

# AGRICULTURE

# 8



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# AGRICULTURE

8



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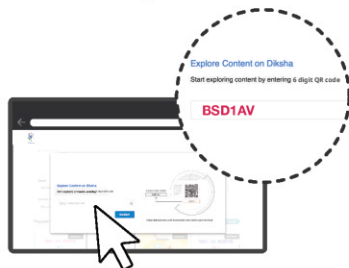
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# **Agriculture-8**

**(For Eighth Class)**



**PUNJAB SCHOOL EDUCATION BOARD**

Sahibzada Ajit Singh Nagar



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# Agriculture-8

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## **FOREWORD**

Punjab School Education Board since its inception has been constantly putting its efforts for re-designing lessons and preparing books according to the needs of national educational view point and occupational requirements of the state.

The present textbook has been prepared in the light of National Curriculum Framework 2005 and Punjab Curriculum Framework 2013. Accordingly, it has been felt that more emphasis should be laid on vocational courses. India is mainly an agrarian economy and Punjab is considered as Food Bowl of the country. This book contains information about agricultural economic development of the country, some common tips about agriculture and information about agriculture based supplementary enterprises and industrial occupations so that students can be made aware to adopt it.

This book prepared by experts of Punjab Agricultural University, Ludhiana will prove helpful for students and teachers.

Suggestions from field are welcome for making the book better.

**Chairman**  
Punjab School Education Board



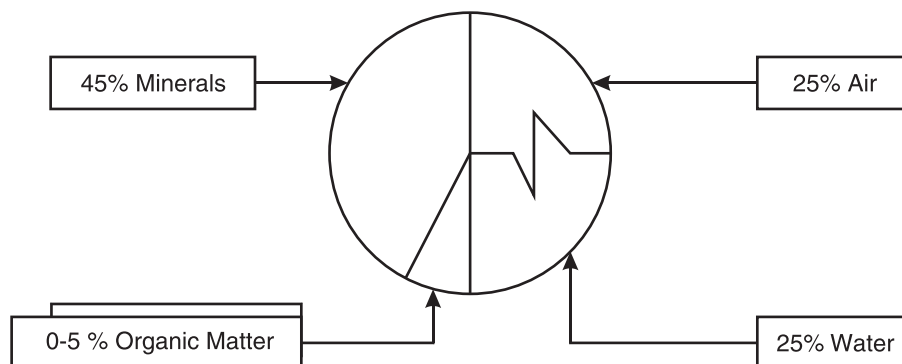
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## Chapter-1

# SOILS AND SOIL MANAGEMENT

For a farmer, soil is an upper layer of earth in which plant roots grow. From this layer plants absorb water and nutrients, it also provides physical strength to roots. Hence, the upper layer of earth which meets the crop requirements is known as soil. For a soil scientist, soil is a dynamic natural body developed by natural forces acting on parent material. Generally it is divided in the layers of mineral and organic matters. According to the farmers, soil is a lifeless thing, but according to a soil scientist it is a lively thing because it has enormous microbes and provides nutrients for plant growth. Soil is a blend of organic matter, minerals, water and air. (Fig.1) Mineral and organic matter in a soil is almost stable whereas, water and air can interchange with each other.



**Fig. 1. Basic constituents of Soil**

Various physico- chemical properties are determined to differentiate one soil from the other. These properties are as under:

### **Physical properties:**

Physical properties include size of soil particles, soil structure, pore size and water holding capacity etc. The relative proportion of different sized soil mineral particles (sand, silt and clay) determines the soil texture. The main three soil types are as under:



- i. **Sandy soils:** Ploughing in these soils is very easy and these soils are generally considered as light soil. These soils contain significant amount of sand. When the moistened soil is rubbed between thumb and finger it feels gritty and does not stick to hand. When a ball of moistened soil in the hand is squeezed, it breaks with slight pressure. Handmade balls of properly moistened soil fall apart easily. After application, the water leaches down quickly. Pore size of sandy soils is greater than clayey soils which results in higher infiltration rate of air and water in such soils.
- ii. **Clayey soils:** Soil with clay content more than 40% is called as clayey soil. Irrigation /rain water takes long time to leach down. Ploughing of these soils under low moisture conditions leads to development of clods. Formation of wide cracks upon drying is the characteristic feature of these soils. Balls can be easily made by moist clayey soils. Water holding capacity of these soils is greater than sandy soils. Water stagnation is the main problem with these soils.
- iii. **Loamy soils:** Characteristics of these soils are in between that of sandy and clayey soils. Soil structure, aeration, water movement, water holding capacity and nutrient content are optimum for crop cultivation. These soils are best suited for agriculture. When rubbed between thumb and fingers, it feels like powder.

#### **Chemical properties:**

Every soil has different chemical properties such as soil reaction (pH), electrical conductivity (EC), salt content, types of salts present etc. Based on these chemical properties soils are classified as under:

- i. **Acidic soils:** Acidity or basicity of soil is measured by pH. The pH range of 6.5 to 8.7 is considered normal for crop production. If pH is less than 7, soils are considered as acidic. These soils are generally found in areas receiving high rainfall, which is high enough to leach appreciable amount of exchangeable bases from the surface layer.
- ii. **Salt affected soils:** These soils contain some amount of soluble salts. However, under some circumstances, when the concentration of salts in a soil is high enough, which adversely affects the crop growth, such soils are known as salt affected soils. Based on types of salts present, pH and EC, the salt affected soils are classified into three groups:

- a. **Saline soils:** Soils with higher concentration of sulphates and chlorides of calcium, magnesium, and potassium are known as saline soils. The pH of these soils is less than 8.7 and EC is more than 0.8 mmhos/cm. A powdered white layer of soluble salts is developed on the soil surface upon drying after irrigation. Water stagnation is not a problem in these soils. In local language, these soils are also called as *kallar, reh, thur or shora*.
- b. **Alkali soils:** Carbonates and bicarbonates of sodium are the main salts in alkali soil. The pH of alkali soils is greater than 8.5. Sodium gets attached to clay particles and deteriorates chemical and physical properties of soils. Infiltration rate of these soils is very low which causes water stagnation problem in these soils.
- c. **Saline-alkali soils:** The soils having higher concentration of sodium and soluble salts in it are called saline-alkali soils. So these soils have combined characteristics of saline and alkali soils. These soils have higher amount of sodium attached to clay particles and higher amount of soluble salts in it.

#### **Management of problematic soils:**

Following measures should be adopted for the improvement of such soils.

##### **i. Management of sandy soils:**

- Incorporation of **45-50 days** old green manure crop of *dhaincha/ sunhemp* helps in improving the sandy soils.
- Application of well decomposed organic manures viz. farmyard manure, poultry manure, pig manure and compost etc. followed by their proper mixing in soil is beneficial.
- Cultivation of leguminous crops improves nitrogen availability in these soils.
- Proper leveling and small plot size (*Kiara*) improves irrigation water use efficiency of sandy soils.
- Incorporation of clay soil or village pond soil improves sandy soils.
- Sandy soils can also be improved by removing their surface layer from the top with the help of tractor operated scrapper (*karaha*).



## **ii. Management of clayey soils:**

- Application of organic and green manures make the soil slightly fluffy which improves the aeration and water infiltration rate of clayey soils.
- Incorporation of crop residue improves the clayey soils.
- Ploughing the field at proper moisture content (near field capacity) prevents formation of large sized clods.
- Proper drainage system should be made to drain out excessive amount of water.
- Rice cultivation should be preferred in clayey soils.

## **iii. Reclamation of acidic soils:**

Acidic soils are reclaimed with the addition of lime. Lime requirement of the soil varies with the extent of acidity and soil texture. Application of press-mud and saw dust helps in reclaiming acidic soils. Application of liming amendment improved physico-chemical environment of the soil and also increased availability of essential nutrients to crop.

## **iv. Reclamation of salt affected soils:**

There are few factors which need to be considered before reclamation of salt affected soils. These factors are sub-soil water level, irrigation water quality, availability of canal water, presence of hard pan in soil profile, drainage conditions, degree of salinity and alkalinity. Based on these factors, reclamation of saline and alkali soils can be done as given below:

**a. Reclamation of saline soils:** Ploughing of flooded field is recommended to leach down the salts from upper layer. Ploughing in flooded field is known as puddling (*kaddu karna*). If good quality irrigation water is not available, scrape the upper salty layer of soil with help of tractor operated leveler (*karaha*). Scrapped soil should be dumped deep into soil profile.

### **b. Reclamation of alkali soils:**

- Level the field properly for equal distribution of water throughout the field.
- Make the strong bunds around the field to prevent outflow of water containing dissolved salts to adjoining fields.

- Get the soil and water tested to know the gypsum requirement.
- Broadcast the recommended dose of amendment (gypsum) as per the soil test and mix it thoroughly with shallow ploughing.
- Irrigate the field to allow the seepage of salts from the surface layer.
- Practice green manure of *dhaincha* before rice transplanting in such fields.
- Application of organic manures also helps in improving physico-chemical properties of alkali soils.

**c. Reclamation of soils in water logging areas:**

In some areas of Punjab, level of underground water table is high. As a result, the soils remain continuously wet due to filling of soil pores and soil air spaces with stagnant water. Such problematic soils are referred as water logged soils. Such a condition is found in some areas of Sri Muktsar Sahib district and along river banks. Due to lack of availability of air and oxygen to the roots, plant growth is retarded and farmers fail to raise a normal crop. Draining out stagnant water, lowering of underground water through tube wells and plantation of water loving crops such as eucalyptus, rice and sugarcane and use of canal water for irrigation may be adopted as measures to reclaim such soils.

## Exercises

**a. Answer in one to two words:**

1. What is pH of a normal soil for crop production?
2. Name any two physical properties of soils.
3. Which soils have highest infiltration rate?
4. What is the percentage of clay particles in clayey soils?
5. Which soil property determines the soil acidity or alkalinity?
6. Which are the prominent salts present in saline soils?
7. The soil with higher concentration of sodium carbonates and bicarbonates are categorized as ?
8. Name two green manure crops.

9. Which crop is best suited for cultivation in clayey soils?
10. Which amendment is used for reclamation of alkali soils?

**b. Answer in one to two sentences:**

1. What is meant by soil according to soil science?
2. Enlist the physical properties of soil.
3. Compare clayey and sandy soils.
4. What is acidic soil?
5. What is saline soil?
6. What is water logged soils?
7. How can we reclamation of saline soils?
8. Give recommended necessary information to reclamation of salt affected soils.
9. What are the major properties of loamy soils?
10. What are saline-alkali soils?

**c. Answer in five to six sentences:**

1. Describe the different types of soils according to their physical properties.
2. Give the diagrammatic representation of soil components.
3. Explain the management practices for improving sandy soils.
4. Explain the method of reclamation of alkali soil.
5. Explain in detail the management strategy for clayey soils.

\*\*\*\*\*

## Chapter-2

# NURSERY RAISING

The population of our country is increasing but land is decreasing day by day. For getting more income from small land holdings, nursery raising is remunerative occupation. More income can be obtained from nursery raising of vegetables, flowers and fruits. For healthy nursery production, full knowledge and skill about nursery operations is required.

## BENEFITS OF NURSERY RAISING

1. Seeds are very expensive and their efficient utilization is done through nursery raising.
2. Seeds of some vegetables are very small and it is difficult to sow them directly in the field but can be easily planted through nursery.
3. There is an appropriate use of land. Fallow land can be used for sowing of other crops till the nursery will be ready for transplanting.
4. It is easy to look after the seedlings in small area of nursery.
5. Nursery can be raised for early and late season crops to get maximum profit.
6. The weak seedlings can be removed in the nursery at the time of transplanting.
7. Seedlings can be protected from extreme cold or heat in small area of nursery.
8. Seedlings can be easily protected from insects and diseases in nursery which minimizes the cost of production.

