Agriculture-10

(For Tenth Class)

Punjab School Education Board

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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.

Chairperson

Punjab School Education Board

CONTENTS

Chapter-1

INSTITUTIONS: ALLIED TO AGRICULTURAL

India is chiefly an agricultural country. Punjab leads the country in the field of progressive farming. The credit for this goes to the industrious farmers, scientists, extension services and public policies. The following organizations have been instrumental in uplifting agriculture in Punjab:

1. Department of Agriculture :

This department has a vital role to play in the advancement of agriculture. It acts as a link between the farmers and the agricultural scientists. It delivers important information to the farmers on scientific cultivation of crops, crop protection, agricultural mechanization, soil conservation techniques, conservation of natural resources, etc. The department organizes camps at village/block/district levels to transfer this information to farmers. In addition to the camps, it also organizes exhibitions and demonstrations of recent technological advancements in agriculture It controls the quality of fertilizers, seeds, pesticides, weedicides etc. as a result of which only those products reach the farmer which go through the quality measures set up by this department. The department also hosts soil testing, seed testing and fertilizer testing laboratories. It also supports Agmark laboratories for testing the quality of edible products such as honey, mustard, chilies, etc. The department oversees all agriculture related government schemes as well as financial assistance for agriculture related projects. The department works under the aegis of the Director, Agriculture. Who is assisted by Joint Directors of Agriculture. Chief Agricultural Officer works at the District level and is assisted by Agriculture Officers, Agricultural Development Officers, Sub-Inspectors (Agriculture) and other officials. The Agricultural Technology Management Agency (ATMA) has also been set up to harmonize all agriculture related activities among various departments related to agricultural development and extension.

2. Punjab Agricultural University:

This University came into being in 1962 and was established on the Model of American Land Grant Colleges. The university deals with agriculture and allied research, teaching and extension. It served a vital role in making India food rich and self-dependent, along with being a key factor in ushering in the Green Revolution in the country. On account of the University's excellent landmarks in agricultural research, teaching and extension, it was honored and credited as the topmost National Ranking Agricultural University in 1996 by the ICAR. For the detailed information about the University, PAU website i.e. www.pau.edu can be logged on.

3. Guru Angad Dev Veterinary and Animal Sciences University:

This university came up in 2005; and is engaged in research, teaching and extension in rearing cattle, buffaloes, pigs, goats, sheep, rabbits, horses and fishes. The university houses a multispecialty 24 x 7 Hospital, catering to sick animals. Lakhs of people who bring along with their unwell and diseased animals have benefitted from the services of this hospital. The university has four constituent colleges; Veterinary College, College of Dairy Science and Technology, College of Fisheries and Veterinary Polytechnic. Besides these, there are three Regional Research and Training Centres- Kaljharani (Bathinda), Booh (Taran Tarn) and Talwara (Hoshiarpur). ICAR has nominated Surgery and Gynaecology Department of the College of Veterinary Sciences as Super-specialty Training Centers. The GADVASU is a competent institution as far as veterinary and animal husbandry is concerned; and their suggestions regarding the same are considered much valuable. More information about the university can be obtained by logging on to their official website www.gadvasu.in

4. Department of Horticulture:

Earlier, this department functioned under the Department of Agriculture; but in 1979-80, it came up as an independent department, catering to the cultivation of fruits, vegetables, flowers and mushrooms. The chief objectives of this department are:

(i) Increasing/expanding area of cultivation for horticulture crops.

(ii) Transfer of technical know-how of horticulture crops to farmers.

(iii) Providing good quality seeds of vegetables, fruits and spawn.

(iv) Providing financial assistance for field demonstration of vegetable crops.

(v) Providing assistance pertaining to post harvest handling after picking vegetables and fruits; and their subsequent marketing.

The Director, Horticulture (Punjab) heads the department; who is assisted by Joint Director and at the District level, there is a Deputy Director and an Assistant Director (Horticulture). They are assisted by Horticulture Development Officer (HDO) and other staff. This department has been undertaking various activities under National Horticulture Mission (NHM) since 2005-06. Under this mission, farmers are provided financial assistance as well as subsidy for making pack house, net house, poly house, for establishing ripening chambers for vegetables/fruits, constructing cold stores, processing units, recent marketing models etc. Support is also provided in the form of technical capacity building of the farmers.

5. Animal Husbandry Department:

Livestock rearing plays a major role in the economic status of Punjab. It is not only an opportunity for self-employment, but also an additional business venture for small farmers and the economically weaker agricultural labour class. To promote this asset, the Department of Animal Husbandry has been established with the following objectives:

(i) To organize timely vaccination and de-worming missions so as to secure animal health.

(ii) To promote fertility of animals and improve breeding amongst them.

(iii) To improve animal care and nutrition.

(iv) To provide extension services.

The Director, Animal Husbandry Department of Punjab heads this Department. He is assisted by three Joint Directors- related to Animal Husbandry, Regional Diseases Diagnostic Laboratory and Fodder Development. At the state

level, there are Assistant Directors for poultry and Deputy Directors for lamb wool. At the District level, it is managed by Deputy Director, Veterinary Officers and Fodder Development Officers, etc.

6. Department of Dairy Development:

This department has been given the responsibility of looking into the overall development of dairy sector in Punjab. The Department functions under the supervision of the Director, Dairy Development and assisted by the Joint Director. At the district level, the charge is with the Deputy Director, Dairy Development. The development and extension work of dairy training and dairy farming are the responsibilities of this department; which efficiently runs eight Training and Extension Centres in Punjab. Trainings imparted at these centres include; Two Week Self-employment Training, Six-week Dairy Business, Two-Week Free S.C./ Women Training and Two-week Dairy Producer Training. Apart from these trainings, one day training camps are organized in villages to instruct the farmers about the benefits of dairy training and also to encourage them to adopt this occupation. In urban sectors, consumers are educated and informed about the quality testing measures of milk as well as the possibilities of adulteration in milk and the measures to check it. The beneficiaries of these trainings are assisted in getting loans sanctioned from banks. They are also given the technical know-how of constructing sheds. Besides, they are given subsidies for their business venture in this field. They are provided assistance in the purchase of milch animals. Not only this, they are provided 75% of insurance money on a three year insurance policy obtained on their purchased milch animals.

The subsidy is also made available for the mechanization of dairy farms-such as on the purchase of milking machine, fodder harvester and fodder cutter. Subsidy is also provided for the purchase of Bulk Milk Cooler which is used to safeguard the quality of milk. New programmes have been designed and developed in order to produce milk products at the dairy farm level. The facilities are also there for purchasing automatic dispensing machine for the direct sale of milk to consumers; purchase of Total Mix Ration wagon (TMR wagon); lending machines on rent; and establishing Dairy Service Centres. Detailed information about this department can be obtained from their official website www.pddb.in .

7. Department of Fisheries:

It is one of the oldest departments of Punjab State. It is headed by the Asstt. Director, Fisheries at the district level; wherein the focus is on the care and maintenance of fishes in rivers, streams, lakes and notified water bodies. The Department earns revenue by lending these resources on rent/lease. Fishery is a good source of self-employment. The Fish Farmers Development Agency was established in 1975 to promote fish farming in the state. Fish Breeding Farms also came into being to encourage this venture. Punjab witnessed a revolution in fish farming due to these constructive steps taken. Prior to the fish breeding farms establishment, fish farming was done by bringing seed fishes from rivers and then breeding them in Panchayati ponds. Fish farming has immense future possibilities and potentialities that is why the department is making concerted efforts to expand it. The fish farming department imparts free five-day training every month, besides granting subsidies and providing other extension services to fish farmers.

8. Soil and Water Conservation Department:

This department came into being in 1969 as an independent department. It was earlier a part of the Department of Agriculture. This department functions under the Chief Soil Conservator, Punjab. Government schemes are made available to farmers via Divisional Soil Conservation Officer at district level, Sub-Divisional Soil Conservation Officer at Tehsil level and Soil Conservation Officer at block level.

The department is concerned with activities like land leveling, contour bunding for cultivation on slopes, improvement of land affected with soil erosion, constructing check dams in *Kandi* area to tame excessive rain water, optimum utilization of conserved water, excavating existing ponds so as to make them viable for usage, laying of underground pipes for irrigation, boosting drip and fountain irrigation and encouraging diversification in farming. The department also helps in arresting the fall of underground water level by recharging the excessive rain water and roof water through recharging walls;

9. Department of Co-operation:

Co-operation may have been an integral part of our society since times immemorial, but it came to existence as an independent department only after the Punjab Co-operative Act which was passed in 1904. The department has played a pivotal role in the development of rural and agriculture sector. The Co-operatives have played an integral part in the Green Revolution of the state by efficiently distributing seeds, fertilizers, agro-chemicals and by providing financial assistance in the form of loans. This department is diligently serving the cause of farming till date. Planned economic development in the rural sector is one of the chief responsibilities of this department. Beneficiary schemes for the ruralites run by this department are as follows:

(i) Providing short and medium term loans to farmers for agricultural production through Primary Agricultural Co-operative Societies (PACSs) at village level.

(ii) Providing self-employment opportunities to rural women under the Mai Bhago Woman Empowerment Scheme.

(iii) Providing free medical aid to members of Multipurpose Primary Co-operative Societies under Bhai Ghania Health Scheme.

(iv) Establishing Agro Service Centres for farmers through Primary Agricultural Multipurpose Co-operative Societies.

(v) Supplying essential domestic items/products to the rural sector through Co-operative Societies.

(vi) Arranging marketing facilities for agricultural produce under Co-operative Marketing Societies.

(vii) Providing seeds, fertilizers, pesticides, etc. at subsidized rates to farmers through MARKFED and also facilitate the processing and marketing of agricultural produce.

