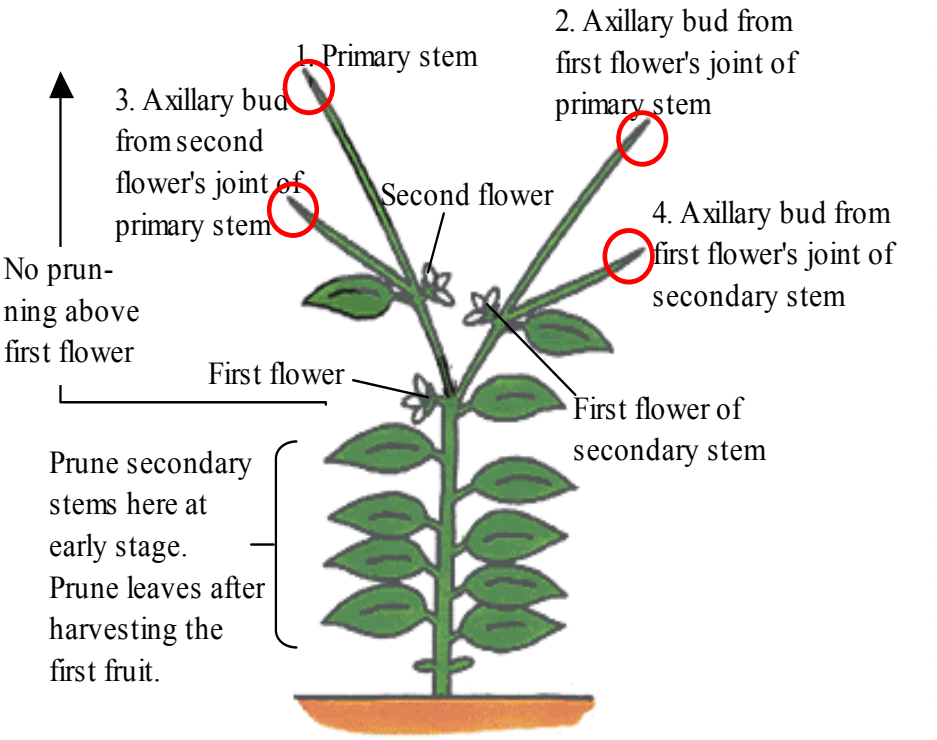
Cover the soil with rice straw or similar one to retain water and to prevent weeds.
Water sufficiently every day.

b) Top dressing

Top dress around or between plants every 2 weeks after the first fruits set.
Example:
Fertilizer type: NPK 15-15-15
Apply a pinch of fertilizer per plant and cover soil.

c) Pinching

Pinch lateral shoots except the primary stems and 2 to 3 of the most vigorous secondary stems.



7. Pest Control

Disease and insect

Disease and insects should be controlled thoroughly in the nursery to avoid them widely spread to the field.
However, little damage occurs after transplanting.

For the insect control, the following measures should be taken.

Aphid on the back of the leaves

Applicable insecticide:
Organic phosphorus compound such as Malathion, Endosulfan and Cyflane.

Application method:
Spray immediately after any insects appear on the plants especially at the nursery, by diluting with 2000 to 3000 times of water.

Leaves infected by Tobacco mosaic virus

Caution:
Spray several times for the complete control.
Keep 3 days for the 2nd spraying after the 1st spraying.

Mosaic virus is a serious issue in pepper cultivation.
Eradicating aphids by chemical is a practical measure to control the virus infection.

Close-up of leaves infected by virus

8. Harvesting

a) Harvesting

Harvest by knife when the fruits matured.

First fruit is recommended to be removed when it is in small size to maintain the plant vigor.

1.10 Cabbage Production

1. Preparation of Nursery

a) Fertilizer application

Find a sunny and flat place for nursery.
Apply NPK compound fertilizer in the amount of 200g/m^2 to the nursery and mix it well with the soil dig up 10cm in the depth.

b) Nursery bed

Make flat bed for nursery about 10–20cm high and 100cm wide by hoe.

c) Improved variety

An improved variety like Copenhagen Market/ F1 Oxylus is recommendable for market sales.