## (A) NURSERY RAISING OF VEGETABLES

There is always shortage of quality seedlings of vegetables. So, there is huge scope to produce nursery of vegetables. Especially, small farmers can earn more income by raising nursery of vegetables. Only the nursery of those vegetables can be raised successfully which can tolerate the transplanting shock e.g. tomato, chilli, capsicum, brinjal, onion, cauliflower, cabbage, Chinese cabbage, broccoli, lettuce etc. The following points must be kept in mind while nursery raising of these vegetables :



- 1. Selection of land:** Select the land for nursery raising which gets at least 8 hours sunshine. It should be free from stones and shade of any big tree. There should be assured supply of water and drainage of excess water from nursery area. Loamy or sandy loam soil is considered best for nursery raising.
- 2. Seed bed preparation:** After well preparation of land, prepare seed bed of 1.0-1.25 m width and 15 cm high from the ground level. Normally the seed bed should be 3-4 metre in length but if field is levelled well then length can be increased. Before preparing seed bed, apply well rotten FYM @ 3-4 q per marla (25 square metre) area. Irrigate the field at least 10 days before sowing the seed in the nursery so that all the weeds can germinate and there will be less problem of weeds in the nursery.
- 3. Soil treatment:** Treat the soil with formalin @ 1.5- 2.0 % before sowing the seed to protect the nursery from soil borne diseases. For preparation of solution, add 15-20 ml Formalin (1.5-2.0%) in 1 litre of water and apply 2-3 litres of this solution in 1 m<sup>2</sup> area in such a way that 15 cm upper layer of soil may saturate with this solution. After this, cover the beds with polythene sheet and air tight for 72 hours. Turn the soil in beds once a day for 3-4 days to eliminate formalin and sow the seedlings in the nursery.
- 4. Seed treatment and sowing:** Treat the seed with Captan or Thiram @ 3g per kg of seed before sowing to protect it from seed borne diseases. Sow seeds 1-2 cm deep in lines with 5 cm spacing. Irrigate the nursery with sprinkler till the seedlings emerge out.
- 5. Caring of nursery plants:** Sometimes seedlings start dying before or after germination in the nursery. Under such circumstances, drench the nursery area with Captan or Thiram @ 3-4 g per litre of water and repeat it after 7-10 days. Transplant seedling of vegetables after 4-6 weeks of sowing. Stop watering 3-4 days before transplanting the nursery so that seedlings can tolerate the transplanting shock. Transplanting should be done in the evening hours and immediately irrigate the field. The detailed information regarding nursery raising of different vegetables for transplanting one acre area is given below:

Vegetables	Time of Sowing of nursery	Seed rate	Area (m <sup>2</sup> )
Tomato	First week of November and first fortnight of July	100 g	50
Brinjal	October, November, February-March and July	400 g	25
Chilli	Last week of October to mid November	200 g	25
Capsicum	Last week of October	200 g	25
Rabi Onion	Mid October to mid November	4-5 kg	200
Kharif Onion	Mid March to mid June	4-5 kg	200
Cauliflower	May-June (Early season crop)	500g,	50
	July- August (Mid season crop)	250g	25
	September-October (Late season crop)	250 g	25

## **(B) NURSERY RAISING OF SEASONAL FLOWERS**

The demand of pot plants has been increased with the development of multi-storey buildings for ever growing population. These are used for decoration of offices, hotels, houses etc. There is a huge demand of seasonal pot plants and chrysanthemum, dahlia and seasonal flowers give more profit. The business of flower nursery is beneficial near the big cities. Zinnia, Kochia and Sunflower can be grown in summer season. Marigold, Gul Ashrafi, Ice plant, Garden pea, Phlox etc. are winter season flowers.

### **METHOD OF NURSERY PREPARATION OF SEASONAL FLOWERS**

Almost all seasonal flowers are prepared in nursery. Nursery can be prepared on raised seed beds or pots. For preparation of nursery, mix soil, leaf mould, FYM in 1:1:1 proportion and add 75 g CAN, 75 g Super Phosphate and 45 g Muriate of Potash per m<sup>3</sup> area. Apply 2-3 cm thick layer of this mixture on raised seed beds.

After sowing, cover the seed with this mixture and irrigate it with sprinkler. Keep the seed beds moist. Nursery is ready in 30-40 days.

### (C) NURSERY RAISING FOR FRUIT PLANTS

Nursery of fruit plants is prepared by two methods:

**1. From seeds:** It is easy and cheapest method to produce plants. Fruit plants like Papaya, Karonda, Jamun and Phalsa are multiplied through seeds. However, the plants prepared from seeds are not true to type, uniform and moreover they attain large size. The management of these plants is very difficult. So the plants which are difficult to prepare from seed are prepared by root stock method.

**2. Vegetative propagation:** By this method, uniform and true to type plants can be produced. The plants prepared by this method bear fruit early. Mainly, the fruit plants like Mango, Citrus, Pear, Guava, Peach, Grapes, Pomegranate etc. are propagated by following methods:

**By cutting:** It is the cheapest and easy method to grow plants. In this method, stem cuttings are placed in suitable environmental conditions so that rooting and shooting may start and new plants may develop. By this method, commonly citrus, pomegranate and grapes can be prepared. Cutting should be 15-20 cm long and have 3-5 buds. Before sprouting in spring season, cuttings should be planted at 6-8 inches distance in the nursery.

**Layering:** In this method, new plants are forced to root while attached to the mother plant. In simple layering, the ring of bark is removed from the 20-30 cm tip of the shoot and it is buried in the soil from the place of removed ring keeping the terminal end of shoot exposed. The soil should remain moist and rooting will emerge after few weeks from this portion. Then separate the plant from mother plant and plant it in nursery or pot.

**Budding:** In this method, healthy scion having 1-2 buds from mother plants are inserted to the rootstock (Fig 2.1). The buds should be taken from healthy plants having good quality fruits and free from diseases. A cut should be given in the bark of rootstock so that the bud can be fitted precisely in this cut. After insertion of bud, a tape should be tightly tied around the cut part of rootstock keeping the tip of the bud exposed. Budding should be done during spring and rainy season.



**Fig:2.1**

**Grafting:** It is similar to budding except that the scion stick having 3-4 buds is turned in place of single bud. The different methods of grafting are performed in different fruit plants e.g. side grafting in mango and tounge grafting in pear and peach.

#### **(D) NURSERY PREPARATION OF AGROFORESTRY PLANTS**

In Punjab, the area under forest cover is negligible. Environmental experts are emphasizing on agroforestry for maintaining natural balance and diversification of agriculture. Poplar, Eucalyptus, Drake and Sisham are important agroforestry tree species which are being grown by the farmers of Punjab. Nursery preparation of these tree species is given as:

**1. Poplar:** It is a major tree of agroforestry landscape. For this species, nursery should be prepared from one year old plant but not from training and pruning of branches of old plants. Cuttings should be 20-25 cm in length and 2-3 cm in diameter. To protect the cuttings from termite and diseases, the cuttings are treated with 0.5 % solution of Chlorpyriphos 20 EC and 0.5 % Emisan solution for 10 minutes each, separately. The ideal time for nursery raising is mid January to mid February. After thorough preparation of beds, dig holes of equal length of cutting in the soil with the help of planting rod at a spacing of 60x60 cm or 50x50 cm. Plant the cuttings in the soil after keeping one bud of the cutting above the soil. Keep the soil moist till the sprouting of cuttings start. Irrigation and hoeing is done as and when required. Remove buds of 1/3 part of plant by rubbing with wet gunny bag. The plants are ready to transplant in the field after one year.

**2. Safeda:** Safeda is a fast growing tree. For preparing of its quality nursery, select healthy and well grown middle aged trees to collect seeds. Collect seeds from the



branches of trees only and not from the ground surface. Seed collected from good plants will produce healthy planting stock. February-March or September-October is the best time of raising nursery on raised beds or in pots.

**3. Drake:** Its nursery is commonly propagated from seeds. Seeds should be collected from healthy, well growing and tall plants during winter. The germination of seed is less (30-40%) due to its hard seed coat. Before sowing, the seeds are soaked in water for 24 hours or buried in FYM for 7 days to improve their germination. The best time for nursery sowing is February-March. Seeds are sown in seed beds at 20 cm distance. Seeds start germinating after 3 weeks of sowing. Thinning should be done at 15 cm spacing when plants attain a height of 5-8 cm. The plants are ready for transplanting after one year or even six months.

**4. Sisham:** Sisham is the state tree of Punjab. Collect ripened pods in December-January from healthy and straight trees. Nursery can be prepared in poly bags or in seed beds or in pots. Suitable time for nursery sowing is mid January-February and July- August. Before sowing, soak pods in cool water for 48 hours. Sow the seed 1.0-1.5 cm deep. Germination of seeds start after 10-15 days of sowing. When the plants attain height of 5-10 cm, thinning should be done keeping 15 X 10 cm spacing.

### Exercise

#### (a) Answer in 1 to 2 words:

1. Which fungicide is used for vegetable seed treatment?
2. What is the optimum time for raising the nursery of tomato?
3. When should the Chilli nursery be raised?
4. Write the name of two summer season flowers.
5. Write the name of two winter season flowers.
6. What is the optimum time for raising nursery of Eucalyptus?
7. What is the length of poplar cutting for nursery raising purpose?
8. Write the method through which true to type fruit plants can be produced.
9. What is the seed rate of onion for one acre?
10. Write the name of two fruits which are raised through budding.

**(b) Answer in 1 to 2 sentences:**

1. Which vegetables are raised through nursery?
2. Write the seed rate and time of sowing for nursery raising of tomato & chilli.
3. Which are two winter season flowers and when these can be sown?
4. Which fungicide is used against damping off of seedlings of vegetables?
5. Which fruit plants are vegetatively propagated?
6. Which fruit plants are grown through seed?
7. Write ideal method of nursery raising of poplar.
8. How to collect the seed for preparation of Drake nursery?
9. Which are the methods for nursery preparation of fruit plants?
10. What are the advantages for preparation of plants through cuttings?

**(c) Answer in 5 to 6 sentences:**

1. How to develop plants through layering?
2. Describe the methods of budding.
3. Describe briefly about the nursery raising of Sisham.
4. Describe the method of nursery raising of flowers.
5. What are the methods for nursery preparation of fruit plants?

\*\*\*\*\*

### Chapter-3

## LAND MEASUREMENT AND DOCUMENTATION OF LAND RECORDS

The measurement of land in India was started in the reign of Mughal Emperor Akbar and Todermal played a significant role in this work. Before that, the measurement of land and its record keeping was not done in a systematic manner. At that time, measurement of land was done with the help of ordinary string. The required tax (*Malia*) was paid to the government in kind i.e. in the form of crop produce. Since 1580 A.D. Emperor Akbar started receiving tax in cash and made the land record systematic. That is why; Emperor Akbar is called the founder of land reforms in India. During British rule and after independence, more land reforms and land measurement improvements were introduced; one of them the Land Consolidation Act (*Murababandhi* Act) of fifties is worth mentioning. Consolidation of land was done in a systematic way in the states of Punjab and Haryana. Both these states are the leading states in ushering Green Revolution in India. The following are the important documents relating to land measurement:

#### (1) *Zareeb*:

The chain made of iron rings (*Karies*) is called *Zareeb* which is used for measuring the land. The land is measured in acres, kanals or marlas in most parts of Punjab. The length of *Zareeb* is 10 *karms* (a unit of land measurement usually equivalent to two footsteps or 5.5 feet).

#### (2) *Shijra/Kishatvar/Paarcha/Latha*:

It is a piece of cloth on which map of the village is carved and all the *Khasra* numbers of village are printed on it.

#### (3) **Measurement of land:**

Whenever boundary of a particular field gets erased and length and breadth of it is not known to the owner and the owner intends to get it measured, then Patwari/Kanugo marks the length and breadth of that *Khasra* number with the help of *Shijra* and *Zareeb*. Demarcating the area on all four sides of field is called measurement.

**(4) Murababandi:**

Consolidation of scattered pieces of land as one unit at one place is called *Murababandi/Chakbandi*. *Murababandi* was started during fifties. According to Punjab Consolidation Act, land was divided into 25-25 acres of land pieces. A piece of 25 acres of land is called *Muraba* or *Musteel*. With the help of *Murababandi*, every work related to land becomes easier.

**(5) Goshwara:**

Sum total of all cultivated crops presented in tabular form is called *Goshwara*.

**(6) Registry:**

When a piece of land, house, shop, etc. is sold or mortgaged by one person to another on a fixed price, an agreement is entered with photos with mutual consent of both parties in the Register maintained in the office of Tehsildar is called Registry or registered agreement. There are different types of registries like Registry Bhai, *Rehan*, share, transfer of ownership etc.

**(7) Intkaal:**

Transfer of ownership rights from one person to another is called *Intkaal*. There are 12 columns of an *Intkaal*. *Intkaal* is of different types like Bhai, *Rehan*, hereditary, transfer of ownership, share, exchange (*tabadala*), division (*Takseem*), etc. *Patwari* enters the *Intkaal* and *Kanugo* checks its contents as per record. After that, Tehsildar summons both the parties at a designated place and time and approve the *Intkaal* on the verification of the *Nambardhar* in the presence of both the parties.