(viii) Procuring milk from rural area through Milkfed and improvise its marketing and processing in the urban sector.

Apart from these, some co-operative organizations are engaged in specialized tasks for not only the rural sector, but also other sectors of the society, such as:

(i) Punjab State Co-operative Bank, Chandigarh and Central Co-operative Banks at the District level provide short and medium term loans for agricultural purposes as well as to other sections of the society. The above mentioned PACSs at the village level are also a part of this organizational structure.

(ii) Punjab State Co-operative Agricultural Development Bank, Chandigarh and Primary Agricultural Development Banks provide medium/long term loans to farmers for farm mechanization and farm development, etc.

10. PUNSEED (Punjab State Seed Corporation Limited):

Punjab State Seeds Corporation Limited started operating from 1976 with the objective to provide better quality seeds at reasonable price to farmers and develop seed production infrastructure that is able to respond rapidly to the fast changing demand of seeds with least costs. It produces certified seed in large quantities and also motivate the farmers to do the same and become a part of seed-production programme. It also deals in buying-selling of seeds.

11. Punjab Agro-Industries Corporation Limited(PAIC) :

This organization of the Punjab Govt. came into being in 1966 with the main objective of bringing diversity in farming through processing and marketing of agricultural produce and contract farming. It is also actively instrumental in promoting agro-based industries.

Punjab Agro Foodgrain Corporation (PAFC) came up as a subsidiary branch of PAIC in 2002. This organization works under the aegis of Food Corporation of India (FCI) and is associated with the procurement of wheat-rice from the farmers of the state.

12. Punjab Agri Export Corporation Ltd. (PAGREXCO):

It is a joint venture of the Punjab Agro Industries Corporation and Punjab Mandi Board. Mainly , it deals with establishing a infra structure for the export of fresh and processed fruits, vegetables and flowers, and other agricultural products.

13. Punjab Khadi and Gram Udyog Board :

This was set up in 1958. It is a semi-government organization, dealing in providing all support for the promotion of rural industrialization to create employment.

14. Punjab State Farmers Commission:

The economy of Punjab has witnessed a continuous boost from 1950-1990. This growth was a result of an increase in the agricultural produce. However, since 1990, the rate of economic growth has declined sharply due to a fall in the agricultural income. This phenomenon also led to a series of serious crisis such as over exploitation of natural resources and ecological imbalance. This adversely affected the sustainability of agriculture. Considering this situation, Punjab Govt. constituted the Punjab State Farmers Commission under the chairmanship of Dr G.S. Kalkat in 2005. The Financial Commissioner (Development), Punjab; along with the Vice-Chancellors of Punjab Agricultural University, Ludhiana and Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana are its official members. The progressive farmers of Punjab/agricultural scientists are also the members of this Commission. This Commission has the following tasks to undertake:

(i) To examine and review the status of agriculture and allied sectors in the state and that of rural infrastructure.

(ii) To suggest measures of economically viable and ecologically sustainable agriculture development.

(iii) Formulating medium and long term policies for ushering farm diversity in direct relation to the fast occurring changes at the national and international levels in view of the World Trade Agreement.

(iv) To examine the potential of employment in agriculture and allied sectors and to promote non-farm activities through the creation of fundamental infrastructure.

(v) To guide in the development and implementation of cost effective post harvest technologies to increase the agricultural production.

(vi) To provide financial help for conducting research on the contentious issues like rural indebtedness, suicides in the rural area, and rural employment.

Then to formulate policies and make recommendations on the basis of the results of these studies.

(vii) To suggest a structure wherein farmers' societies or rural co-operative societies may buy heavy equipment and lumpy farm machinery on a large scale and rent it out to fellow farmers, so that individual farmer is not required to make heavy investment on the same.

(viii) To understand the demands and problems of different farm organizations and their representatives and then framing policies for their solutions.

15. IFFCO, KRIBCO and NFL:

Indian Farmers Fertilizer Co-operative Ltd., Krishak Bharti Co-operative Ltd. and National Fertilizer Ltd. are the chief organizations engaged in the production and distribution of fertilizers. IFFCO has the unique reputation of being the largest co-operative in the world since 1967. NFL which was established in 1974 as a central public sector organization dealing with urea. KRIBCO came up in 1980 mainly deals in the production of urea. All these three organizations are not only concerned with the marketing of fertilizers but also with transfer of latest agricultural technologies to the farmers through extension activities, thereby helping in the betterment of farmers' economic status. These organizations also offer free services to the farmers for testing their soil and water.

16. Food Corporation of India (FCI):

Keeping in mind the interests of the farmers and to provide them reasonable prices for their produce, the FCI came into being under the Food Corporation Act, 1964. The foodgrains procured through this agency is further distributed in the country through Public Distribution System. This corporation is also responsible for maintaining a buffer stock to ensure food security of the nation. It also helps to stabilize the prices of agricultural produce.

17. National Seeds Corporation (NSC):

This organization was set up in 1963 with a view to produce certified seed. It functions under the Union Ministry of Agriculture. Currently, it is producing seeds of at least 600 varieties of 60 crops. The NSC has implemented stringent quality control measures through its five testing laboratories in order to supervise

seed quality. Apart from this, this organization also looks after distribution of seeds, their marketing and tissue culture of crops. It also imparts training to state level seed production companies.

18. Indian Council of Agricultural Research (ICAR):

It is an autonomous body of the Department of Agricultural Research and Education of the Union Ministry of Agriculture. Working since 1929, it has its main office in Delhi. It is an esteemed organization which manages and provides directions to the research, extension and teaching and also maintains a mutual balance among all these components in the country. Approximately 100 institutions across the country and 55 state agricultural universities are linked/associated with it. The major objectives of ICAR are to conduct research in agriculture, horticulture, forestry, animal husbandry, fisheries, home science as well as planning the dissemination of their technologies. ICAR aims at boosting and encouraging agricultural research and extension at large.

19. National Bank of Agricultural and Rural Development (NABARD):

This organization was set up in 1982 under the Reserve Bank of India (RBI). It is one of the chief organ of RBI and is primarily associated with sanctioning agricultural and rural development loans. Its headquarters are in Mumbai while its Regional and Sub-offices function in almost all the state capitals and major cities. It is mainly concerned with overall rural development which includes – promoting agriculture, small scale industries, domestic and rural business ventures, handloom and other rural economic activities. Besides, it is instrumental in providing loans to scheduled castes, commercial bank, State Land Development Bank, Regional Rural Bank etc. The NABARD also maintains mutual harmony among all these organizations, besides keeping a watchful observation on their working. It acts as a regulator for all these banks. It assists the state governments to achieve their proposed loan targets for agricultural and rural development.

20. Agriculture related other International Organizations:

(i) World Trade Organization (WTO):

The General Agreements on Tariff and Trade (GATT) was established in 1948 for the smooth functioning of international trade and also to take care of any difficulties that arise in the same. Earlier, agricultural trade was

not included in the purview of this organization, but since 1995, agricultural trade, textile or cloth industry, Intellectual Property Rights (IPR) and services, too have come under its ambit and GATT was changed to World Trade Organization (WTO). It started with merely 23 members, which has now grown to 160.The major objectives of WTO are:

(a) Removing restrictions/lifting bans on the sale of agricultural produce.

(b) To reduce or abolish the agricultural subsidies given to farmers.

(c) Reducing tariffs on the sale of agricultural produce.

(d) Reduction in agricultural export subsidies.

(e) Patenting varieties of crops and trees similar to industrial goods.

(f) To abolish fixed export quota system and draft a working export policy regarding the same.

(ii) Food and Agricultural Organization (FAO):

This United Nations Organisation was established in 1943 to eliminate hunger and starvation from the face of this earth. Its headquarters are situated in Rome (Italy). Its chief mission is to ensure food security to each individual in the world. Apart from this, its aim is also to ensure sustainable maintenance of natural resources for prosperity.

Exercise

(A) Answer in one or two words:

1. Which central agency is responsible for procurement of agricultural produce in Punjab State?
2. Which Corporation carries out the export of agricultural produce?
3. Name the organizations set up jointly by the Punjab Agro-Industrial Corporation and Punjab Mandi Board?
4. When did the Punjab Horticulture Department came into being?

5. Who is responsible for research, teaching and extension of Animal Husbandry and Fish farming, in Punjab?
6. Which Co-operative is engaged in fertilizer production and distribution?
7. Which Department implements schemes of National Horticulture Mission?
8. How many field laboratories of NSC are functional to assess the quality of seeds?
9. Which corporation involves farmers in seed production?
10. Which organization is responsible for procurement and marketing of milk in Punjab ?

(B) Answer in one to two sentences:

1. Which agricultural items are exported by the Punjab Agro Export Corporation Ltd.?
2. What facilities are provided to farmers by IFFCO?
3. What is the main function of PAIC?
4. State any two activities carried out by Punjab Co-operative Department?
5. How is MARKFED serving the farmers?
6. What are three main different tasks performed by PAU?
7. Write a brief note on FAO.
8. What was the objective behind establishing the WTO?
9. Why was the ATMA established?
10. What was the purpose behind setting up Punjab Khadi and Gram Udyog Board?

(C) Answer in five to six sentences:

1. Briefly describe the Department of Agriculture.
2. Highlight the reasons for establishing the Punjab State Farmers' Commission.

3. Discuss the objectives of the PAIC.
4. Write a short note on GADVASU.
5. Which facilities are provided for dairy development by the Dairy Development Board?