2. Sowing

a) Sowing and covering

Make 5 sowing ditches/m^2 about 1 to 1.5cm in the depth at 20cm interval on the bed. Sow seeds in the drilled ditches uniformly.
Cover the sowing ditches with light soil sieved by fine mesh for quick germination.

b) Covering

After watering gently, cover the nursery soil thinly with palm leaves or any dry grass for promoting germination and preventing dryness.

3. Raising Seedling

a) Removal of the cover

Remove the cover from the soil when seeds germinate, and gradually refrain from watering. Watering is preferred to be done every morning.

b) Optimal time for transplanting

Check out the optimal time to transplant. Optimal time is when there are 5-6 true leaves and about 25-30 days after the sowing date.

4. Land Preparation

a) Compost application

Manuring is preferred. Put it as much as possible.

It should be applied one week before transplanting.

Example:

Prepare 10m x 10m land for 250 to 300 plants.

Till to the depth of 20cm from surface soil and mix.

b) Ridging

Make ridges in height of 15cm and width of 1m by hoe.

Open a space between ridges wide enough to walk.

5. Transplanting

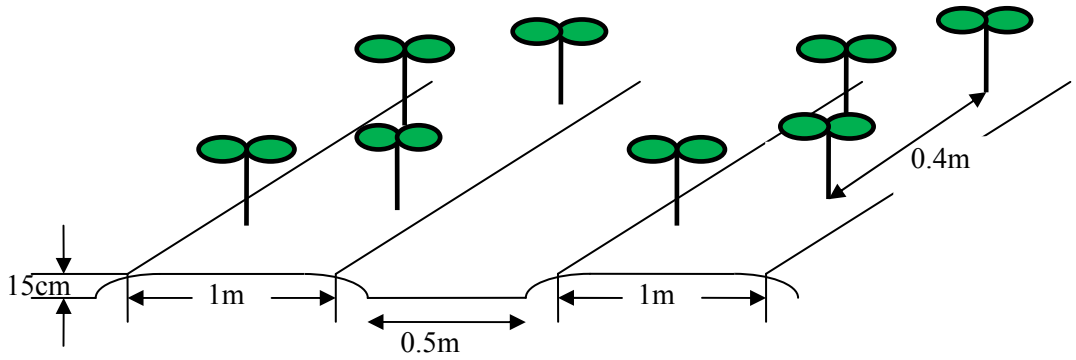
a) Cutting inter-row space

Cut inter-row spaces by knife every two days starting a week before transplanting to stimulate the growth of new roots.

b) Uprooting

After watering substantially, uproot them from the bottom of the roots by hand.
Be careful not to injure the roots.

c) Planting density



d) Transplanting

Dig planting holes and put seedlings in the holes.
The planting depth is to coordinate soil surface and root of the seed leaf.
Push the soil softly by hand.
Root taking will be done within 3 days.

e) Fertilizer application

Apply 4kg/10a on K_2O base of NPK compound fertilizer along the plants.
The fertilizer has to be covered with the soil.
Example:
Fertilizer type: NPK 15-15-15
Amount: 27Kg/10a
Apply a hand grip of fertilizer for each plant and cover it with soil.

6. Crop Management

a) Mulching

Cover the soil with rice straw or similar one to retain water and to prevent from weeds. Water sufficiently every day.

b) Top dressing

Top dress around or between plants every 2 weeks after the head formation starts.
Example:
Fertilizer type: NPK 15-15-15
Apply a pinch of fertilizer per plant and cover with the soil.

7. Pest Control

Disease and insect

Disease and insects should be controlled thoroughly in the nursery to avoid them widely spread to the field.
However, little damage occurs after transplanting.

Insects such as aphid, caterpillar, and worm normally attack severely on cabbage.
For insect control, the following measures should be taken.

Applicable insecticide:
Organic phosphorus compound such as Malathion, Endosulfan and Cyflane.

Application method:
Spray immediately after any insects appear on the plants especially at the nursery, by diluting with 2000 to 3000 times of water.

Caution:
Spray several times for the complete control.
Keep 3 days for the 2nd spraying after the 1st spraying.

Aphid on the back of the leaves

Cabbage webworm is feeding the core of cabbage

Severely damaged by Caterpillar

8. Harvesting

a) Harvesting

Harvest by knife when the heads are well compacted. 2 to 3 outer leaves should be attached for protection of the heads.

It is recommended to apply salt water on the cut section to avoid discoloration.