**(8) Jammabandi:**

*Jammabandi* or *Fard* is one of the important documents of Punjab Revenue Act regarding ownership of land. The ownership of land is continuously changing like transacting a part of land on Bhai, *Rehan*, transfer, hereditary, unirrigated to irrigated, change from rental to crop share basis (*mamla* to *bhatai*), change of cultivators etc. Entering of these changes in record is essential. Earlier, *Jammabandi* was carried out after a span of four years, but now *Jammabandi* of every village is renewed after a span of five years. The changes made during the preceding five years are entered in the record of *Jammabandi/Fard* which consists of 1-12 columns in which particulars of *Khevet number*, *Khatauni*, name of village *Pati* or *Thuley* and name of owner



according to his or her share, existing cultivator and source of irrigation etc. are kept. This document is called *Jammabandi*.

**(9) Division of land (*Zameen dee Takseem*):**

When the number of shareholders of a particular piece of land increases, then division of land as per the consent of share holders is called division of land. After division of land, every shareholder becomes owner of his or her share. Now one can sell or mortgage one's land. One can also take loan from banks, transfer any number of his or her share and can have a separate turn for canal water supply. One can also take his or her own electric connection. It facilitates the shareholder to take independent decision about his/her land share such as sell or mortgage, taking loan from banks, separate turn for canal water supply, own electric connection etc.

**(10) *Girdawary and Darusti Girdawary*:**

*Girdawary* is also called *Gardauri*. It is a type of survey of land and cultivated crops. *Girdawary* is done twice a year during the month of March for *Rabi* crops and October for *kharif* crops. In addition, *Girdawary* is also done twice a year in the months of May and December for the crops falling between *Rabi and Kharif* seasons.

**(11) Rectification of *Girdawary* :**

Corrections in the *Girdawary* can be made with consent and signatures of both the parties by the Patwari. In case of dispute, then it can be got rectified or corrected in the Court of Tehsildar.

**(12) *Theka or Chakota*:**

Land given by the owner to another person for cultivation on rent for fixed amount and time period is called *Theka* or *Chakota*. The time period may be one year or two years or five years, etc.

**(13) *Rehan (Mortgage)*:**

When an owner of the land gives temporarily a piece of his land to another person for cultivation for mutually agreed amount and fixed time, it is called mortgage of land. The land will remain with the person who leases in the land till its original owner returns the whole amount.

#### **(14) Loss (*Khraba*):**

Destruction of crops on large scale due to any natural calamities, e.g. excessive rains, drought or the attack of insects/pests *etc.* is called loss (*Khraba*). Although different government departments have their own yardsticks for assessing the crop losses but destruction of crops in the area is assessed assuming 100% production of crop in the area.

#### **(15) Computerization of land record:**

These days, land record is being provided through computerization and *Jamabandi* and *Intkaal* can be checked by sitting at home. The certified copies of *Jamabandi* and *Intkaal* can be obtained personally from the nearby office of Sub-Tehsildar/Tehsildar by paying the requisite fee. Land record is also available on the website: [www.plrs.org.in](http://www.plrs.org.in)

#### ***Scales of Measurement of Land:***

1 foot	= 12 inch
1 yard	= 3 feet
1 furlong	= 220 yards
1 mile	= 1760 yards or 8 furlongs
1 karm	= 66 inch (5½ feet)
1 square karm	= 1 Sarsahi
1 marla	= 9 sarsahian or 272 sq. feet or 30 sq.yard
1 kanal	= 20 marlas
1 Acre	= 8 kanals or 160 marlas or 220 x 198 sq.ft or 36 x 40 karm or 96 bisweys or 4000 sq.metre
1 hectare	= 2.5 acres or 10,000 sq.metre
1 biswa	= 50 sq.ft
1 Muraba/1 Musteel	= 25 acres

## Exercise

### a. Answer in one or two words

1. How the land was measured in ancient time?
2. Which Emperor is called the founder of land reforms?
3. How many acres are there in one hectare?
4. How many marlas make one kanal?
5. In which states of India, Murababandi has been done in a systematic way?
6. In which decade, Murababandi was started?
7. Which site is to be seen for *Jammabandi*?
8. How many acres are there in a *Muraba* according to *Murababandi* Act?
9. At what time, Girdawary of *Rabi* crops is prepared?
10. After how many years, new *Jammabandi* is carried out?

### b. Answers in one or two sentences:

1. Who corrects the *Girdawary* of a disputed land?
2. What is *Jammabandi*?
3. What is *Intkaal*?
4. What instruments are required for measurement of land?
5. What is *Goshwara*?
6. What is Rehan or Mortgage?
7. What is Khraba/loss of crops, how it is assessed?
8. What is Shijra and what are its other names?
9. What is *Murababandi* and what are its benefits?
10. What is *Zareeb*?

**c. Answers in 5 to 6 sentences:**

1. What is *Girdawary* and at what time it is done?
2. Why division of land is essential and how it is done?
3. What is computerization of land record?
4. What is *Theka* or *Chakota* or renting in or renting out of land?
5. Write a brief note on land registry.

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## Chapter-4

# SOLAR ENERGY

Energy is a major constraint in achieving high production and productivity. The stage of development of a country depends upon its energy utilization. The sources of energy present in the whole universe are classified into two categories :-

- (1) Non-renewable sources (such as oil, coal, electricity, etc.) which are very costly and limited in nature. These are depleting very fast.
- (2) Renewable energy sources (such as biogas, solar energy, producer gas, wind energy, chemical energy, tidal power, geothermal power, animal and human energy etc.) which are very cheap and unlimited in nature. These energy sources are easily available everywhere as far as life exists in this universe.

### Importance of solar energy

Solar energy is a renewable source of energy. Solar energy is very important because it is a very large source of energy. It is very clean source and available in wide area. Solar energy may be used directly as thermal energy, or can be converted into electricity through photo voltaic cells.

- (1) The thermal route uses the heat for water heating, cooking, drying, water purification, power generation and such other applications.
- (2) The photovoltaic route converts the light in solar energy into electricity which can then be used for a number of purposes such as lighting, pumping, communication and power generation.

### 2. Solar apparatus or equipments

The description of different solar gadgets is given as follows:

#### (1) Solar dryers

Solar dryer is required for drying crops, vegetables and fruits. While drying these products in the direct sunlight, the birds, insecticides and dust will spoil these products. The colour of the vegetables and fruits also changes and nutritious ingredients also get spoiled when dried in open sunshine.



Solar dryer is made up of hot (wooden) box. On one side of the dryer, an insulated door is provided for loading and unloading the perforated trays. For air flow, holes are provided on the bottom and in the back side near the top of the dryer. The interior of the dryer is painted with dull black paint for absorption of solar radiation. A transparent window glass sheet is fixed as glazing on the front of the hot box for solar energy interception. The hot box is supported on the base frame mounted on castor wheels for easy mobility of dryer. The perforated trays are arranged at different levels, one above the other inside the hot box. The product to be dried is placed in these perforated trays.

Solar dryers are of two types:

**(i) Domestic solar dryer**

Domestic solar dryer is small sized natural circulation solar dryer. Most of the products that are used in powder form in domestic kitchen, e.g. chillies, garlic, ginger, mango powder, coriander, onion, fenugreek leaves etc. are dried in this dryer. It is capable of drying about 2-3 kg of fresh product in 2-3 days. Its photograph is shown in Figure 4.1.



**Figure 4.1**  
**Domestic Solar Dryer**

**(ii) Multi product solar dryer**

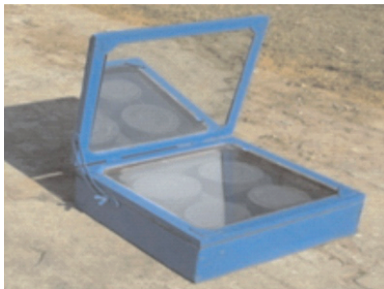
For drying agricultural products, drying air temperature should be below its maximum allowable temperature because temperature above this causes quality deterioration of dried product. In multi product solar dryer, drying air temperature is maintained below maximum permissible temperature limit of drying product. This solar dryer has capacity to dry 20-30 kg of agricultural products per day. The photograph of this solar dryer is shown in Figure 4.2



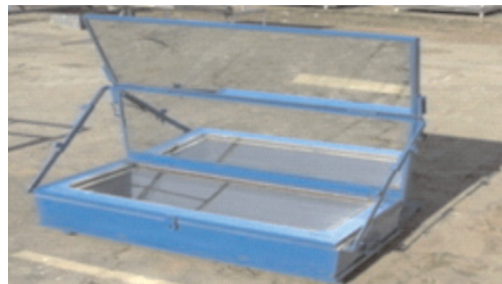
**Figure 4.2**  
**Multi product solar dryer**

## (2) Solar cooker

Solar energy is one such source which can save 20% to 50% conventional fuels used for cooking. A solar cooker is a device in which cooking of the food is done by using solar energy. Solar energy is collected in the form of heat by using reflectors / lenses or insulated boxes and the heat thus collected is used for cooking. A solar cooker consists of an insulated box with a transparent window through which sunshine enters the box. With the use of these reflectors, it becomes necessary to make a few adjustments of the cooker towards the sun. *Chapaatti* making and frying cannot be done in the solar cookers. The different types of solar cookers have been shown in Figures 4.3 and 4.4.



**Figure 4.3 Box type solar cooker**



**Figure 4.4 Double reflector solar cooker**

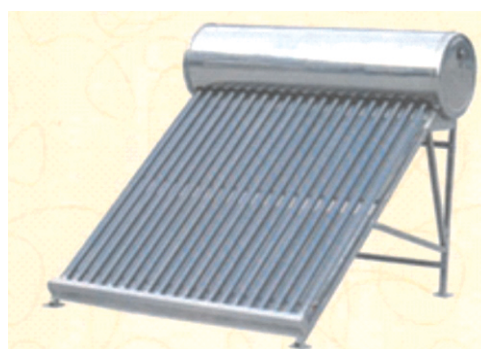
### Method of cooking in solar cookers:

- (i) Setup the solar cooker in the sun so that it starts getting pre-heated before the ingredients of the food stuffs are placed in it.
- (ii) Put the ingredients of the food in the containers and add just sufficient quantity of water (if water is required e.g. for rice, lentils etc.) along with required quantity of salt, peppers, spices, etc. as per recipe.
- (iii) Vegetables, eggs, potatoes etc. do not require water in solar cookers. Large pieces of vegetables and potatoes be cut into smaller pieces before placing these in solar cooker.

- (iv) The food ingredients along with water should preferably fill about half or less the depth of the containers.
- (v) Lift the double glass cover to open hot box. Clean it from inside and place the food containers in it. Now close the double glass cover fully.
- (vi) Adjust the cooker towards the sun.
- (vii) Do not open lid of the hot box too frequently.

### (3) **Solar water heater**

One of the popular devices that harness the solar energy is solar water heating system for heating water. Where heat energy needed at relatively low temperatures i.e. less than  $100^{\circ}\text{C}$ , solar water heaters are used for heating water. Solar water heater is a device which absorbs solar energy and converts it into heat energy. Solar water heater is also called a solar collector.



**Figure 4.5 Solar water heater**

A typical solar water heater is shown in Figure 4.5. The tubes of the collector are joined to header of the bottom and the top. Insulated storage tank is mounted such that its bottom is at least 60-70 cm above the top of the collector. The tube and fin assembly is insulated at the back and the sides and its front is covered with a glass sheet. When the sun rays fall on the tube and fin assembly, water gets heated and moves to the upper part of the storage tank by natural convection and relatively heavier cold water from the bottom of the storage tank flows to the bottom header of the collector.

### (4) **Solar lantern:**

This is an emergency light charged with sunlight and works for 3 to 4 hours. It has been shown in Figure 4.6.



**Figure 4.6 Solar lantern**

**(5) Solar home lighting system**

In this system, the inverter is charged with solar light which can operate two lights and two fans for 5 to 6 hours. It has been shown in Figure 4.7.



**Figure 4.7 Solar home lighting system**

**(6) Solar street light**

In this system, the battery is charged with solar light which operates solar light after sunset. These lights can be installed in the streets and on the road sides and are operated automatically when the sunsets. It has been shown in Figure 4.8.



**Figure 4.8 Solar street light**

**(7) Solar water pump**

This system consists of motor which operates during the day time with solar panel for water pumping. It pumps water from water level up to 35 to 40 feet. It has been shown in Fig. 4.9



**Figure 4.9 Solar water pump**

## Exercise

### A. Answer in 1 to 2 words:

1. What is the major benefit of solar water heater?
2. Give two examples of renewable sources of energy.
3. Give two examples of non-renewable sources of energy.
4. How many types of solar dryers are there?
5. Name any two vegetables which are dried in the solar dryer.
6. What is the capacity of multiple solar dryer for drying agricultural product?
7. What is the major benefit of solar cooker?
8. What percentage of conventional fuel can be saved by the use of solar cooker?
9. For how many hours solar lantern can be used?
10. How many types of solar cooker are there?