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Chapter -2

PUNJAB AGRICULTURAL UNIVERSITY: A LIGHT HOUSE OF SCIENTIFIC KNOWLEDGE OF FARMING

Agricultural research and education programme in Punjab started in 1906 with the establishment of Punjab Agricultural College and Research Institute, Lyallpur, (presently Faisalabad, now in Pakistan). With the partition of the country in 1947, this institute remained with Pakistan. To meet the food requirement of the country, a great need was felt to establish a new agricultural research institute. In Punjab, agricultural research was initiated by College of Agriculture, Ludhiana in 1957. Later in 1962, this College was upgraded to Punjab Agricultural University which is known as the mother institute for bringing 'green revolution' in the country. At the time of its establishment, the University had two campuses, one at Ludhiana and another at Hisar (now in Haryana). Later in 1966, a third campus was established at Palampur to cater to the needs of hilly areas. After bifurcation of the state into Punjab and Haryana in 1966, the two separate Universities – Punjab Agricultural University, Ludhiana and Haryana Agricultural University, Hisar came into being as per Act of Parliament. In July 1970, Palampur campus was made part of Himachal Pradesh University that later became Himachal Pradesh Krishi Vishwavidyalaya, Palampur. At the time of its establishment, Punjab Agricultural University had five Colleges – College of Agriculture, College of Agricultural Engineering, College of Basic Sciences & Humanities, College of Veterinary Science, and College of Home Science. In 2005, the College of Veterinary Science was upgraded to Guru Angad Dev Veterinary and Animal Sciences University (GADVASU). To make the country self sufficient in food was the dream of our first Prime Minister, Pandit Jawahar Lal Nehru. The slogan of 'Grow More Food' was popularized. First agricultural university in the country was established in 1960 at Pant Nagar. In 1961 the second agricultural university was set up at Bhubaneshwar, Odisha. Punjab Agricultural University was the third agricultural university in the country which was established at Ludhiana, Punjab in 1962. Dr. P. N. Thapar was chosen as its first Vice- Chancellor.

Several eminent scientists were appointed in the University and they were imparted training at world renowned research institutes/organizations. Exposure at international level gave a new perspective to our scientists for agricultural research which later helped to spark a green revolution in the country. PAU was established with the aim to address the challenges facing agriculture and make the country self sufficient in food. PAU contributed a lot for making the country self-sufficient in food and it also helped Punjab to become a developed state.

For any organization engaged in agricultural research, the major aim is to develop high yielding varieties. For this, PAU established close ties with International Wheat and Maize Development Centre (CIMMYT), Mexico and International Rice Research Institute, Manila, Philippines. At present, PAU has linkages with several other international organizations/institutes. Wheat varieties Kalyan Sona and WL 711; rice variety PR 106 and maize variety Vijay have made significant contribution in bringing Green revolution. The father of dwarf wheat varieties and Nobel Laureate, Dr. Norman E. Borlaug had a close association with PAU. He developed dwarf wheat varieties while working in Mexico. And when these varieties were tested in different countries, our scientists gave the best results. Dr. Borlaug was so impressed that he developed a special liking for PAU and this association lasted till his death.

Dr. Gurdev Singh Khush, the eminent rice breeder who developed dwarf rice varieties was a PAU alumnus. The varieties evolved by him have been mainly responsible for increased area under rice cultivation in Punjab. Main reason for increased area under paddy was more income due to higher yields. In a way the credit for increased income of Punjab farmers due to rice cultivation, goes to Dr. Khush. Shortage of foodgrains was a problem before green revolution era whereas post green revolution saw problems of storage and handling. As a result, a great need was felt to evolve efficient marketing and distribution system. Market and transportation facilities were developed, villages were connected with metal roads. Assured water and power supply greatly facilitated raising of two crops in a year. Farmers' linkages with the University increased and for the first time in 1967, PAU organized a *Kisan Mela* which later on became a regular feature. Farmers show great enthusiasm in the *Kisan Mela* and their participation in these *Melas* is ever increasing. The *Kisan Melas* have become so popular among farmers that they found a place in folk songs.

Jind mahe je chalion Ludhiane

Uthon wadia beej Liyane

(O my dear! if you are going to Ludhiana, then bring quality seeds from there)

Rural landscape started changing. Solid brick houses started appearing in villages replacing old mud houses. With the introduction of radio and television, the farm knowledge started reaching the remotest villages. Farmers started showing great interest for latest farm technologies developed by University. The achievements of the University scientists became a topic of discussion and PAU became a household name among farmers.

PAU scientists have developed many varieties of different crops including field crops, flowers, fruits and vegetables. Till the year 2013, the University had developed a total 730 varieties out of which 130 varieties have been recommended at national level. Record production of wheat and rice has not only boosted farmers' income but has also contributed towards the betterment of state's economy. In the year 1960-61, per hectare production of wheat and paddy was 12 and 15 quintals respectively, which has now increased to 51 and 60 quintals, respectively.

PAU has been pioneer in several spheres of research, extension and education. World's first hybrid of pearl millet (H.B.-1) was developed by PAU. Also India's first single cross maize hybrid (Paras) and first hybrid of gobhi sarson (P.G.S.H 51) were developed by PAU. Besides, the ever popular muskmelon variety Hara Madhu was also developed by PAU. The University scientists have also developed the technique of producing hybrid cows. Farm conservation techniques like zero tillage, leaf colour chart, tensiometer, happy seeder, laser land leveler etc. have been evolved by the University. PAU has been leading institute for evolving Integrated Pest Management (IPM) in cotton, Integrated Nutrient Management (INM) in maize and Integrated Disease Management in potato. University has also pioneered for protected cultivation of capsicum and brinjal crops.

Punjab Agricultural University is the first University in the country to introduce Italian honey bees in the country which has revolutionized honey production. Punjab, today is the leading state for honey production and is producing 37 per cent of the country's honey. Research on additional bi-products

from honey have helped in increasing the income of farmers who have taken up bee keeping as a subsidiary occupation. In addition to the increased honey production, bee keeping has greatly contributed towards raising the production of other crops as a result of increased cross pollination by bees. Growth of fruit trees which were earlier seen in south western districts of the state has now spread throughout the state. Kinnow cultivation in Punjab began with the introduction of Kinnow from California, USA in 1955-56. Today, it is the number one fruit crop in Punjab.

PAU has also developed mushroom varieties which can grow all the year round. Commercial cultivation of mushroom has become popular because of PAU's efforts. At present Punjab is the leading state in mushroom production contributing 40 per cent of the total production in India.

The University has evolved several technologies for the conservation of natural resources. About six lakh hectare of *kallar* land has been reclaimed. Land leveling by land laser leveller has greatly contributed towards saving irrigation water. Apart from laser leveling, drip irrigation and sprinkler irrigation techniques, bed planting also helps in conserving water. The research to develop varieties requiring less water is going on. Technologies for optimum use of fertilizer have also been evolved. Leaf colour chart in rice, maize and wheat greatly helped in cutting down nitrogen fertilizer up to 25 per cent. University has always recommended the integrated use of manures and fertilizers. Use of insecticides, pesticides, herbicides, etc. in Punjab is more as compared to other states. University has always stressed on the need-based use of these chemicals in order to save human beings as well as environment from chemical pollution. To save the crop from insect pests, IPM techniques in paddy, cotton and vegetable crops have been developed and implemented in the farms. The use of chemicals is reduced upto 30-40 per cent. This has greatly helped in conserving the environment.

University has also developed several techniques for precision farming. With net house cultivation of vegetables, better quality crop can be raised in off-season. This technique ensures less pesticide use and more profit for farmers.

Punjab state has been leading in the development and popularization of farm machinery in the country. Due to this, Punjab is known as center for farm

mechanization. Direct sowing of wheat in paddy stubbles with happy seeder reduces cost of sowing by 20 per cent. The use of this machine on wider scale will check the problem of paddy straw burning and consequently the environmental pollution. It will also improve the physical properties of the soil.

A modern 'School of Biotechnology' has been established in the University to give a boost to research for developing new varieties. With biotechnological tools, better disease resistant varieties of wheat and paddy will be developed. University has already developed a good basmati variety Punjab Basmati-3 through this technique.

Electron Microscopy and Nanotechnology Laboratory at PAU is a high end laboratory of its kind in North India. School of Climate Change and Agro-meteorology regularly forecast weather for the benefit of farmers. Agricultural Marketing Cell of the University updates the farmers on market trends in different crops.

PAU is internationally acclaimed university for its quality education. Students from different countries come to PAU for study. PAU is making great contributions in research, education and extension fields. It is a matter of pride for the University that several PAU alumni have occupied key positions in the country and abroad. Dr. N. S. Randhawa an alumnus of PAU became the Director General of Indian Council of Agricultural Research(ICAR), a highest agricultural institution of the country.

University is known world-wide for its research and extension linkages. University has strong linkages with farmers as well as various Govt. departments associated with rural development programmes. PAU was the first to set up a Farmer Service Centre. Later on, this concept has been adopted by ICAR. Directorate of Extension Education has direct linkages with farmers through Krishi Vigyan Kendra and Farm Advisory Service Scheme with different districts. Apart from the farm literature published by Centre for Communication and International Linkages, University has direct contact with farmers through training, exhibitions, field demonstrations, fields trials, *Kisan Melas* and Plant Clinic. They serve as a bridge between farmers and University experts through telephone and internet.

Every year, before the start of *rabi* and *kharif* season, PAU organizes *Kisan Melas* at Ludhiana and other districts. In these *melas*, subject matter experts interact

with farmers to satisfy their queries. Different departments of the University put up exhibitions. Farm literature, seeds of new varieties, fruit plants and vegetable kits for kitchen gardening are put on sale at different stalls. In the agro-industrial exhibition, different firms showcase their machinery/equipment. Every year, about three lakh farmers and farm women attend these *melas.*

In addition to the great strides made in the field of education and research the University has made significant contributions in the fields of sports, literature and culture. The University can take pride in the fact that it has produced three captains for Indian Hockey team for Olympics. PAU was adjudged as the best agricultural university in 1995 for its role in providing food security for the country,

PAU has completed more than 50 years of its existence. By bringing green revolution, it has played a key role in making India self sufficient in food. There are big challenges for the future. Sustainable production, crop diversification, natural resource management and changing climatic conditions are some of the areas which need attention. There is a need to gear up research in these areas and also to develop adequate human resource to face these challenges.

