

## 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 queen less 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. How many days a drone bee takes to complete its life cycle?

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 equipment 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?
5. Explain importance of beekeeping.

## 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** 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. 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 has also been 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?

## 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 tones 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?



## 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 lubrication 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?

## Post-Harvest Handling of Fruits and Vegetables

According to World Health Organization (WHO), 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 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 be 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 markets 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 and vegetable 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 and vegetables such as apple, peach, plum, tomato. The paper shreds or pieces of cardboard 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).



**Fig10. 2 : Shrink film packaging machine**



**Fig10. 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. Which fruits are ripened with ethylene gas?
7. Which parameters should be taken into consideration for harvesting of tomato?
8. Which produce is packed in jute sacks?
9. Which wax is approved by FSSAI?
10. What kind of boxes is 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 precaution should be taken during harvesting of fruits and vegetables?

**Activities**

1. At home scale try to ripe mango and 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 or 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 tones of fruits and 162.19 million metric tones 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 tons of fruits with Kinnow being the largest produce of the State and 41.11 lakh tons 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 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 vegetable produced 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 meta bisulphate 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, 4-4gm 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 sentences:

1. What is the place of India in world for production of fruits and vegetables?
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 annual production of fruits in India?
10. How much 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 Meta bisulphate 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 are the important factors for the production of fruits and vegetables in Punjab?
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?