### B. Answer in 1 to 2 sentences:

1. How many types of natural energy sources are there? Give examples.
2. Name the products which are dried with solar dryer.
3. What is meant by solar cooker?
4. Briefly discuss solar street light.
5. What are the points kept in mind when the cooking is done in solar cooker?
6. Briefly discuss the solar home lighting system.
7. What is solar water pump?
8. Briefly discuss solar lantern.
9. Briefly explain the working of domestic solar dryer.
10. Briefly discuss the multi product solar dryer.



**C. Answer in 5 to 6 sentences.**

1. Explain the method of cooking in solar cooker.
2. Explain the solar water heater in details.
3. Explain the solar dryer in details.
4. Briefly discuss the different gadgets of solar energy.
5. How the solar energy can be used in different ways?

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## Chapter-5

# MUSHROOM CULTIVATION

Mushrooms are used as a health food product all over the world. In Punjab there is huge potential for production of mushrooms and the primary reason is the easy availability of raw materials and appropriate environmental conditions (season) for the cultivation of mushrooms. There are about 400 mushroom growers in various parts of Punjab and the production of mushrooms in the State is about 45,000 – 48,000 tones per annum.

Mushrooms are used as food because they possess nutritional attributes required for good health. They are rich in proteins which mainly consist of digestible proteins. In addition, they contain minerals such as calcium, phosphorus, iron, potassium, etc. in ample amounts. Mushrooms contain low amounts of fats and carbohydrates and are hence good for consumption by patients suffering from blood pressure and diabetes.

### Commonly cultivated mushrooms

Punjab has suitable environmental conditions for the production of five different varieties of mushrooms including, Button mushroom (Fig 5.1), Oyster mushroom, Shiitake mushroom, Chinese mushroom and Milky mushroom. In winter two crops of button mushroom (September – March), three crops of oyster (October – March), and one crop of Shiitake (September – March) can be taken. In summer, one can have up to 4 crops of paddy straw mushroom (April – August) and 3 crops of milky mushroom (April – October). The production of winter mushrooms is started in mid-September. The most widely grown and commercially produced mushroom is button mushroom. The cultivation of button mushroom is done as follow:-

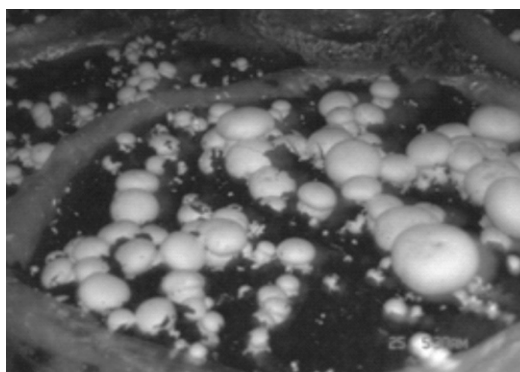


Figure 5.1 Button Mushroom

**a) Compost formulation:**

Ingredients	Quantity (kg)
Wheat straw ( <i>Turi</i> )	300
Wheat bran ( <i>Choker</i> )	15
Calcium ammonium nitrate (CAN)	9
Urea	3
Superphosphate ( $P_2O_5$ , 16 17%)	3
Muriate of potash or potassium sulphate (MOP)	3
Molasses	5
Gypsum	30
Gamma BHC (20% E.C.)	60 ml
Furadan (3G)	0.15

**b) Stack preparation:**

Wheat straw is spread on a “pucca” floor and wetted thoroughly with clean water for up to 48 hours. Side by side, wheat bran/husk powder is mixed with fertilizers (CAN, urea, superphosphate and M o P) and moistened with water. The bran-fertilizers mixture is then broadcasted on the wet wheat straw and mixed with it using pitchforks. Thereafter, a stack (pile) of 5’x5’x5’ is prepared with the help of 3 wooden boards. The boards should be removed from the sides of stack as soon as it is ready.

**c) Turning of stack:**

Proper turning of the stack is important so that microbial activity during decomposition is maximum. To achieve this, turnings of the stack are done, which means outer portions of the stack are exchanged with inner portions. In all, 7 turnings are given to get a final grade compost. In all 7 turnings are given. First turning on 4th day when 5 kg molasses are added in the form of its solution in 20 liters of water, second turning on 8th day, third turning on 12th day when 30 kg gypsum is mixed by sprinkling the powder on dismantled stack and mixing it before restacking. The 4<sup>th</sup> to 7<sup>th</sup> turnings are given at intervals of 3 days each. Furadan is added at the 5<sup>th</sup> and

Lindane at the 7<sup>th</sup> turn. Compost prepared from 300 kg straw is sufficient for 20-25 boxes of 0.25 sq. m each. The final grade compost is checked for quality parameters. The ready compost should be dark brown in colour with no ammonical smell. At the time of spawning it should contain 65-72% moisture and pH of 7-8.

#### **d) Spawning:**

After cooling the compost and checking for quality parameters, spawning is carried out. For one sq. meter space, 300 g of spawn is used. Thus for the 3 quintals of wheat straw, 3 kg of spawn is required. Spawn can be procured from Department of Microbiology, PAU, Ludhiana. Generally, the two layered spawning technique is used. For this method, the containers (trays) are filled up to about 3" depth and spawned with 1/3rd of the required quantity of spawn. Then more compost is added to bring it to the level of about 6" depth and the remaining 2/3rd quantity of spawn is evenly distributed on the surface and slightly pressed in. The spawned surface is covered with newspaper sheets. The bags/trays are arranged in tiers in the growing rooms and watered with sprayers regularly to keep these sheets moist. The trays/boxes show initiation of spawn run after 2-3 days of spawning. It takes about 2 weeks for the trays to show 80-100% coverage with white mycelial growth.

#### **e) Casing:**

At this stage the newspaper sheets are removed and spawn run surface of compost is covered with 1 to 1.5" thick uniform layer of casing soil consisting of a mixture of well rotten FYM and sand. This is disinfected with 4-5% formalin solution for 48 hours before using the casing mixture.

#### **f) Disinfection of casing mixture:**

The casing soil mixture is disinfected by using 4-5% solution of formaldehyde (formalin). In addition, 20g Furadan per quintal of casing soil may be added to check any possible outbreak of nematodes. The treated soil is heaped and covered with a tarpaulin sheet or polythene sheet for at least 48 hours. Thereafter, it is opened and turned again and again to free it from fumes of formaldehyde.

#### **g) Procedure for casing:**

After 2-3 weeks of spawning, remove the newspaper sheets and spawn run surface of compost is covered with 1 to 1.5" thick uniform layer of disinfected casing soil.

#### **h) Arrangement of boxes:**

For obtaining high yields of button mushroom and for optimal use of the space of the room, the boxes are arranged one on top of the other. The distance between adjacent row of boxes is kept at 2-2.5 feet and the vertical space between boxes stacked on top of other is one foot.

#### **i) Appearance of Crop:**

After 2-3 weeks of casing, mushrooms will start appearing in the form of small pin heads which develop into button mushrooms ready for harvest in 2-3 days.

#### **j) Yield of mushrooms:**

A yield of 8-12 kg of fresh mushrooms can be harvested from one sq. meter bed area. As per the calculations based on input raw material costs, the cost of production for button mushroom is about Rs. 33.14 and for oyster mushroom (dhingri) it is about Rs. 31.84.

#### **Control of insect pests of mushrooms**

To prevent mushroom flies in the growing rooms, spray the room with 30 ml Dichlorovos per 100 m<sup>3</sup>. After spraying, the doors and windows of the room are closed for about 2 hours. The spraying should not be done directly on the growing mushrooms and do not harvest mushrooms for up to 48 hours after spraying.

#### **Marketing of mushrooms**

Mushrooms should be harvested once a day before the buttons open up. During the process of harvesting, mushrooms are picked by holding the ready to harvest mushrooms by the cap and gently twisting in a clock-wise direction. The mushrooms should not be picked by pulling them directly as this results in damage to the smaller growing mushrooms. The lower end of the harvested mushrooms are trimmed using a knife and packed in poly bags. Each bag contains 200 g of fresh mushrooms and are sold in the local market. The oyster mushroom can also be dried in the sun and dried oyster mushroom can be sold.

## Exercise

### A) Answer in one to two words:

1. Name two important commercially grown mushrooms.
2. Name the health benefits of mushrooms.
3. How many crops of button mushroom can be obtained in the winter season in Punjab?
4. What is the maximum height of the compost stack during compost preparation for button mushroom?
5. What is the ratio of farm yard manure and sandy soil for preparation of casing soil?
6. Which insecticide is used for control of insect pests of mushrooms?
7. What is the gap period between spray of insecticide for control of flies and next harvest of mushrooms?
8. What is the amount of spawn required for 3 quintals of straw?
9. What is the total mushroom production in Punjab presently?
10. How many turnings are given during preparation of compost?
11. What is the pH of good quality ready compost?

### B) Answer in one to two sentences:

1. What are the important nutritional attributes of mushrooms?
2. What are the requirements for growing mushrooms?
3. Why is it important to turn the compost stack during compost preparation?
4. How is the compost prepared for mushroom growing treated?
5. What is the significance of casing? How is casing soil prepared?
6. What are the recommended varieties of mushrooms for cultivation in Punjab and give their technical names?
7. Give the turning schedule for preparation of compost and the details of what all is required for compost production.



8. How is casing soil mixture disinfected before use?
9. What are the quality attributes of well prepared compost?
10. What is the production of mushrooms from one square meter bed area?

**C) Answer in 5 to 6 sentences:**

1. What is the importance of mushrooms in our diet?
2. Give the procedure for preparation of stack for composting in button mushroom?
3. What do you know about the marketing of mushroom?
4. What is mushroom spawn? How is spawning done in trays for button mushroom?
5. What are the different steps in button mushroom production and briefly discuss each one?

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## Chapter-6

# BEEKEEPING

Beekeeping is an important agriculture based subsidiary occupation. It can be adopted as subsidiary or main occupation by farmers, ladies, students, unemployed youth. There is no requirement of land for starting beekeeping. Investment of money is also relatively low.

Beekeeping can be practiced as stationary or migratory, however, migratory beekeeping is more profitable. Average honey production by Italian honey bees under stationary beekeeping is 20 kg per colony per year whereas it is 60 kg honey per colony per year under migratory beekeeping. Apart from honey, beeswax, propolis, pollen, bee venom and royal jelly are other hive products. Beekeeping income can further be increased by rearing and selling queen bees and surplus honey bees. Honey bees increase crop yield and improve crop produce quality by pollinating our field, fruit and vegetable crops.

Earlier, beekeeping in India was practiced by rearing Indian honey bee *Apis cerana*. But it was mainly confined to hilly and southern states of India. Punjab Agricultural University, Ludhiana successfully introduced Italian honey bees in India during 1962-64 at Nagrota Bagwan and in 1965 at PAU Ludhiana. Colonies of this bee were given to Punjab farmers in 1976 and later on to other states of India. Beekeeping with Italian honey bees developed quickly and established Punjab as leader in honey production and export.

## BODY STRUCTURE OF HONEY BEES

Body of honey bee is broadly divided into three parts namely head, thorax and abdomen. Head bears a pair of compound eyes, a pair of antennae and mouthparts. Thorax bears two pairs of wings and three pairs of legs. Female bees (queen and worker bees) have sting at the tip of abdomen and male bees lack sting. Queen bee generally uses its sting only against rival queen bees.

## SPECIES OF HONEY BEES

There are four major honey bee species in India. Out of these, *Apis dorsata* (rock bee) and *Apis florea* (little bee) are wild species whereas *Apis cerana* (Indian bee) and *Apis mellifera* (European bee/Italian bee) are hive bees. *Apis dorsata* constructs single, very large comb on projections of water tanks, buildings, rocks and thick branches of trees. This bee species is very aggressive. *Apis florea* is smaller than other three species and constructs single small (Palm size) comb in bushes, stacked sticks or thin twigs of trees.

Italian and Indian honey bees are reared in hives. In nature, they construct several parallel combs in cavities in trees or walls etc. In Punjab, only Italian bees are being reared.

## CASTES OF HONEY BEES

There are three castes of honey bees in a colony. Every colony has one queen bee, a few drones (male bees) and thousands of worker bees (Fig 6.1). Compound eyes of worker bees are small and do not meet at top of their head. Their abdomen is conical. Compound eyes of drones are very large and unite at top of their head. Their abdominal tip is roundish and hairy. Abdomen of queen bee is very long and tapering and does not have stripes. Wings of queen bee does not cover their abdomen completely (Fig



Figure 6.1 Castes of the Honey Bee

## LIFE CYCLE OF HONEY BEES

Life cycle of honey bees is completed through four developmental stages, namely egg, larva, pupa and adult. Life cycle of drone, worker and queen bee is completed in 24, 21 and 16 days respectively.