Keeping in view the need for the coming two decades, research, extension and education programmes have been reoriented in the University. University is proactive for playing a leading role in agriculture.

Exercise

A. Answer in one to two words:

1) When was Punjab Agricultural University established?
2) When was the first agricultural university of India established?
3) Kalyan Sona and WG 711 are varieties of which crop?
4) Who won the Nobel Prize for developing wheat varieties?
5) In which year did PAU start organizing *Kisan Mela* ?
6) How many varieties developed by PAU have been recommended at national level?

7) For which crop the first ever hybrid was developed in India?

8) For which crops PAU has developed technology for protected cultivation?

9) Which PAU Department gives weather forecast to farmers?

10) In which city the PAU is located?

B) Answer in one to two sentences:

1) Name the two Universities which were carved out of PAU.

2) Name the crops that have played big role in bringing green revolution.

3) What are the functions of Punjab Agricultural University ?

4) Name the resource conservation technologies developed by PAU.

5) Name the international organizations with whom PAU developed linkages to bring green revolution.

6) What roel PAU Doot play in agriculture development ?

7) What is the contribution of PAU in sports?

8) What was the main purpose to establish PAU?

9) Which hybrids of various crop have been pioneered by PAU ?

10) What is the contribution of PAU in mushroom production ?

C) Answer in five to six sentences:

1) Give a brief account of PAU's extension programme.

2) Give a brief information on PAU *Kisan Melas*.

3) Explain the future challenges to faced by PAU in near feature.

4) What is the contribution of PAU in honey production?

5) What type of international linkages PAU has developed for agricultural research?

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Chapter-3

RABI CROPS

Rabi crops are sown in October-November and harvested in March-April. *Rabi* crops in this chapter have been classified into three categories:

1. CEREALS
2. PULSES AND OILSEEDS
3. FODDERS

1. CEREALS

Wheat and barley are two major cereals in *rabi* season. Wheat, being a major constituent of human diet, is the major contributor to food security of our country.

1.1 WHEAT

China is the top most producer of wheat in the world. Uttar Pradesh leads in its production in India. In Punjab, wheat is sown on area of about 35 lakh ha and its average grain yield is about 18-20 quintals per acre.

Climate and soil: It needs cool climate during the early stage of its growth. Warm temperature at this stage is unfavorable to tillering and also promotes several diseases. It can be grown on all kinds of soil, except the highly deteriorated alkaline and water-logged soils. But medium loamy soils, in which water does not stagnate, are best suited for its cultivation. Durum wheat should preferably be sown on medium to fine textured soils.

Crop rotations: Crop rotation is the sequence of crops grown on a field in a year. Rice-wheat, Cotton-wheat, Maize-wheat, Maize/rice-potato-wheat, Moong/arhar/mash-wheat, Groundnut-wheat, Soybean-wheat are some major crop rotations.

Improved varieties: HD 2967, PBW 621, DBW 17 and PBW 343 are improved varieties of common wheat and WHD 943, PDW 291 and PDW 233 are improved varieties of durum wheat. Durum wheat flour is used in pasta making.

Field preparation: After paddy (rice) harvest, if the field has enough soil moisture, undertake tillage straight way, otherwise apply first irrigation (*rauni)*. At idealistic moisture (*wattar)* condition use disc harrow once for ploughing but if straw of combine harvested paddy is to be incorporated into the soil then give at least two ploughings with disc harrow followed by planking. Then give one cultivation in normal soils and two cultivations in heavy soils with cultivator followed by planking. Incorporation of rice straw into soil improves soil health.

For field preparation after other *kharif* crops give *rauni* irrigation and at *wattar* condition give two cultivations/ploughings followed by planking. Wheat can also be sown with zero-till drill without any preparatory tillage. If there is problem of weeds then before sowing spray Gramoxone herbicide to control weeds. Zero tillage has many benefits such as saving in diesel and time, less environmental pollution, saving in water during first irrigation; lower weed infestation particularly of *gullidanda,* no yellowing of leaves after first irrigation, timely sowing, improved input use efficiency and less lodging. In combine harvested paddy fields, Happy Seeder machine can be used for sowing of wheat in standing stubbles without its burning or removal.

Sowing: Good quality 40 kg seed treated with recommended insecticides and fungicides, should be used for one acre. 4th week of October - 4th week of November is the optimum time of its sowing. Its timely sowing is very important as delay in sowing reduces grain yield by 150 kg per acre per week. Sow the crop with a seed-cum-fertilizer drill at a depth of 4-6 cm and at a row to row spacing of 20-22 cm. Bi-directional sowing of wheat (Half fertilizer and seed in one direction and remaining half in other direction at right angle to the 1st one) gives about 2 q per acre additional yield with the same seed rate and other inputs. Wheat can also be sown on beds with bed planter. It needs only 30 kg seed/acre and also saves irrigation water.

Fertilizers: Apply 50 kg nitrogen, 25 kg phosphorus and 12 kg potassium per acre. Use potassium on soil test basis as Punjab soils generally have its high content. Drill 1/2 nitrogen, whole phosphorus and whole potassium at sowing and broadcast the remaining nitrogen with the first irrigation. Apply 25% less nitrogen to wheat sown after leguminous crops as these crops are able to fix atmospheric nitrogen in the soil.

Manganese deficiency: It generally appears in light soils and its symptoms appear on lower 2/3rd portion of middle leaves as interveinal chlorosis with buff coloured specks which later on coalesce to form bands in between the veins which remain green. It can be managed by spraying manganese sulphate solution.

Zinc deficiency: It generally appears in light soils and its deficiency symptoms are stunted and bushy plants with leaves chloratic in the middle, which later break and keep hanging. It can be managed by applying zinc sulphate.

Weed control: Infestation of weeds in wheat can be reduced by its early sowing from last week of October to first week of November. Infestation of *gullidanda* can also be reduced by rotating wheat with other crops *viz. berseem*, potato and raya. To control emerged weeds give one hand weeding before 1st irrigation and 2nd at *wattar* condition after the irrigation. Alternatively, broadleaf weeds (*Bathu*, *kandiali palak*, *button booti*, *maina*, *maini*, *senji*) can be controlled by herbicides like Algrip or Aim. Grass weeds like *gullidanda* can be controlled by herbicides like Stomp, Leader, Topik, Total, Atlantis, *Treflan* etc. Do not use Leader, Atlantis or Total for control of weeds if *raya* or *gobhi sarson* is sown in wheat.

Irrigation: The first irrigation should be given after three weeks to October-sown crop and after four weeks to the crop sown later as at this particular stage wheat plants form crown roots. Crop needs 4-5 irrigations.

Harvesting and threshing: Harvest the crop by sickle or tractor-operated reaper and thresh by power thresher. Combine harvester combines both these operations. Grains should not contain more than 10% moisture at the time of storage otherwise it would be spoiled by moulds and excessive heat that develops during storage.

Insect-pests and diseases: The major insect-pests of wheat are termite, aphid, army worm and gram pod borer. The major diseases are yellow or stripe rust, brown or leaf rust, loose smut, ear cockle *(Mamni)*, yellow ear rot *(Tundu)* and Karnal bunt.

1.2 BARLEY

Russian Federation is the top most producer of barley in the world. Rajasthan leads in its production in India. In Punjab, it is cultivated on an area of about 12,000 ha and its average grain yield is about 15-16 quintals per acre. Its cultivation is generally done in low rainfall areas.

Climate and soil: Barley requires cool weather during early growth and warm and dry weather at maturity. Being drought resistant, barley suits to areas with scanty rainfall. It can do well even in salt affected soils during the early phases of the reclamation of these soils.

Crop rotations: Paddy-barley, Cotton-barley and Bajra-barley.

Improved varieties: PL 807, VJM 201, PL 426

Sowing: A seed rate of 35 kg per acre under irrigated and 45 kg per acre under rainfed and late-sown conditions is required. Seed should be treated with recommended fungicides. Its optimum sowing time is October 15 - November 15. Row to row spacing of 22.5 cm for the normal sown crop and 18-20 cm for the late-sown and rainfed crop is recommended. Barley can also be grown without any preparatory tillage with zero till drill.

Fertilizers: Apply 25 kg nitrogen, 12 kg phosphorus and 6 kg potassium per acre. Use potassium on soil test basis. Drill all the fertilizers at sowing.

Weed control: Give one weeding after the first irrigation. For chemical control of broadleaf weeds (*bathu* etc.) use 2, 4-D or Algrip. Control *Jaundhar* (*Jangli javi*) with Isoproturon or Avadex BW and *gullidanda* with Puma Power or Topik.

Irrigation: Only 1-2 irrigations are required.

Insect-pests and diseases: The major insect-pest is aphid and major diseases are stripe disease, covered smut, loose smut and yellow rust.

2. PULSES AND OILSEEDS

Gram and Lentil are major pulse crops and mustard, toria, taramira, linseed (Alsi) and sunflower are major oilseed crops in *rabi* season.

2.1 PULSES

India ranks first in production of pulses in the world but still we have to import pulses as India is also the largest consumer of pulses. Rajasthan tops in pulses production in India. In Punjab, a small acreage is under gram, lentil and field pea during the *rabi* season.

2.1.1 GRAM (CHICKPEA)

In Punjab, it is cultivated on an area of about 2,000 ha and its average grain yield is about 5.0 quintals per acre.