## Colony Organisation and Division of Labour

Every colony of honey bees has a queen bee which is the mother of all bees in the colony. Queen bee can survive for 2-4 years, queen should be replaced every year for getting higher honey production. New queen bee is golden brown and has long firm abdomen, whereas old queen bee has dark brown or black abdomen and is sluggish in movements. Queen plays role of laying eggs and maintaining cohesion of the colony. A queen bee can lay up to 2000 eggs in a day. Fertilized eggs produce worker bees and unfertilized eggs produce drone bees.

A honey bee colony may have 8,000-80,000 bees. As the name indicated, almost all the hive duties are performed by worker bees. Their average life is 6 weeks. During the first three weeks of their life, workers perform the duty of cleaning the hive, feeding young ones and queen, helping in storage of nectar and pollen in combs, construction of new combs, temperature regulation and guarding the hive. During the next three weeks worker bees forage out of hive to collect nectar, pollen, propolis and water.

A few hundred drone bees are produced by strong colonies only during the breeding season. They do not collect nectar and pollen. They fertilize newly produced queen bees by mating in the air outside the hive.

## STARTING BEEKEEPING

**Equipment required:** For starting beekeeping, hive, honey bee, hive tool, bee veil, smoker and comb foundations are needed (Fig 6.2). Honey extractor may be hired from other beekeepers as and when required.



Bee Hive



Honey Extractor



Hive Tool

**Bee flora:** *Toria*, *sarson*, *gobhi sarson*, *eucalyptus*, *berseem*, pear, sunflower, *sheesham* and arhar are very good source of nectar and pollen to honey bees in the

Punjab. Apart from these, litchi, *ber*, *khair*, acacia, sesame and cucurbits also provide nectar and pollen to bees.

**Suitable season to start:** February-March and November are suitable for starting beekeeping in Punjab.

**Selection of site:** Site for apiary (place where honey bee colonies are placed) should have availability of bee flora for most part of the year and provision for shade and water. It should be away from highway or railway tracks but easily approachable. It should not be a low lying area.

**Purchase of colonies:** Preferably start new colony with eight bee frames for higher productivity. Purchase new colonies having young mated queen bee, open and sealed brood, pollen and honey but with minimum drone brood and drone bees population.

**Transportation of colonies:** Colonies should be shifted only during late night or early morning by closing the gates of the hives. Place these colonies at the selected site with hive to hive distance of 6-8 feet and row to row distance of 10 feet.

### **SEASONAL MANAGEMENT OF HONEY BEE COLONIES**

**Spring season management:** This is the best season for honey production and multiplication of honey bee colonies. Provide space to the colonies by providing combs or comb foundations. If the chamber is full to its capacity, provide super chamber with combs on the top of the full hive chamber. If space is not provided bees may swarm. Swarming is a condition in which almost half of the bees leave the hive along with the older queen bee. To prevent this loss, provide combs, clip half of the one side wings of queen bee and destroy queen cells after examining at weekly interval. Ripe honey from mustard and eucalyptus may be extracted.

**Summer season management:** To protect bees from heat, shift colonies to thick shade by daily moving the hives 2-3 feet towards shade. Improve ventilation of hives and provide source of water in the apiary. Extract sunflower and berseem honey.

**Monsoon season management:** Cotton and khair are the important bee flora in this season. In most of the areas there is feed scarcity period. So provide honey bee colonies with sugar water solution (in 1:1 ratio) filled in feeder, empty com, tin etc. Unite weak and queenless colonies. Prevent robbing of honey by strong colonies

from weaker colonies. Wax moth, wasps and ants attack honey bee colonies during this season, so keep a check on these bee enemies.

### **Winter season management:**

To protect bees from low temperature, shift honey bee colonies to sunshine by daily moving the hives 2-3 feet. Remove extra combs from the hives and provide winter packing. Wrap paddy straw in polythene or newspaper sheet and provide it as winter packing in the empty space within the hive. In case of scarcity of feed, provide sugar water solution (2:1 ratio, prepared by mixing sugar double in quantity than water) by filling in empty combs.

### **HONEY EXTRACTION**

Never extract honey from combs having brood also. Do not extract unripe honey, as its shelf life is low. Honey bees seal ripe honey with a layer of wax. Select such ripe honey combs. Remove bees from these combs by shaking and with the help of bee brush. Take these combs to a room or large mosquito net. Remove wax layer (honey cell capping) from honey combs with the help of uncapping knife. Extract honey by rotating these combs in honey extractor. After extracting honey, empty combs should be given back to the colonies. Remove wax and floating impurities from the extracted honey and filter it through double layer of muslin. Store honey in steel or food grade plastic containers.

### **WAX EXTRACTION**

Capping removed from honey combs, very old, broken or damaged combs or wild bee combs may be put in hot water and filtered through thick cloth. Larger impurities remaining on the top of the cloth are discarded. Filtrate containing water and molten wax should be allowed to settle overnight. Wax being lighter in weight than water, will come to the surface and harden. Remove this wax cake the next morning.

### **MARKETING OF HONEY**

Honey in Punjab is being procured by honey traders and exporters. Several Self Help Groups (SHGs) are also actively involved in honey marketing. In retail market, bottling of honey in attractive bottle with proper label will increase profitability from honey trading (Fig 6.3).





Figure 6.3 Bottled Honey

## GOVERNMENT SUPPORT

For further development of beekeeping, Government is providing subsidy on bee hives and honey bee colonies through National Horticulture Mission. Subsidy on honey extractor, drip tray, uncapping knife, food grade plastic containers for honey storage is also being provided by the Government.

## TRAINING

Practical training on beekeeping may be obtained from Punjab Agricultural University Ludhiana, Krishi Vigyan Kendras or Department of Agriculture. More information on beekeeping may be obtained from PAU publication '*Italian madhu makhian di sambh sambhal*' (Management of Italian honey bees) in Punjabi.

## Exercise

### A. Answer in one to two words

1. Name two hive bee species.
2. How many legs a honey bee has?
3. Name two wild species of honey bees.
4. Which is the most suitable period to start beekeeping in Punjab?
5. By what other name are made honey bees known?

6. Do you have to pay fee for getting beekeeping training?
7. How many bee frames should be used to start a new colony for higher profit?
8. What material is used by honey bees to seal ripe honey?
9. After how much period, queen bee in a colony should be replaced?
10. Are the worker bees male or female?

**B. Answer in one to two sentences:**

1. Where do rock bees construct their comb?
2. How will you differentiate new and old queen bee?
3. From where training on beekeeping may be obtained?
4. How will you shift honey bee colonies to shady place during summer season?
5. What should be hive to hive and row to row distance of colonies in an apiary?
6. What hive products other than honey can be obtained from honey bee colonies?
7. Why should not unripe honey be extracted?
8. How can honey be filtered?
9. What are the equipments required for starting beekeeping?
10. Write a note on honey marketing.

**C. Answer in five to six sentences:**

1. What care should be taken while purchasing honey bee colonies?
2. Explain the process of honey extraction.
3. How can bees wax be extracted?
4. What are the subsidy facilities being provided by the Government in Punjab for honey production?
5. Explain importance of beekeeping.

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## Chapter-7

# CROP DIVERSIFICATION

Rice and wheat are the prominent crops in Punjab state as these cover about 28.3 and 35.1 lakh hectare area, respectively. During the last five decades there is incredible shift in area from groundnut, oilseeds, sugarcane and pulses to paddy. Rice-wheat cropping system requires approximately 215 cm of irrigation water during a year, out of which 80 % of irrigation water is consumed by rice crop. Rice crop cultivation has exploited the soil health in Punjab. Crop diversification refers to growing alternate crops by reducing some area under rice- wheat with other crops such as potato, maize, basmati rice, pulses, oilseed crops, sugarcane and fodder etc. The crop diversification has become an important option to achieve several objectives viz. natural resource sustainability, ecological balance, enhancing farmer income, buffer stocks, employment generation, risk coverage, etc. There are various initiatives taken by Government of Punjab for agricultural diversification and some projects are also in pipeline and forwarded to Central Government for the farmers welfare and agricultural diversification. Research projects are being carried out in Punjab Agricultural University, Ludhiana to develop relevant, more profitable and eco-friendly cropping systems.

### Agro-climatic zones of Punjab

In Punjab, the total area under cultivation is about 41.58 lakh hectare. Punjab has been divided into 3 agro-climatic zones i.e. sub-mountainous zone, Central Zone and South-West Zone (Fig 7.1).

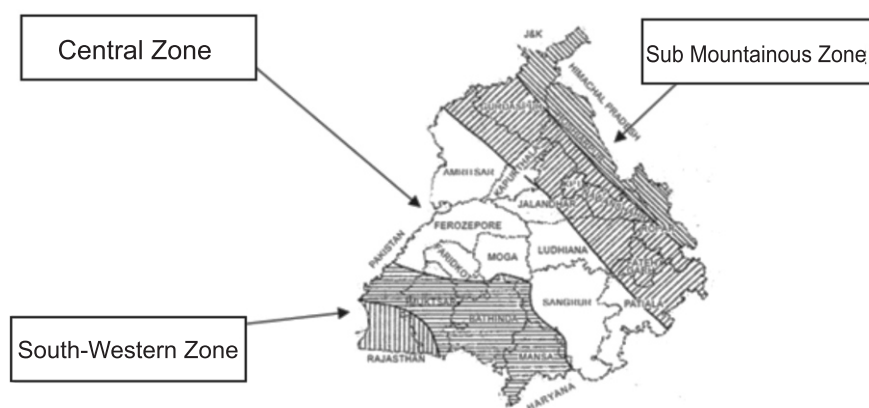


Figure 7.1 Different Agro-climatic zones of Punjab

**Undulating Mountain Zone:** It lies at the Himalayan foothills and it receives almost double rainfall in comparison to south-west Punjab, therefore; the problem of soil erosion persists in undulating mountain region. Most prevalent crops cultivated in this zone are wheat, maize, rice, potato and oilseeds. *Kandi* belts covers 9% of area under sub-mountainous region. Rainfed area is also included in this region.

**Central zone:** Rice-Wheat is the main cropping system in central Punjab. The underground water of this region is of good quality. Depleting water table is the major problem of this region and approximately 74 cm of water table depletes every year. Due to this problem farmers have to increase the bore depth every year. Most of the farmers have to opt for submersible pumps to meet the irrigation requirements of crops which in-turn increase the cost of production. The other crops grown in this area are maize, basmati, potato, peas, sugarcane, sunflower, chilies, etc.

**South-Western Zone:** Cotton-wheat cropping system is dominant in South-Western Zone of Punjab. In the area where rice can be cultivated, farmers prefer to cultivate rice over cotton. The groundwater of this region is mostly saline or saline sodic. During *Rabi* season some farmers also cultivate oilseed crops.

In Punjab almost 98% of area is under irrigation. Punjab is having approximately 14 lakh tube wells. Canal irrigation is also adopted as an alternative to ground water. With the introduction of high yielding Rice-Wheat varieties, various problems have also emerged out such as nutrient mining, depleting water table, decrease in organic carbon content of soil, loss of biodiversity, emergence of new insect-pest and weeds, more use of pesticides and chemical fertilizers, increase in cost of crop production, decrease in profitability and climatic changes.

To solve the above said problems and to fulfill the food, pulses and oil requirement of increasing population of India, crop diversification can be adopted.

### **Intensive Cropping System**

It means that when farmer sow more than two crops in a year. It mainly aims to grow more than two crops in time between the harvesting of first crop and sowing of next crop. It can only be possible if the selected crops give more yield and have less crop duration.

### **Advantages of Intensive Cropping System:**

1. This system is helpful in attaining higher yields even from small land holdings.
2. It also helps in tackling climate change.
3. It is helpful in maintaining balanced nutrition.
4. It helps in conserving natural resources.
5. It helps in reducing the use of chemical fertilizers.
6. It helps in increasing employment opportunities.
7. It is helpful in maintaining agro- ecosystem.

In addition to this the cultivation of leguminous crops in cropping system also helps in increasing soil fertility through nitrogen fixation with the help of rhizobium bacterium.

### **Important multiple cropping pattern:**

**1. Green manuring based cropping system:** Green manuring is helpful in increasing successive crop yield and maintaining soil fertility. Hence, before cultivating *Kharif* crops i.e. basmati rice and maize, the green manuring must be done. Green manure crops such as dhaincha, cowpea, sesbania should be sown immediately after harvesting of wheat crop and incorporate it into the soil approximately after 6 weeks. In *Kharif* season, if basmati crop is to be transplanted then incorporation of green manure should be done one day before transplanting. Whereas in maize crop incorporation of green manure should be done 8-10 days before sowing. Besides, the strover of summer moong after picking the pods can also be incorporated within the soil as green manure.

**2. Maize based cropping system:** There are many maize based cropping systems which can be adopted such as maize-potato-summer moong bean/sunflower, maize-potato/toria-sunflower, maize-potato-onion/ mentha and maize-gobhi sarson-moong.

**3. Soybean based cropping system:** The rice yield decreases due to infestation of insect/ pest and several diseases. So, soybean can be the best alternative to rice crop. In this system soybean- wheat-cowpea cropping system can be adopted and

soil fertility can be maintained. In addition, to this small scale industries with soybean cultivation will enhance the employment opportunities for the rural youth of Punjab. Soybean contains 35-40% protein content. Soya milk, soya cheese, soya biscuit, soya nutri and other food items can also be prepared from soybean.

**4. Groundnut based cropping system:** In sandy soils groundnut based cropping systems can be adopted such as groundnut-potato/toria/wheat, groundnut-potato-bajra(fodder), groundnut-toria/gobhi sarson which will be helpful in saving irrigation water and enhancing farmers income.

**5. Fodder based cropping system:** Fodder crops have contributed a lot in bringing “White revolution” in Punjab. Higher milk yield can be attained from domestic animals (cows and buffaloes) if 40 kg green fodder is given to them as feed on daily basis. Keeping in view the importance of green fodder crops in Punjab, various cropping systems such as, maize-berseem- bajra, maize-berseem-maize/cowpea are recommended from which high fodder yield can be attained.

**6. Intercropping system:** Mixed cropping or intercropping is helpful in attaining a maximum yield from two or more crops at same time. It also helps in meeting the food requirement of our population and to enhance farm income. Some of the examples of mixed cropping are Maize + moong bean, Arhar + moong bean, soybean + moong bean, maize + soybean, maize + maize fodder + groundnut, cotton + maize, cowpea fodder/cotton + moong bean. By adopting intercropping systems, there is no effect on yield of main crop and more economic yield can be attained. These cropping systems are also helpful in maintaining soil fertility and in controlling the problem of weeds.

**7. Vegetable based cropping systems:** The farmers of villages which are near or far-by city can adopt vegetable based cropping system to enhance their income.

1. For farms which are away from city:
  - a) Potato-onion-green manure
  - b) Potato-late sown cauliflower-chilli
  - c) Potato-lady's finger-early sown cauliflower
  - d) Potato(seed)-radish/carrot(seed)-lady's finger(seed)



2. For farms which are near-by city:
  - a) Brinjal(long)- late sown cauliflower-bottle gourd
  - b) Cauliflower-tomato-lady's finger
  - c) Potato-melon
  - d) Spinach-knol khol-onion /green Chilli /radish

Beside the above said cropping systems the cultivation of vegetables can be taken as additional source of income for farmers. Hence, farmers should sow seeds which are recommended by Punjab Agricultural University which are disease resistant and cheap in comparison to other companies. Besides this, timely sowing, use of fertilizers, control of weeds, controlling insect-pest and diseases and harvesting of vegetables should be done at right time.

**8. Integrated Farming System:** In these days, with small land holding farmers are adopting integrated farming system to meet the nutritional food requirements of the family members and also to increase their income. In integrated farming system, beside cultivating crops the farmers can adopt one or two additional enterprises according to the available inputs to increase their income. These enterprises may be Dairy farming, Fish farming, Mushroom cultivation, Fruits, Vegetables, Rabbit farming, Pig farming, Goat farming, Bee keeping, Poultry farming and Agro-forestry.

## Exercise

### A. Answer in one to two words:

1. Which cropping system is adopted in sub-mountainous region?
2. Which is the main cropping system in south western region?
3. Give examples of multiple cropping systems.
4. How much water table is depleting every year in central Punjab due to cultivation of rice crop?
5. Which bacterium helps in nitrogen fixation?
6. Which fertilizer can be saved in Dhaincha-Basmati-wheat cropping system?

7. Which crops are imported by India from foreign countries?
8. How many days before basmati transplanting, green manure should be incorporated in the field?
9. What percentage of area is under irrigation in Punjab state?
10. How many tubewells (no.) are there in Punjab?

**B. Answer in one to two sentences:**

1. What do you mean by crop diversification?
2. Which crops can be grown in dry land areas?
3. Enlist maize based cropping systems.
4. Enlist fodder based cropping systems.
5. Write significance of intensive cropping system.
6. Which enterprises can be adopted in integrated farming system?
7. Write about source of irrigation in Punjab.
8. Name the alternate crops which can be cultivated in central Punjab over rice-wheat.
9. Write the names of main crops cultivated in sub-mountainous region.
10. Which cropping systems should be adopted in areas having light soils?

**C. Answer in five to six sentences:**

1. What do you mean by crop diversification? Write about its aim and significance?
2. Why there is need for crop intensification? Describe in detail with examples?
3. Write about the problems related to agriculture in Punjab.
4. What is integrated farming system? Describe in detail with examples?
5. What do you mean by inter cropping system? Describe with examples?

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## Chapter-8

# ORGANIC FARMING

Organic farming is a system of farming in which agricultural production is done without any use of chemical fertilizers, herbicides, fungicides and insecticides. It is achieved by maintaining a natural balance and sustainable use of natural resources (soil, air, water). It is based on the concept, 'Feed the soil not the plant' and stress is laid on increasing the soil fertility rather than supplying nutrition to the crop plants. But this does refers to the type of farming during pre-green revolution era. Now, we can use improved varieties, agricultural machinery, vermicompost, bio-fertilizers and bio-pesticides etc. which were not available in our traditional farming.

Some major advantages of organic farming include increased soil productivity, lower production cost, premium returns on organic produce, sustained agricultural production, employment generation, availability of pesticide residue free food and less environmental pollution.

### **Why organic farming:**

Green revolution no doubt increased the food grain production but it also led to some agricultural problems. Excessive use of chemical fertilizers and pesticides, less use of organic manures, burning of rice and wheat straw etc. led to deterioration of environment and soil health.

Green revolution promoted rice-wheat cropping system which resulted in decrease in area under traditional pulse and oilseed crops. Rice-wheat cropping system ignored two basic principles of agriculture i.e. rotation of deep rooted with shallow rooted crops and legumes with non-legumes. Excessive and un-timely use of nitrogenous fertilizers (urea) led to contamination of ground waters due to leaching of nitrates with rains and irrigation water. Use of un-recommended and un-timely pesticides at higher than the recommended doses resulted in appearance of pesticide residues in agricultural food products like milk, rice, wheat etc. Awareness about adverse effects of modern agriculture and increased demand for organic food products led to the development of organic farming.

There is a great demand of tea, basmati rice, spices, fruits, vegetables, pulses and cotton in the world organic food market. USA, Japan and European Union are the major organic food markets. Increased demand for organic food products also resulted in increase in area under organic farming in India. Presently in India about 47 lakh ha area is under organic farming out of which only 7 lakh ha is cultivated area and rest is the wild forest area. To promote organic farming, the government has established a National Centre for Organic Farming at Ghaziabad which has several regional centres. In north India this centre is situated at Panchkula, Haryana.

### **Organic standards:**

These are some minimum requirements for organic food production and the food produced as per these standards are called organic. India formulated organic standards in 2004 which have also been accepted by USA, Japan and European Union. These standards are not limited to production only but encompass processing, storage and transportation also. The ultimate aim of all these standards is to maintain the integrity of organic products till they reach the consumer. Some of the major standards for agriculture production are:

- Burning of crop residues is not allowed.
- Seed should be from the organic crop but if it is not available then untreated conventional seed may be used.
- There must be a legume crop in the cropping system to maintain soil health.
- Genetically modified crops like Bt varieties of crops are not allowed but Bt spray can be used for insect-pest management.
- There must be a natural or artificial buffer around organic farm to separate it from chemical farms.
- Use of all agro-chemicals is prohibited.
- Use of contaminated water e.g. sewage water is prohibited.

### **Organic production practices:**

Most of the inputs and production practices like seed, varieties and sowing methods are the same as that for conventional farming. The use of herbicides for weed control in organic crops is prohibited and weeds are to be managed by crop rotations

or manipulating other cultural practices. Intercropping of cowpea in maize rows and harvesting it for fodder at 35-40 days after sowing controls weeds in addition to supply of fodder for animals. Cowpea, being a legume, has no adverse effect on maize. In some crops like turmeric, weeds can be managed by rice straw mulching. Weeding can be done by hand, wheel hoe or with tractor.

Prohibition of chemical fertilizers necessitates the buildup of soil fertility which is achieved through inclusion of legume based cropping systems and incorporation of crop residues or their use as mulches or for making compost. Wherever possible legumes are used as intercrops and green manuring is done. To meet nutritional requirement of crops farmyard manure, vermicompost, compost, bio-fertilizers (Rhizobium, Azotobacter) and non-edible cakes like castor cake are used. The farmyard manure from commercial dairy farms is not allowed on organic farms. The crops are protected from insect-pests by using beneficial insects, birds, bio-pesticides (Bt, Trichogramma etc.), traps and locally available materials like extract of Neem etc. For disease management bio-fungicides like Trichoderma etc. can be used. Mixed cropping like wheat + gram also helps in managing insect-pests and diseases.

### **Organic certification:**

Certification is not the requirement of organic farming rather it is a requirement of organic food market. If we are producing organic products for home consumption or to sell these to known consumers, then certification may not be required. But if we are to sell these as organic product in the market or to export to other countries then certification is must. It guarantees to the consumer that the organic product has been produced as per the organic standards. Presently, twenty four certification agencies have been authorized to do organic certification in India. For certification, a farmer has to get his farm registered with any one of these agencies. Inspector of the agency inspects the farm and checks the compliance of organic standards by the farmer at his organic farm and only then produce of the farm is certified as organic. The produce of crop sown after two years from the date of registration of the farm with certification agency is certified as organic. More information regarding organic standards and certification can be obtained from the website of APEDA- [www.apeda.gov.in](http://www.apeda.gov.in)

### **Prospects of organic farming:**

Though organic farming is emerging as a good alternative to chemical farming

yet this is not a solution to all the agricultural related problems. Lower crop yields under organic farming and lack of marketing mechanism are its two major limitations. Increasing foodgrains demand for the burgeoning population is a big challenge to organic farming as we need about 276 million tonnes of foodgrains by 2020. So keeping in mind the foodgrains requirement, the degradation of natural resources, excessive use of agrochemicals and their ill effects on human health, it has become necessary that in 32% of the irrigated area of India, i.e. green revolution belt, we should adopt integrated crop production practices. In integrated production management, chemical and non-chemical methods of nutrition and pest management are combined. Organic farming in this belt should be done with only those crops in which there is no yield reduction under organic farming and organic premium and market is available. Organic farming can be promoted in 68% of rainfed area of India where fertilizer and pesticide use is very less and which are organic by default or are nearly organic. In these areas also, the emphasis should be on organic cultivation of non-food crops as it will not have any adverse effect on our national food security.

## Exercise

### A) Answer in 1 to 2 words:

1. According to organic farming concept should we feed the soil or plant?
2. Where is National Centre for Organic Farming situated?
3. Shallow rooted crops should be rotated with which type of crops?
4. Is burning of crop residues allowed or not in organic farming?
5. Can Bt crops be grown in organic farming?
6. Which types of crops are grown as inter crops in organic farming?
7. Name any one bio-fungicide.
8. Name any one bio-insecticide.
9. Name the website from where information on organic farming can be obtained.
10. In which year India formulated standards for organic farming?



**B) Answer in 1 to 2 sentences:**

1. Which type of crops should be rotated in field under organic farming?
2. What are the causes of increasing demand of organic products?
3. Which countries are the major markets for organic products?
4. Define organic farming.
5. Define organic standards.
6. Which areas in India are more suitable for organic farming?
7. Which organic products have higher demand in world food market?
8. Which countries have higher demand for organic products?
9. What are the organic standards for use of seed in organic farming?
10. How weeds can be managed in organic maize?

**C) Answer in 5 to 6 sentences:**

1. Why there is need to go in for organic farming?
2. How soil fertility is maintained under organic farming?
3. How insect-pests and diseases are controlled in organic farming?
4. What is organic certification and who does provide the certification?
5. What are the advantages of organic farming?

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## Chapter-9

### CARE AND MAINTENANCE OF FARM MACHINERY

These days, farming in Punjab is not possible without mechanization. After land cost, the next highest investment by farmers is farm machinery. Presently, Punjab is having farm machinery worth crores of rupees. If farmers do not properly maintain the farm machinery, they will not be able to efficiently utilize it when it is needed. With maintenance, farmers can increase the working life of the machinery and can reduce their expenses. If farmers want to get their machines in proper working condition during next crop season, they will have to keep their machinery carefully under some shed after use in the current season.