Climate and soil: It is a winter season crop but severe cold and frost are injurious to it. It is primarily a crop of low-rainfall areas. Early onset of summer reduces its growing period, hastens maturity and reduces the yield. It grows best on well drained light to medium textured soils but its cultivation is also possible on light soils where other crops are unable to grow. Saline, alkaline or waterlogged soils are not suitable for its cultivation.

Crop rotations: Bajra-gram, Rice/maize-gram

Improved varieties: GPF 2 and PBG 1 are *desi* gram varieties for irrigated conditions and PDG 4 and PDG 3 for rainfed conditions. L 552 and BG 1053 are improved varieties of *Kabuli* gram.

Field preparation: It does not require fine tilth. Deep tillage reduces the wilt attack and increases the seed yield.

Sowing: The optimum seed rates for *desi* and *kabuli* gram are 15-18 kg and 37 kg per acre, respectively. Treat the seed with insecticide followed by fungicide and microbial culture as per the recommendations. Microbial culture promotes formation of root nodules which fix the atmospheric nitrogen into soil. The optimum sowing time for *desi* gram under rainfed conditions is from October 10 - October 25. Under irrigated conditions both *desi* and *Kabuli* gram should be sown from October 25 - November 10. The crop should be sown by *pora or* drill in rows 30 cm apart. The seed should be placed 10-12.5 cm deep as the shallow-sown crop is more liable to be damaged by wilt and lowers its yield.

Weed control: One or two hand-hoeings at 30 and 60 days after sowing help to keep the weeds under check. Alternately, use Treflan or Stomp herbicides.

Fertilizers: Gram being a legume crop needs less nitrogen as it is capable of fixing atmospheric nitrogen into its roots. Apply 6 kg nitrogen to both *desi* and *kabuli* gram. Phosphorus requirement of *desi* gram is 8 kg and *kabuli* gram is 16 kg per acre. Drill all the fertilizers at sowing.

Irrigation: Crop generally needs one irrigation between mid-December and end-January depending upon the rainfall. But this should not be given earlier than 4 weeks after sowing.

Harvesting: Harvest the crop when pods mature and plants dry up.

Insect-pests and diseases: Termite and gram caterpillar are major insect-pests and blight, wilt and stem rot are major diseases.

2.1.2 LENTIL

In Punjab, Lentil (*Masar*) is cultivated on an area of about 1100 ha and its average grain yield is about 2-3 quintals per acre.

Climate and soil: It requires cool climate and being hardy can tolerate frost and severe winter. All soils, except saline, alkaline or waterlogged soils are suitable for growing this crop.

Crop rotations: Rice-lentil, Cotton-lentil and Groundnut-lentil.

Improved varieties: LL 931, LL 699

Field preparation: The land should be ploughed two or three times and each ploughing should be followed by planking.

Sowing: The optimum seed rate is 12-15 kg per acre and the seed must be treated with recommended fungicides and microbial culture. The crop should be sown in the 2nd fortnight of October at a row to row spacing of 22.5 cm.

Weed control: One or two weeding at 30 and 60 days after sowing are enough. Alternatively, weeds can be controlled with Stomp or Treflan herbicides.

Fertilizers: Being a leguminous crop it needs only 5 kg nitrogen per acre. If seed is inoculated with microbial culture then apply 8 kg phosphorus and if not inoculated then apply 16 kg phosphorus. Apply both the fertilizers at the time of sowing.

Irrigation: It requires one or two irrigations depending upon the rains during the growing season. In case of one irrigation, apply it at 6 weeks after sowing and in case of two irrigations, apply one at 4 weeks after sowing and second at flowering or pod formation stage.

Harvesting: The crop should be harvested when the plants dry up and pods mature.

Insect-pests and diseases: Lentil pod-borer is the major insect-pest and blight and rust are the major diseases.

2.2 OILSEEDS

These are the crops from the seeds of which oil is extracted. USA is the top oilseed producing country in the world and Rajasthan leads in its production in India. In Punjab, raya, gobhi sarson, toria, taramira, alsi, safflower and sunflower are grown as *rabi* oilseeds.

2.2.1 RAYA

Climate and soil: It is grown in medium and high-rainfall areas and can be grown on all soil types.

Crop rotations: Maize/bajra-raya-summer moong, Cotton-raya.

Improved varieties: RLC 1, PBR 210, PBR 91

Field preparation: Give 2-4 ploughings each followed by planking. Raya can also be sown with zero till drill without any preparatory tillage.

Sowing: A seed rate of 1.5 kg per acre is required. The optimum time of its sowing is mid October - mid November. Sowing should be done in 30 cm apart rows at a depth of 4-5 cm. Thinning should be done at three weeks after sowing to maintain a plant to plant distance of 10-15 cm.

Fertilizers: Apply 40 kg nitrogen and 12 kg phosphorus per acre. Apply potassium on soil test basis. Drill 1/2 nitrogen and full phosphorus and potassium before sowing and the remaining 1/2 nitrogen with first irrigation. For oilseed crops, Single Super Phosphate should be used to supply phosphorus as it contains sulphur which is essential for these crops. If this fertilizer is not available, then apply 50 kg Gypsum per acre as a source of sulphur.

Weed control: Give one or two hoeings. Weeds can also be controlled with application of Treflan before sowing the crop or Isoproturon after sowing the crop.

Irrigation: First irrigation should be given 3-4 weeks after sowing to promote deeper rooting and for better utilization of applied fertilizers. If necessary, second irrigation may be given at flowering stage. The third and the last irrigation should be given during second fortnight of February.

Harvesting and threshing: The crop is ready for harvest when pods turn yellow. The harvested crop should be stacked for 7-10 days before threshing.

Insect-pests and diseases: The major insect-pests are painted bug, mustard sawfly, mustard aphid and leaf miner. The major diseases are *Alternaria* blight, downy mildew and white rust.

2.2.2 GOBHI SARSON

In trade, gobhi sarson is included in rapeseed group. A type of gobhi sarson called Canola has less erucic acid in oil and less glucosinolates in defatted meal. The oil from canola type varieties is healthy for human consumption and their defatted meal is good as animal feed.

Climate and soil: It is grown in medium and high-rainfall areas. It can be grown on all soil types.

Crop rotations: Rice/maize-gobhi sarson-*s*ummer moong, Cotton-gobhi sarson

Improved varieties: PGSH 51, GSL 2, GSL 1. Canola type varieties are GSC 6 and GSC 5

Field preparation: Give 2-4 ploughings each followed by planking.

Sowing: A seed rate of 1.5 kg per acre is required for sowing in rows 45 cm apart. The optimum time of its sowing is 10 October - 30 October. Thinning should be done at three weeks after sowing to maintain a plant to plant distance of 10 cm.

Fertilizers: Apply 40 kg nitrogen and 12 kg phosphorus per acre. Apply potassium on soil test basis. Drill 1/2 nitrogen and full phosphorus and potassium before sowing and the remaining 1/2 nitrogen with first irrigation. For oilseed crops, Single Super Phosphate should be used to supply phosphorus as it contains sulphur which is essential for these crops. If this fertilizer is not available, then apply 50 kg Gypsum per acre as a source of sulphur.

Weed control: Give one or two hoeing. Weeds can also be controlled with application of Basalin before sowing the crop or Isoproturon after sowing the crop.

Irrigation: First irrigation should be given 3-4 weeks after sowing to promote deeper rooting and for better utilization of applied fertilizers. If necessary, second irrigation may be given at flowering stage. The third and the last irrigation should be given during second fortnight of February.

Harvesting and threshing: The crop is ready for harvest when pods turn yellow. The harvested crop should be stacked for 7-10 days before threshing.

Insect-pests and diseases: The major insect-pests are painted bug, mustard sawfly, mustard aphid and leaf miner. The major diseases are *Alternaria* blight, downy mildew and white rust.

2.2.3 SUNFLOWER

Sunflower seeds contain 40-43% high quality oil which is very well suited for the manufacture of edible refined oil and *vanaspati*. Its oil can also be used for soap making and a number of allied products. Ukraine is the top most sunflower producing country in the world. In Punjab, it is cultivated on an area of about 20-21 thousand ha and its average seed yield is about 6.5 quintals per acre.

Climate and soil: It requires relatively cold climate and performs well on well drained and medium texture soil. Salt affected soils are not suitable for its cultivation.

Crop rotations: Rice/maize-potato-sunflower, Rice-toria-sunflower, Cotton-sunflower, Basmati-sunflower

Improved varieties: PSH 996, PSH 569, Jawalamukhi

Field preparation: Give two or three ploughings each followed by planking.

Sowing: Two kg seed per acre is required which should be treated with recommended fungicides. The sowing of sunflower should be done by end of January. Sow the seeds in rows 60 cm apart with a plant-to-plant spacing of 30 cm. Early sown crop performs better if planted on southern side of East-West

ridges. The higher temperature on this side of ridge in winters helps in early germination of seeds and faster growth of crop. Place the seed about 6-8 cm below the ridge top. The crop sown on ridges does not lodge and also saves irrigation water.

Fertilizers: Apply 24 kg nitrogen and 12 kg phosphorus per acre at the time of sowing. If potassium is deficient, then apply 12 kg potassium per acre. Single Super Phosphate should be preferred as a source of phosphorus.

Irrigation: It generally requires 6-9 irrigations. Apply first irrigation about a month after sowing followed by irrigations at 2-3 week interval. During hot summer months of April - May irrigate the crop at 8-10 days interval. Irrigations at flowering and grain formation are very critical.

Weed control: The first hoeing should be done at 2-3 weeks after the weed emergence followed by second hoeing at three weeks thereafter. Weeds can also be controlled with Stomp.

Harvesting and threshing: The crop is ready for harvesting when sunflower heads turn yellowish brown at lower surface near the stalk and the discs start drying up. The harvested sunflower heads should be threshed immediately after harvesting with sunflower thresher.