Basically, the farm machinery can be divided into three categories. First category is of prime movers (power source) comprising of tractors, engines, electric motors etc. Second category is tractor or engine operated equipments or implements like cultivators, disc harrows, seed-cum-fertilizer drills, happy seeders etc. Third group consists of self-propelled machines like combine harvesters, mechanical paddy transplanters etc. Maintenance of these machines is also different as per their type.

#### Maintenance of Tractor

Tractor has most important role in agriculture. It is head of farm machinery. If the head is healthy, then only it can take work from other members of the family. Every tractor company provides an operator manual with the tractor which contains all the information about its care and maintenance. Servicing of a tractor after 10, 50, 125, 250, 500 and 1000 hours is very important. The tractor should be got overhauled after using it for 4000 hours from a good workshop.



Figure 9.1: Tractor

After season, when we do not require tractor for long period, following points must be taken care of during long term storage or parking of a tractor:

1. Park the tractor under a shed after properly washing and cleaning it.
2. If there is any requirement of small repair or there is any oil leakage, get it repaired before storage. The lubrication oil level in the engine should be maintained up to the marked level.
3. All greasing points should be cleaned with diesel and should be re-filled with new grease.
4. Clean the battery with hot water and coat the battery terminals with petroleum jelly after properly cleaning them. If the tractor is to be stored for very long period, batteries should be removed from the tractor and occasionally charge the battery.
5. Generally, tractors are required for petty operations during off-season. To keep it ready for any work, farmers should start and operate the tractor for some time atleast once or twice a month. By doing so, various parts and seals of the tractor will get lubricated.
6. For long term storage, jack up the tractor and put it on wooden blocks to avoid load on tyres. We should also reduce the air pressure in tyres.
7. Always park the tractor in the neutral gear, in switched off position and apply parking brakes.
8. Cover the exhaust pipe and engine breather with some cloth to protect entry of moisture in it.
9. Occasionally clean the air cleaner.

### **Maintenance of Combine Harvester**

Like tractor, combine harvester is also an expensive machinery. Engine is the part of self-propelled combine harvester. So, while storing self propelled combine harvesters, all the points related with tractor should also be followed as applicable. In addition to this, the following points should also be kept in mind:

1. Grain tanks, conveyors, straw walkers and sieves should be properly cleaned and all the dirt, straw, chaff, grains etc. should be removed. Un-cleaned combine

can become home for rodents who can further damage electrical circuits, pipes etc. and can result in huge damage to the machinery.

2. Combine harvester is mainly made of sheet metal which gets rusted due to moisture. So it is very important to store combine harvester under shed. If shed is not available, cover the machine under a polythene sheet to protect it from moisture and dust. Paint all the parts where paint has taken off.
3. All repairs should be done and worn out parts should be replaced before storage because at that time we have knowledge that which part is to be replaced and which part is to be repaired. If it is not possible at that time, we should note down the information about the fault and the list of parts to be replaced/repared so that the repair could be done during free time.
4. Remove all the belts and store at safe place by putting identification mark on them. This will help in re-installation.
5. Chains should be properly cleaned with the diesel and a thin layer of grease should be applied over them.
6. Lubrication oil should be applied over the rubbing parts. Grease should be filled in the greasing points after properly cleaning them with diesel.



Self propelled combine harvester



Tractor mounted combine harvester

### **Maintenance of Farm Implements**

For maintenance of farm implements, keep following points in mind:

1. Follow points mentioned at Sr. No. 2 to 6 for maintenance of combine harvesters.

2. During season, after working for 4-6 hours, lubricate the axle bearings/bushes with oil or grease. If machine is fitted with ball bearings, lubricate them after 3-4 days with grease.
  3. Farmers should clean the grain and fertilizer boxes and metering mechanism of seed drills daily otherwise they will get corroded/damaged due to fertilizer. While storing for long period, apply a thin layer of lubricating oil after thoroughly cleaning the boxes. If seed or fertilizer is left, they will harm seed and fertilizer box and metering mechanism of the machine and the machine will not work properly when it is desired.
  4. Soil working tools of machines such as furrow openers of cultivators and seed drills, discs of disc harrow, blades of rotavator and straw chopper, blades of diggers and cutter bar of harvesting machines etc. should be coated with grease or lubricating oil after thoroughly washing and cleaning them to protect from rusting.
  5. Machine should be kept on wooden blocks or bricks to avoid contact with soil.
  6. Wash the spray pumps with fresh water before and after using them. Always take clean water while using them. After use, operate the empty pump for a while to drain water from spray lines and then store it after drying.
  7. Plastic pipes, rubber parts, belts etc. should be prevented from direct sunlight.
- By keeping in mind the above mentioned points, we can improve the working life of the machine. The machine will be always ready for use when its needed and we will also not face any problem during next operating season.

### **Exercise**

#### **(A) Answer in 1 to 2 words:**

- 1) After land cost, the next highest investment by farmers is in which form?
- 2) Who is considered as head of farm machinery?
- 3) Name any three machines that are driven by tractors.
- 4) Which are those machines where the source of power is part of the machine?

- 5) When the tractor should be over-hauled?
- 6) In which gear the tractor should be stored?
- 7) After proper cleaning of battery terminal of a tractor, it should be coated with which material?
- 8) After proper cleaning and removal of seed and fertilizer from seed sowing machinery, what should be coated to its components?
- 9) What should be done to protect soil working tools of tillage machinery from rust?
- 10) Why the spray pump should be operated empty after using it?

**(B) Answer in 1 to 2 sentences:**

- 1) What are the basic categories in which farm machinery can be divided?
- 2) After how many hours, the tractor should be serviced?
- 3) What should be done to protect tyres if tractor is to be stored for long term?
- 4) What should be done to protect battery if tractor is to be stored for long term?
- 5) What point should be kept in mind for maintenance of exhaust pipe and crank case breather?
- 6) During season, what should be done for maintenance of axle bearings?
- 7) Why it is important to clean the seed and fertilizer box of a seed drill daily?
- 8) Why farmer should properly clean grain tank, conveyor, straw walkers and sieves in combine harvesters?
- 9) What should be done to protect combine harvester from rust?
- 10) What should be done to avoid contact of machine with soil during storage?



**(C) Answer in 5 to 6 sentences:**

- 1) Why there is a need for the maintenance of farm machinery?
- 2) Which points should be kept in mind regarding maintenance of tractors?
- 3) Why repair of machinery should be done before its storage?
- 4) Which points should be kept in mind for maintenance of battery?
- 5) Which points should be kept in mind regarding maintenance of combine harvesters?

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## Chapter-10

# Post-Harvest Handling of Fruits and Vegetables

According to Indian Council of Medical Research (ICMR), the requirement of fresh vegetable and fruit per person per day is 300 g and 80 g respectively. Although India is the second largest producer of fruit and vegetable in the world, but the availability of fruit and vegetable per person per day is 30 g and 80 g only. The main reason for this meager availability of fruit and vegetable is that every year about 25-30% of harvested produce goes waste before they reach to markets. If the freshly harvested fruit and vegetable are carefully handled then the postharvest losses can be avoided to a great extent. The techniques for postharvest handling of fruit and vegetable are divided in following sub-heads.

1. Harvesting of fruits and vegetables.
2. Packaging of fruits and vegetables.
3. Storage of fruits and vegetables.
4. Transportation of fruit's and vegetable.

### 1. Harvesting of Fruits and Vegetables:

The parameters to judge the maturity of fruits and vegetables for harvesting are as under:

**Color:** Color charts are used for determining the maturity of tomato, mango, peach, plum etc. For example, tomato for local market can be harvested when red ripe, for medium distance markets at pink stage and for distant markets at breaker stage.

**Firmness:** The degree of softness (firmness) can be measured/estimated with instrument known as Penetrometer. For determining the firmness of fruit, it is inserted inside the fruit with desirable force. The firmness of fruit decreases with ripening of fruits.

**Size and shape:** Size and shape is a useful index for determining the harvest maturity of most of the fruits and vegetables. For example fullness of cheeks and roundness of shoulder are important maturity index for determining maturity of mangoes etc. Sizing rings with holes for specific sized produce can be easily made from a thin piece of wood or strong plastic.

**TSS (Total Soluble Solids) :** A hand held refractometer is used to measure TSS percentage in a small sample of fruit juice. A few drops of fruit juice are put inside refractometer to measure the sweetness of fruit. This instrument is a useful tool and can be used at the time of harvesting of fruits.

**TSS/Acid ratio:** Knowing the sugar content alone is not enough to measure maturity and quality of citrus fruits and grapes. In these fruit, the ratio of sugar to acid content is a much better predictor for harvesting of high quality produce.

**Days from full bloom to harvest:** Time period between full bloom and fruit maturity is quite constant in some crops like pear, mango, apple, and pomegranate. Therefore this parameter can be used for judging the harvesting period of these fruit. In some vegetable crops, time period from sowing/transplanting to maturity also serves as an indicator of harvesting and is practiced in some crops like watermelon, okra, bell pepper etc.

**Table 1. Some typical characteristics of maturity indices**

FRUITS	Maturity Indices or Characteristics
Kinnow	Fruits from outer periphery should have attained TSS-acid ratio of 12:1 and fruits from interior of trees should have TSS-acid ratio of 14:1.
Peach	Ground color change from green to yellow (varies with cultivars).
Plum	Reddish colour on $\frac{1}{4}$ - $\frac{1}{2}$ of surface.
Mango	Change in shapes (increased fullness of checks or bulge of shoulder), change of flesh colour to yellowish-orange
Guava	Colour break stage
Cabbage	Fully developed, but firm.
Peas (green)	Pods well filled but not faded in color
Bell pepper	Fruits fully developed, still green and shining.
Potatoes	Harvest after vines show signs of senescence (drying).
Tomatoes	For local market harvest when red ripe, for medium distance market at pink stage and for distant market at green stage.

### **Do's and don'ts for harvesting high quality produce**

- Use sharp knives and clippers for harvesting of produce
- The fruit should never be harvested by pulling. It will lead to injury and disease infection at the point of attachment of fruit.
- Use cloth bags to collect the harvested fruit.
- The tripod ladder should be used for harvesting the fruit from high trees.
- Harvesters should be trained to recognize the proper maturity stage for the produce such as size, shape, color and firmness etc.

**2. Pre-cooling:** The harvested produce should immediately be cooled. It will help in increasing the shelf life of horticultural products. Depending upon the type of commodity to be pre-cooled, use appropriate cooling method such as room cooling, forced-air cooling and hydro-cooling.

**3. Waxing:** There is loss of water from the harvested produce during marketing, which affect the natural gloss and quality of the commodity. Therefore, in order to reduce this loss, the food grade wax should be applied on fruit and vegetable. The application of wax coating has proved useful in capsicum, tomato, citrus (kinnow), apple and pear etc. The waxes approved by Food Safety Standard Authority of India (FSSAI) are Shellac wax, Carnauba wax and Bees wax.

**4. Sizing/Grading:** The produce should be graded after harvesting. The grading should be done as per the requirement of different markets. The produce can be graded according to its size, weight, colour etc. Selling of produce after doing necessary grading can fetch better profit to the farmers. At commercial scale, the fruits and vegetables are graded with the help of mechanical graders.

**5. Packaging:** Packaging of fruit's and vegetable's play an important role for their safe transportation. The techniques for packaging of produce are as under:

**Wooden boxes:** Wooden boxes are used for distant transportation of fruit's and vegetables such as apple, peach, plum, tomato. The paper shreds or pieces of card-board paper should be used in these boxes during transportation in order to avoid bruising of produce.

**Wooden basket:** These baskets are used for packaging of cauliflower, capsicum and leafy vegetables etc. for local marketing.

**Jute sacks:** Jute sacks are usually used for packaging and marketing of potato and onion etc.

**Plastic crates:** Plastic crates are used for packaging, storage and marketing of Kinnow, tomato, grapes etc.

**Corrugated Fiber Board (CFB) boxes:** These boxes are used for packaging of high value produce such as apple, mango, grapes, Kinnow, peach, plum, litchi etc. for safe transportation to distant markets (Fig 10.1).



**Fig 10.1 : Packaging of fruits in Corrugated Fiber Board(CFB) boxes**

**Shrink and cling film packaging:** The fruit and vegetable are packed in paper tray and wrapped with shrink or cling film. The produce packed with this technique remains visible to the consumers. This technique also maintains the quality of packed produce. High value fruit and vegetable such as kinnow, tomato, capsicum, seedless cucumber etc can be packed in shrink or cling film and marketed in retail markets for earning better profit (Fig 10.2).



**Fig 10.2 : Shrink film packaging machine**

**6. Storage of fruits and vegetables:** The produce should not be sold in the market when there is glut. The produce should be stored and once the glut is over, it should be sold. This way a good profit can be earned. The apple and potato can be stored for longer period of time. The storage conditions for storage of Kinnow, potato and onion are as under:

Fruit/Vegetable	Temperature (°C)	Relative humidity	Storage life
Kinnow	4-6	90-95	1.5-2 months
Potato	1-2	90-95	4-6 months
Onion	0-1	65-70	3-6

**7. Transportation methods:** Carelessness at the time of transportation can lead to loss of produce. Vehicles can be padded or lined with a thick layer of straw in order to avoid the losses of produce during transportation. Heavy weight produce should not be loaded over soft produce.

**8. Safe technique for ripening of fruit:** Generally, banana, papaya etc. are commercially ripened with harmful chemical “calcium carbide” which is known as *masala*. The consumption of such ripened fruit is harmful for health and sometimes may lead to blister in mouth and ulcer in stomach. Therefore, the use of this chemical for ripening of fruit is banned by Government of India. At home scale, the fruit can be ripened by wrapping in the news papers. The wrapped fruit should be packed in baskets and kept in ventilated rooms. The fruit are ripened and ready to eat in 4-5 days.

**Ripening of fruit with ethylene gas:** Ripening of fruit with ethylene gas is an internationally acceptable technique. In this technique the fruit are exposed to ethylene gas (100-150 ppm) in an enclosed chamber for 24 hours for triggering the ripening process. The temperature of the chamber is maintained at 15-25°C and relative humidity at 90-95%. The ethylene generator is used to produce the ethylene gas.

## Exercise

### (A) Answer in one to two words:

1. Which instrument is used to measure the firmness of fruits and vegetables?
2. Which parameter is measured with refractometer?
3. How much fruits and vegetables are lost before they reach markets?
4. On which fruit the use of waxing is useful?
5. What is the storage temperature for potato and kinnow?
6. How much should be the relative humidity for storage of onion?
7. Which fruit are harvested on the basis of TSS and acid ratio?
8. What precautions should be taken during transportation of produce?
9. Name the harmful chemical used for ripening of fruit.
10. Name the internationally acceptable technique used for ripening of fruits.

### (B) Answer in one to two sentences:

1. On what basis fruits and vegetables are graded?
2. Why produce should be cooled after harvest?
3. What are the benefits of storage of fruits and vegetables?
4. What is the use of penetrometer and refractometer?
5. How fruits and vegetables are graded on commercial scale?
6. Why is it necessary to cool the produce after harvesting?
7. On what basis can fruits and vegetables are graded?
8. Which fruits are ripened with ethylene gas?
9. Which parameters should be taken into consideration for harvesting of tomato?
10. What kind of boxes are used for the packaging of high-value produce?



**(C) Answer in five to six sentences**

1. What do you mean by waxing of fruits and what are its benefits?
2. Write brief note on ripening of fruits with ethylene gas.
3. Write a short note on shrink and cling film packing of fruit.
4. What is the importance of packing of fruits in corrugated fiber board boxes?
5. What precautions should be taken during harvesting of fruits and vegetables?

**Activities**

1. At home scale try to ripe mango or papaya after wrapping them in news paper and write a note on it
2. Visit the office of Department of Horticulture or Punjab Agricultural University and discuss with the scientists regarding postharvest handling of fruits and vegetables.
3. Visit orchard and vegetable farm and write a note on fruits and vegetables.

## Chapter -11

### PROCESSING OF FRUITS AND VEGETABLES

India's diverse climate ensures availability of all varieties of fresh fruits & vegetables. It ranks second in fruits and vegetables production in the world, after China. As per National Horticulture Database published by National Horticulture Board, during 2012-13 India produced 81.285 million metric tonnes of fruits and 162.19 million metric tonnes of vegetables. The area under cultivation of fruits stood at 6.98 million hectares while vegetables were cultivated at 9.21 million hectares. Punjab produces around 15.41 lakh tonnes of fruits with Kinnow being the largest produce of the State and 41.11 lakh tonnes of vegetables with potato making more than 50% of the vegetable production. Due to perishable nature of these crops and with the onset of glut, 30-40% of produce goes waste.

Fruit's and vegetables production worth Rs 44,000 crore is going waste annually in the country due to lack of proper cold chain storage infrastructure and improper pre and post harvest handling and management of the produce. In India only 2.0% of the fruits and vegetables produce are processed. Therefore, processing of vegetables and fruits is very essential to save such losses.

Fruits and vegetables can be processed into following various products:

#### **Lime/ lemon syrup**

Squeeze the lime to take out juice either with hand or by a juice extractor. In 1 litre of water add 2 kg of sugar and dissolve it. Heat it slightly to dissolve sugar into water. After cooling the sugar syrup add 1 litre lime juice, 4gm essence and 3.5gm of potassium metabisulphate. Fill the lime syrup into the bottles. Dissolve it in cold water before serving.

#### **Mango squash**

Well riped mangoes should be selected for the preparation of pulp. After washing, pulp is prepared either by manually squeezing with hands or with fruit pulper. Pulp is further used for making squash. Syrup is prepared by mixing and heating 1.4kg sugar, 25-30gm citric acid and 0.6 litre water. The mixture is filtered through muslin

cloth. 1 kg prepared pulp is added to the sugar syrup after cooling. Potassium metabisulphite 2.8gm is added in the squash after dissolving in small amount of squash and then mixing in bigger lot. Pack the mango squash into the bottles. Dissolve 1 part of squash into 3 to 4 parts of cold water before drinking.

**Malta/orange/kinnow squash:** After peeling, juice is extracted from the fruit by using screw type juice extractor or squeezer. Juice is further used for making squash. Syrup is prepared by mixing and heating 2 kg sugar, 25-30gm citric acid and 1 kg water. The mixture is filtered through muslin cloth. Juice is added to the sugar syrup after cooling. Potassium metabisulphite 2.8 gm is added in the squash after dissolving in small amount of squash and then mixing in bigger lot. Squash is filled into 650 ml capacity bottles and crown corked or squash can be filled in plastic bottles which can be capped airtight. The bottles are shelf stable up to one year at ambient room temperature. At the time of serving it is diluted four times with cold water.

**Lime and barley syrup:** To make lime and barley syrup, in 150 gm of barley flour 300 ml water is added and it is heated slightly to gelatinize the starch. Squeeze the lime to take out juice either with hand or by a juice extractor. In one liter of water add 1.7 kg of sugar and dissolve it. Heat it slightly to dissolve sugar into water. After cooling the sugar syrup add one liter lime juice and 3.5gm of potassium metabisulphite along with gelatinized barley batter. Fill the syrup into the bottles. Dissolve it in cold water before serving.

**Tomato juice:** Take well riped red tomatoes. Boil the tomatoes to take out the juice. Boil the juice by adding 4% sugar, 0.6 % salt, 0.1% citric acid and 0.02% sodium benzoate and fill it into clean, heat resistant bottles and crown cork to make it airtight. Boil the bottles for 20 minutes in the boiling water. Cool the bottles slowly under running water without falling water directly on the bottles. Juice will remain shelf stable for 1 year at room temperature. Juice can be used for drinking as well as for adding in vegetable curries.

**Lime/lemon pickle:** After washing, slice the lime/lemon into pieces. To one kg of lime/lemon pieces add 200gm of salt, 7 gm dried powder of cumin, 2 gm cloves and 20 gm carom seeds. Keep it in sun for 2-3 weeks. It will be ready for serving.

**Mango pickle:** After washing, cut the unripe mangoes into pieces. Add 200gm salt, 25gm fenugreek seeds, 20gm onion seeds, 20gm red chilies, 40gm fennel seeds, 25gm turmeric powder and mix it properly with mango pieces. Add 200ml of mustard oil into the pickle. Keep the pickle for 2-3 weeks in sun. Shake it properly till it is prepared.

**Amla pickle:** Take 1kg of amla and dip it in 2% salt water overnight. Next day, after cutting amla cook it in 100ml mustard oil for 5 minutes. After this, add 100 gm salt and 50 gm turmeric powder and cook for 5 minutes. Cool it.

**Carrot pickle:** After washing and peeling of carrots, cut it into pieces, dry it in sun for 2 hours. Put one kg of carrots in 250ml hot mustard oil. Add 100gm salt and 20gm red chili. After cooling, add 200gm crushed mustard seeds. Pack pickle in clean jars.

**Lime, green chili and ginger pickle:** Wash lime, green chili and ginger. Cut 750gm of lime. Peel 300gm of ginger and cut it into slices. Give a slight slit into 200gm of green chilies. Add 250gm of salt in lime, green chili and ginger mixture. Squeeze 250gm of lemon and put the juice along with lemon into the pickle and mix it. Pack it in wide mouth jars.

**Tomato ketchup:** Cut ripe tomatoes into slices and boil. Take out the juice of boiled tomatoes. In 1kg of tomato juice add a bundle of muslin cloth containing 15gm of onion pieces, 2-3 gm garlic pieces, 4-5gm cloves, 2-3 gm black pepper, 2 gm cardamom, 1-2 gm cumin seeds, 1-2gm cinnamon, 1-2 gm red chili and heat it till gets thickened. Add 100gm sugar, 12-15gm salt. Once material remains half add 40ml vinegar into it. Take out bundle of muslin cloth from the ketchup and squeeze it in the ketchup. Heat it 1-2 minutes and add 700mg/ kg of sodium benzoate into the final product.

**Amla preserve:** Take banarasi variety of amla for making preserve. Put amla into 2% of salt solution for one night. Keep changing salt solution of dipped amla for 3 to 4 days. After washing amla, prick it with fork. Boil amla into 1 liter of water containing 2gm of tartaric acid for 2-3 minutes. Wash and put in sugar syrup containing 700gm of sugar in 500ml of water. Next day, add 250gm sugar into the syrup and boil syrup

without fruit. Add amla into it. Next day, add remaining 200gm of sugar into the syrup and boil it till the syrup gets little thick without the fruit. Then add fruit into the syrup and boil once again. Boil the syrup again next day if it gets diluted and make it thick. Keep watching the syrup everyday for 15 days. if there is any kind of dilution further heat it again for making the syrup thick.

**Dehydrated fruits and vegetables :** To keep the food products for longer time, dehydration is the best method. The process of dehydration involves removal of water from the food under controlled conditions. Food may be dehydrated to decrease weight and bulk. Various dehydrated products i.e. potato chips, potato powder, green leafy vegetables, tomato halves and powder, mushroom powder have been prepared by several basic drying methods i.e. cabinet drier, fluidized bed drier, spray driers, freeze dehydration, solar and sun drying depending upon the type of food to be dried and the quality level that must be achieved and the cost that can be justified. In these products removal of all water leaves one-eighth the weight. These reductions can result in lower transportation and container cost.

Processing and value addition in fruits and vegetables has become the need of hour. Food processing not only help to avoid post-harvest losses of horticultural produce but also help farmers to get remunerative prices for their produce and generate employment for their youth, thereby boosting the rural economy.

### Exercise

#### A. Answer in 1 to 2 words:

1. What is the total production of fruits and vegetables in India?
2. What is the area and production of vegetables in Punjab?
3. What is the area and production of fruits in Punjab?
4. Write the amount of salt to be added in lime pickle.
5. Which preservative is used in tomato ketchup (chutney) and how much quantity is used?
6. Which preservative is used in mango squash and how much quantity is used?

7. Which fruit is produced maximum in Punjab?
8. How much percentage of salt is used for dipping in preparation of Amla preserve?
9. How much is the annual production of fruits in India?
10. How much is the annual production of vegetables in India?

**B. Answer in 1 to 2 sentences:**

1. What kind of products can be made from fruits and vegetables?
2. How processing of fruits and vegetables is useful for the farmers?
3. What is the difference between tomato juice and tomato ketchup (chutney)?
4. What is the importance of addition of Potassium Metabisulphite in various food products?
5. What is the temperature of drying of fruits and vegetables and why these are kept at that temperature?
6. How much quantity of sugar is added in Amla preserve and why?
7. Write the recipe of tomato juice.
8. Which preservative is added in lime, mango and barley lime squash/syrup and write the quantity?
9. What is the most distinctive feature of India's production of fruits and vegetables?
10. Write the types of packaging in fruits and vegetables.

**C. Answers in 5 or 6 sentences:**

1. Give comments on production of fruits and vegetables in Punjab.
2. What is the importance of processing of fruits and vegetables?
3. Write a note on production of fruits and vegetables in India.
4. What is the status of processing of fruits and vegetables in India?
5. What are the reasons of fruits and vegetables spoilage?

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