Insect-pests and diseases: The major insect-pests are cutworms, tobacco caterpillar, Bihar hair caterpillar and American bollworm. The major diseases are stem rot, root rot and head rot.

3. FODDERS

Green fodder is a major component of animal diet. An adult animal requires about 40 kg green fodder per day and its availability is far less than this. *Rabi* fodders include berseem, shaftal, lucerne, oats, rye grass and senji.

3.1 BERSEEM

Berseem is known as king of fodders. It gives a highly nutritious and palatable fodder in repeated cuttings from November to mid-June.

Improved varieties: BL 42, BL 10, BL 1

Field preparation: Give three ploughings each followed by planking.

Sowing: Use 8-10 kg seed per acre and it must be inoculated with microbial culture. To make the seed free from seeds of chicory (*Kashni)* and other weeds, put the berseem seed into water and sieve the floating weed seeds. The optimum time of its sowing is last week of September to first week of October. Sowing should be done by broadcasting the seed in standing water. In case of high wind, the seed should be broadcasted evenly in dry land followed immediately by raking and irrigation.

Fertilizers: Apply 6 tonne farmyard manure and 20 kg phosphorus per acre at sowing time. If farmyard manure is not available then apply 10 kg nitrogen and 30 kg phosphorus per acre.

Weed control: Basalin herbicide can be used to control *Bueen* weed in berseem. If *itsit* is a problem, then sow berseem mixed with raya. Raya, being a fast growing crop, smothers this weed. In fields where *itsit* is a serious problem, delay the sowing of crop to the second week of October, as during this period, the incidence of the weed is drastically reduced due to decrease in temperature.

Irrigation: The first irrigation should be given 6-8 days after sowing. Afterwards, it may be applied within 8-10 days during summer and 10-15 days during winter.

Harvesting: First cutting is ready in about 50 days after sowing and subsequent cuttings at 40 day intervals during winter and 30 day intervals in spring.

Insect-pests and diseases: The major insect-pests are Bihar hairy caterpillar (*Bhabu kuta*), grasshopper, gram caterpillar and cabbage semilooper. Its major disease is stem rot.

3.2 OATS

Oats is next to berseem in nutritive value. It can be grown on all types of soils, except the alkaline or water logged soils.

Improved varieties: OL 9, Kent

Sowing: Use 25 kg seed per acre and it should be treated with recommended fungicides. The optimum time of sowing is from second week to last week of October. It should be sown in rows 20 cm apart. It can also be sown with zero till drill after the harvesting of rice.

Fertilizers: Apply 15 kg nitrogen and 8 kg phosphorus per acre at the time of sowing. Apply 15 kg nitrogen at 30-40 days after sowing.

Weed control: Weeding is generally not required but if required then give one weeding.

Irrigation: Three to four irrigations including the pre-sowing irrigation are sufficient.

Harvesting: The harvesting should be done from boot to milk stage.

Insect-pests and diseases: The major insect-pest is aphid and major diseases are loose smut and covered smut.

Note: For the control of insect-pests, diseases and weeds, use pesticides (insecticides, fungicides and herbicides) recommended by the Punjab Agricultural University, Ludhiana. Use these pesticides at recommended doses and at recommended times as their over-use is harmful to human health and environment.

Exercise

A) Answer in one to two words:

1. Name any two oilseed crops.
2. Name any two improved varieties of wheat.
3. How much seed is required to sow one acre of raya?
4. Name two insect-pests of gram.
5. Name any two diseases of wheat.
6. Name any two weeds of wheat.
7. Which crop is known as king of fodders?
8. What is the sowing time of lentil?
9. Name any two improved varieties of barley.
10. How much is the oil content in sunflower seeds?

B) Answer in one to two sentences:

1. Write the per acre nutrient requirement of wheat.
2. Name two wheat based crop rotations.
3. In which crop and against which weeds herbicide Total is used?
4. When should oats be harvested for fodder?
5. How to control Itisit in berseem ?
6. When should sunflower be harvested?
7. What is canola sarson?
8. Write the time and method of sowing of barley.
9. Write the sowing time and per acre seed rate of desi gram.
10. Which soils are not suitable for lentil?

C) Answer in five to six sentences:

1. Write the sowing time and sowing methods of wheat.
2. Give methods of sowing of berseem.
3. Give importance of sulphur in oilseeds and name its sources?
4. Name varieties of raya and give its nutrition requirement.
5. Name broadleaf weeds of wheat and give their control measures.

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Chapter-4

WINTER VEGETABLES

Vegetables are an important part of human's diet. Plant's succulent parts like roots, stem, leaves, flowers, fruits etc. are either consumed fresh as salad or consumed after cooking are called vegetables. Vegetables play an important role in human diet as they contain high quantity of carbohydrates, proteins, minerals, vitamins which are very essential for proper maintenance of human body. In countries like India, there is a great importance of vegetables as its large population is vegetarian. According to the scientists, an adult requires 284 g of vegetables daily to maintain good health. Out of which, one should consume 114 g leafy vegetables, 85 g root vegetables and 85 g other vegetables.

Scope of vegetables:

There is a great scope of vegetables in our country as availability of vegetables is less as compared to the requirement. Therefore, there is a great need to increase the vegetable production as these are also a rich and cheap source of dietary nutrients. Moreover these are short duration and 2 to 4 crops of vegetables can be raised in a year. The yield of vegetables is 5-10 times more than wheat–rice rotation and income is also higher and that too on daily basis. Vegetable cultivation is a good source of employment as it requires more labour per unit area. Thus, farmers' family members can get employment in their own fields and moreover, agricultural resources can be utilized efficiently all the year round.

Basic information about cultivation of winter season vegetables

Basic information is very essential for successful cultivation of winter season vegetable which is given below :-

1. Selection of soil :

Vegetable can be grown on wide variety of soils but sandy loam or clay loam soils are ideal for vegetable cultivation. Sandy loam soil is good for root vegetables like carrot, radish and turnip and tuber vegetable like potato etc.

2. Manures and fertilizers:-

There are mainly two types of manures i.e. organic (bio-fertilizers) and inorganic (chemical fertilizers)

i) **Organic manures:-** Organic manures provide organic matter and other essential nutrients to plants. Organic matter improves the physical and chemical structure of soil and also improves the aeration in the soil.

ii) **In organic or chemical fertilizers:-** These fertilizers are produced in factories by chemical means and they consist various nutrients such as Nitrogen, Phosphorus, Potash etc.

3. Seed and sowing:- Always use the seed of an improved variety and it should be free from any disease, insect-pest and seeds of weeds and other varieties. There are two methods of seed sowing.

a) **Direct sowing:-** Some vegetables like carrot, radish, turnip, peas, spinach, methi, coriander and potato are sown by direct sowing.

b) **By transplanting:-** Only those winter season vegetables can be sown through transplanting method which can bear the transplanting shock e.g. cauliflower, cabbage, Chinese cabbage, broccoli, onion, lettuce etc.

4. Irrigation: There should be proper availability of irrigation water during growing and flowering period of crop. It is important to irrigate the crop before wilting.

5. Control of Insect-pests and diseases:-

i) By using correct crop rotation, potato and peas can be protected from some diseases.

ii) Summer ploughing is helpful in controlling various types of insect-pests, fungi and nematodes.

iii) By destroying the diseased plant debris and by clean cultivation, crop can be protected from various diseases.

iv) By early sowing and destroying the insect-pests mechanically, crop can be protected from the insect damage.

v) By treating the seed with Captan or Thiram and by sowing disease resistant varieties, crops can be protected from the attack of insect-pests and diseases.

vi) Use insecticides like Seven, Fame etc. to protect the crop against caterpillars and beetles and for sap sucking insects and aphids, use Rogor, Metasystox and Malathion against sap sucking insects and aphids.

Important winter or Rabi season vegetable crops:

1. **Carrot:-** Carrot is an important winter season vegetable crop which is used for salad and vegetable. In Punjab, two types of carrot are available i.e. Desi and European. Desi varieties can tolerate high temperature and give more yield. But European varieties give more yield in low temperature. In Punjab, two carrot varieties are mainly sown i.e. Punjab Black Beauty and PC 34. The colour of Punjab Black Beauty is purple-black having abundant juice and yield is 196 q/acre. While PC 34 is red in colour and yield is 200 q/acre. Sow carrot always on ridges and maintain 45 cm distance between ridges. For sowing one acre area, 4-5 kg seed is sufficient. After one month of sowing, thinning of plants is essential to maintain 7-8 cm distance between plants. To control weeds in carrot field, spray Goal 23.5 EC @ 200 ml in 200 litre of water per acre within two days after sowing. Apply 1st irrigation immediately after sowing and 2nd irrigation after 10-12 days of sowing. Total 3-4 irrigations are essential. Excessive irrigation causes poor coloration of roots, induce more foliage and delays maturity and it should be avoided. Carrots take 90-100 days from sowing to harvesting depending upon different varieties.

2. **Radish:-** Radish can be used as salad, vegetable preparation and for *parantha* making. Punjab Pasand and Pusa Chetki are two important varieties of radish which are mainly sown in Punjab. The yield of Pusa Chetki is 105 q/acre and Punjab Pasand is 215 q/acre. With careful selection of varieties, radish can be grown almost throughout the year. The schedule of sowing radish varieties is given as under:-

Variety	Sowing time	Root availability
Pusa Himani	Jan.-Feb.	Feb.-April
Punjab Pasand	2nd fortnight of March	End April-May
Pusa Chetki	April –August	May-Sept.
Punjab Pasand	Mid Sept.-Oct.	Oct.-Dec.
Japanese-white	Nov.-Dec.	Dec.-Jan.

A seed rate of 4-5 kg is sufficient for one acre. Always sow radish on ridges. Maintain a spacing of 45 cm between ridges and 7.5 cm between plants. Apply 1st irrigation immediately after sowing. After that irrigate the crop at 6-7 days interval in summers and at 10-12 days interval in winters according to the soil type. Radish become ready for harvest in about 45-60 days depending upon variety and season.

3. **Pea:-** Pea is a cool season crop which contains a sufficient amount of protein. Matar Ageta-6 and Arkel are early maturing varieties. The yield of these varieties is about 20-24 q/acre. Mithi Phali and Punjab-89 are main season varieties and the average yield ranges between 47-55 q/acre. Mithi Phali is an edible podded variety and its shelling is not required. The best time of sowing is mid Oct.–mid Nov. Seed rate is 45 kg for early maturing varieties and 30 kg for main season varieties per acre. Line x plant spacing should be 30x7.5 cm for early and 30x10 cm for main season varieties. In areas where pea crop has not been sown earlier, it is advisable to treat the seed with Rhizobium culture to ensure nodule formation and it increase the yield. For weed control, use Stomp 30 EC @ 1 litre per acre or Tafalon 50 WP @ 500 g per acre as pre-emergence within two days of sowing in 200 litre of water solution. Seed should be sown in proper soil moisture condition. First irrigation should be given after 15-20 days of sowing. Next irrigation should be given at flowering and then at fruit set. Harvest the crop at proper edible maturity.

4. **Cauliflower:-** The optimum temperature requirement for cauliflower cultivation is 15-20^0 C. Giant Snowball for main season and Pusa Snowball-1 and Pusa Snowball K-1 for late season, are important varieties.

The best transplanting time is June-July for early varieties, August to Mid September for main season varieties and Oct.–first week of Nov. for the late sown varieties. The seed rate for main and late season varieties is 250g per acre, whereas for early season varieties, 500 g seed is required. The spacing for main season crop is 45x30 cm. For weed control, apply Stomp 30 EC @ 1 litre/acre in 200 litre of water. Stomp should be applied one day before transplanting of seedlings in the moist soil conditions. First irrigation should be given just after transplanting. The total number of irrigations required are 8-12. Crop is ready for harvesting in about 90-100 days of transplanting.

5. **Cabbage:-** The ideal time for transplanting of cabbage is Sept.-Oct. 200-250 g seed is sufficient for one acre area. The distance between rows and plants should be 45x45 cm in early season varieties and 60x45 cm for late season varieties. For early crop, cabbage can be grown by direct sowing. For this method, maintain 60 cm distance between ridge and 15-20 cm between seeds. The weed control and irrigation practices are the same as in cauliflower.

6. **Broccoli :-** Punjab Broccoli-1 is an improved variety and its average yield is 70 q/acre. The ideal time of nursery sowing is mid August-Mid Sept. Transplant the nursery seedlings in field after one month of sowing. Use 250 g seed for an acre. Maintain 45 cm distance between rows and plants. The weed control and irrigation practices are the same as in cauliflower.

7. **Chinese Cabbage:-** Chini Sarson-I and Saag Sarson are its improved varieties. Nursery sowing should be done in Mid Sept. and transplant the seedlings in field in Mid October. Use 200 g seed per acre for transplanting method and one kg seed per acre for direct sowing. Keep 45 cm distance between rows and plants respectively. It takes 30 days for 1st cutting and gives total of six cuttings.

8. **Potato:-** Kufri Surya and Kufri Pukhraj are early season varieties which take 90-100 days for harvesting and give yield of 100-125 q/acre. Kufri Jyoti and Kufri Pushkar are mid season varieties which are ready for

harvesting in 100-110 days after sowing and give yield of 120-170 q/acre. Kufri Sindhuri and Kufri Badshah are late season varieties which give 120-130 q tubers from one acre in 110-120 days. Use 12-18 quintals of seed for sowing one acre. In Punjab, the best time of sowing for autumn season crop is last week of Sept.-Mid Oct. and for spring season is first fortnight of January. For spring season crop, use 8-10 q/acre of seed for early varieties and 4-5 q/acre for late varieties. Keep 60 cm distance between ridges and 20 cm between tubers. To control the weeds, use Stomp 30 EC @ 1 litre or Arelon 75 EC @ 500 g or Sencor 70 EC @ 200 g in 150 litres of water at pre-emergence stage after first irrigation. Apply first irrigation just after sowing which helps in quick germination of the crop.

Description of Potato Varieties:

Season	Variety Name	Yield(q/acre)	Duration(days)
Early season	Kufri Surya and Kufri Pukhraj	100-125	90-100
Mid season	Kufri Jyoti and Kufri Pushkar	120-170	100-110
Late season	Kufri Sidhuiri and Kufri Badshah	120-130	110-120

Exercise

B. Answer in 1 to 2 words:

1. How much vegetables should be consumed per person per day for maintenance of good health?
2. Which type of soil is best for potato cultivation?
3. Name the types of fertilizers.
4. Write the name of black carrot variety.
5. When is Pusa Chetki variety of radish sown?
6. Write the name of two early maturing varieties of pea.
7. Give the ideal time of broccoli nursery sowing.

8. Name two late maturing varieties of potato.
9. How much seed is required for raising one acre nursery of cabbage?
10. Write the name of improved varieties of cauliflower.

B. Answer in 1 to 2 to sentences:

1. Define vegetables.
2. Which vegetables are grown through transplantation?
3. How vegetable cultivation is useful for livelihood security?
4. How to control weeds in pea?
5. How to control weeds in potato?
6. Give seed rate/acre and spacing in carrot.
7. Write improved varieties and seed rate/acre of potato.
8. Write ideal time of planting and seed rate/acre in Chinese cabbage.
9. Which type of soil is best suited for vegetable cultivation?
10. Write improved varieties of Chinese cabbage.

C. Answer in 5 to 6 sentences:

1. How radish can be raised around the year?
2. What is the importance of vegetables in human diet?
3. How to save winter vegetables from the attack of insect-pests and diseases?
4. Describe briefly the early cultivation of peas.
5. Write ideal time of nursery sowing ,seed rate/acre and spacing for early, mid and late season cauliflower.

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Chapter -5

PLANTATION OF NEW ORCHARDS

Fruits are nature's gift to mankind. These are not only delicious and refreshing, but also the major source of vitamins, minerals and proteins. In Punjab, the fruit trees occupy an area of 76,500 ha. According to the varying climatic conditions of Punjab, It can be divided into three distinct zones as given below:

1. Sub-mountainous Zone
2. Central Zone
3. Arid-irrigated Zone

1. **Sub-mountainous Zone:** It comprises the districts of Roopnagar, Hoshiarpur, Pathankot, SBS Nagar, Gurdaspur, SAS Nagar (Mohali) and union territory of Chandigarh. Mango, Litchi, Kinnow and other mandarins, Lemon, Pear, Guava, Peach, Plum, Sapota and Amla are the recommended fruits for cultivation in this zone.

2. **Central Zone:** Amritsar, Taran taran, Kapurthala, Jalandhar, Ludhiana, Barnala, Sangrur, Patiala, Moga, Fatehgarh Sahib are the main districts. Pear, Guava, Grapes, Peach, Mango, Kinnow and other mandarins and lemon are the recommended fruits for cultivation in this zone.

3. **Arid-irrigated Zone:** Bathinda, Faridkot, Sri Mukatsar Sahib, Mansa, Ferozepur and Fazilka are the main districts. Kinnow and other mandarins, malta, lemon, guava, grapes and ber are the recommended fruits for cultivation in this zone.

Planting Season: The fruit trees can be divided into two categories according to the plantation time:

1. **Evergreen fruit plants**: Evergreen fruit plants such as citrus, mango, litchi, guava, loquat, and sapota should preferably be planted during February- March and September- October.

2. **Deciduous fruit plants**: The deciduous fruit plants such as pear, grapes, peach, plum etc. should be planted during winter when they are dormant. Their planting must be completed up to middle of January in Peach & Plum and up to mid February in Pear and grapes.

Important points to be kept in mind while planting new orchards:

1. **Suitable soil for orchard plantation**: The soil for growing fruit plants should be deep, well-drained, loamy and fertile without hard pan up to two meters of the depth of soil. Water logged, marshy, saline or acidic soils are not fit for fruit cultivation.

2. **Water**: Water table should be below three meters and not fluctuating.

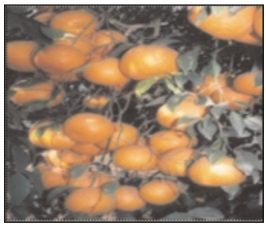
3. **Method of planting**: Proper planning is must before the actual plantation of new orchard. The roads, water channels and paths should be constructed within the orchard before planting. One meter deep pits of one meter diameter should be dug. The pits should be left exposed to sun for few days before actual planting. Refill the pits with a mixture of half of the top soil and well rotten farmyard manure and should be watered a few days before planting. To protect the fruit trees from the termite attack, mix 15 ml Chloropyriphos 20 EC in 2.5 kg soil per pit.

4. **Improved cultivars**: The life cycle of fruit trees is different from field crops as these take only six months to complete their life cycle. But fruit crops is a long term investment. Therefore one should plan a new orchard with utmost attention and care. Selection of unhealthy and poor quality plant material reduces the profitability of the farmer and it comes into his notice after 3-4 years of the plantation when the fruit trees come into bearing stage. That's why it is recommended that one should go for the plantation of improved varieties under the technical guidance of the experts. The list of recommended cultivars of different fruits by PAU, Ludhiana is as given below:

Fruits	Recommended cultivars
Mandarins	Kinnow, Local, Daisy, W. Murcott
Sweet Orange	Musambi, Jaffa, Blood Red, Valencia

Lime/Lemon	Kagzi, Baramasi Lemon, Galgal
	Mango Dusehri, Langra, Alphonso, Sucking Mangoes (GN_1 to GN_7 & Gangian Sandhuri)
Pear	Punjab Nakh, Patharnakh (Hard pear), Punjab Gold, Punjab Nectar, Punjab Beauty, Baggugosha, Le Conte (semi soft pear), Punjab Soft (soft pear)
Peach	Florda Prince, Partap, Shan-e-Punjab, Early Grande, Prabhat
Plum	Satluj Purple, Kala Amritsari
Guava	Shweta, Sardar, Allahabad Sufeda, Arka Amulya, Punjab Pink
Grapes	Perlette, Beauty Seedless, Flame Seedless, Punjab Purple
Ber	Umran, Sanaur-2, Wallaiti
Litchi	Dehradun, Calcuttia, Seedless late
Banana	Grande Naine
Sapota	Cricket Ball, Kalli patti
Amla	Kanchan, Balwant, Neelam
Pomegranate	Bhagwa, Ganesh, Kandhari

Recommended Cultivars

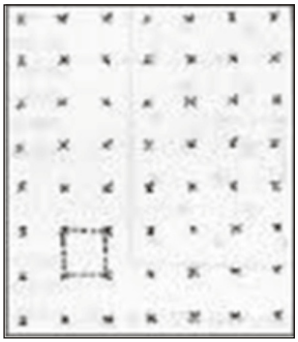


Kinnow

Allahabad Safeda

Pear

Shan-i-Punjab



Square system of planting

Harvesting of fruits with clipper

Packing of fruits

5. Planting distance and number of plants per acre: Optimum spacing regulates the proper utilization of sunlight, avoids competition in uptake of nutrients and facilitates proper irrigation so that the fruit trees may grow and bear properly. That's why, the fruit trees should be planted at optimum planting density as recommended by PAU, Ludhiana.

6. Planting Systems:

1. **Square system:** In Square system, plant to plant and row to row distance is the same. The plants are at right angle to each other and every unit of four plants form a square. The farmers of Punjab prefer this system as it facilitates the interculture in two directions after the orchard is planted. The orchards remain productive for a long time and intercropping is also feasible during the initial years of plantation.

2. **Quincunx/Filler system:** Some of the fruit trees like Mango, Litchi, and Pear come into very late bearing. In such orchards, additional income can be generated by the plantation of filler trees. The filler is uprooted when the permanent trees come into bearing.

3. **Hexagonal System:** In this system, the trees are planted in each corner of an equilateral triangle. This system accommodates 15 per cent more trees per unit area than the square system. In this system, pruning should be done very carefully as the trees have a tendency to overcrowd after a few years.

7. **Selection of nursery plants:** Selection of fruit seedlings from the nursery is the most important point to be kept in mind while plantation of new orchards. Healthy, vigorous, free from diseases and insect-pests and of known pedigree should be obtained from the reliable nursery preferably from PAU, Ludhiana, State Horticulture Department or from government approved nurseries. The plants should be of medium budded or grafted on suitable rootstocks. The bud union should be smooth. Evergreen plants should be lifted with well sized earthen balls. Tying material should be removed from the bud/graft union before transplanting. Purchase 10 per cent more plants than the actual requirement to fill up the gaps.

8. **Use of fertilizers**: Balanced application of fertilizers is very important to get the maximum profit from the fruit trees. The vegetative growth of fruit trees takes place mostly in the month of February to April. The availability of nutrients should be optimum at this time. Organic manures such as FYM should be applied 2-3 months before the initiation of new growth. However, the nitrogenous fertilizers (Urea) should be applied generally in two split doses, first half to be applied before growth/flowering and the second half should be applied after fruit set. Phosphorous should be applied along with the first dose of nitrogen. Potash should be applied 4-5 months before the ripening of the fruits to improve the quality of the fruits. Macronutrients such as Nitrogen, Phosphorous and Potash should be applied through broadcasting. Micronutrients should be applied as foliar sprays only on the appearance of deficiency symptoms on the plants.

9. **Irrigation:** The young plants up to the age of three to four years should be irrigated at weekly intervals from March to June, after 2-3 weeks interval from November to February and from July to November depending upon the climate, rainfall and type of soil. Irrigation is crucial before sprouting, after fruit set and in the hot weather, otherwise the growth of bearing trees may be adversely affected resulting in the excessive shedding of flowers/ fruits.

10. **Training and pruning:** The fruit plants should be trained to an appropriate system during the initial years of plantation to give them a particular shape and size. Training of the fruit trees should be done in such a manner that sufficient light and air get penetrated inside the foliage to enhance the quality of fruits and such trees are also capable of bearing heavy crops over the years. The training of deciduous fruit trees such as Grapes, Pear, Peach and Plum should be completed in initial 4-5 years of the planting. Pruning is desired to remove the non-productive parts, diseased, dried, crisscrossed and broken branches and to regulate the fruit crop of good quality and productivity.

11. **Harvesting of fruits:** To minimize the post-harvest losses, the harvesting of the fruits should be based on certain maturity indices. There are certain fruits those can be ripened even after harvesting such as Mango, banana, plum but the grapes, litchi etc. cannot be ripened after harvesting of the fruits. That's why, harvesting of the fruits should be done at different timings depending upon the varying maturity indices. The fruits should not be pulled from the branches during harvesting. It will lead to rupturing of the fruit skin from the stem end and breakage of the branches. The harvested fruits should be graded into 3-4 sizes. Do not pack the immature, over ripe, small, soft and bruised fruits.

Exercise

a) Answer in one to two words:

1. How much is the area of the fruits under Punjab?
2. Name the insecticide used to control the termite attack.
3. Name two recommended peach cultivars.

4. Give the number of planting systems for the plantation of new orchards.
5. What is the time for plantation of deciduous fruit trees?
6. Give the suitable time for the plantation of mango and litchi orchards.
7. Give the time of application of FYM to the orchards.
8. Write the name of two recommended amla cultivars.
9. What is the pit size for the plantation of fruit crops?
10. Name the fruit trees recommended for cultivation in district Amritsar.

b) Answer in one to two sentences:

1. Which kind of soil is suitable for plantation of fruit trees?
2. Name the fruit trees recommended for cultivation in Sub-mountainous zone?
3. Name the fruit trees recommended for cultivation in arid-irrigated zone.
4. Define evergreen fruit trees with suitable examples.
5. Define deciduous fruit trees with suitable examples.
6. What is square system of planting?
7. What is the irrigation interval for the fruit trees?
8. What is the depth of water table for successful cultivation of orchards?
9. What do you mean by Filler system of planting the fruit trees?
10. From where the nursery plants should be purchased?

c) Answer in five to six sentences:

1. What points should be kept in mind while purchasing the fruit plants from nursery?
2. Describe the various planting systems of orchards in detail.
3. Why the training and pruning of fruit trees is necessary?
4. What points should be kept in mind while harvesting the fruits?
5. Write down a short note on the use of fertilizers in orchards.

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Lesson -6

AGROFORESTRY

Our National Forest Policy (1988) envisages that the plain states should have 20 per cent of its geographical area under forests for environmental stability and to meet the needs of demands for wood. Punjab is an agrarian state having maximum area under agriculture, thereby having only 6.49 per cent area under forests (2013). There is little scope to bring more area under forests directly. However, growing of trees on farms along with agriculture crops will help to achieve the desired forest/tree cover in the state. Agroforestry is a land management system which helps to maintain environmental stability and diversification of agriculture.

Agroforestry: Agroforestry is land management system where tree and crops are grown together along with rearing of animals is undertaken on same farm/ piece of land alternatively and sequentially. The main objective of agro-forestry is to meet the demands of the farmer's viz, food, fuel, fodder, fibre and fertilizers along with maintenance and amelioration of natural resources (land, water and air). The income of the farmers increased through the adoption of this system than traditional agriculture cropping system (Rice – Wheat).

Main Agroforestry Models:

1. Boundary plantation
2. Intercropping in block plantations

Boundary plantation: In this system farmers raise trees on the boundaries of their fields in one or two rows. The trees are planted in systematic manner and these do not create disturbance in the operations of agriculture. The application of water and nutrients to agriculture crops are also available to these trees and these trees grow better. Trees should be planted in North- South direction on boundaries. The trees affect crops yield when intercropped. The correct selection of tree species with desirable characters for agroforestry and by increasing spacing in rows and in plants in a row helps to reduce the adverse effect of trees on crops. Many trees

can be planted on boundaries. These are Eucalypts, Poplar, Tut, Subabul, Drek, Siris, Lassora, Sohanjana, Neem and Tahli etc.

Intercropping in block plantations: In this model trees are grown in whole field. In the interspaces of tree lines crops viz., wheat, Sarson, Turmeric, Mentha, Ginger, Colocasia, fenugreek, carrot, cabbage, chukander, Potato, Spinach and Garlic etc. are grown. Generally big farmers adopt this type of agroforestry. For planting in block plantations tree i.e. Poplar, Eucalyptus, Dhrek, and Tun are good choices.

Fig. 1. Intercropping with Poplar

Tree selection for various agro climatic zones of Punjab:

On the basis of climate, Punjab is divided into three major agroclimatic zones. Every tree species needs different soils, water, and climatic requirements. Due to this, different tree species are grown in these zones.

1. **Sub-mountainous zone :** The topography of this region is undulating, due to which soil erosion is a major problem in this region. Irrigation facility is lacking in this region and farmers adopt rain fed farming. In this region mainly trees i. e. Khair, Kikar, Tahli, Ber, Toot, Nim, Mango, Kachnar, Bel, Amala, Phali, Dhak, Chhal, Beri , Subabaul, Sohanjana, Dek, Harar, Behra and Arjun are grown. In winters, the scarcity of fodder is felt in this area. To meet the shortage of fodder in winter in this region trees viz., Dhak, chhal, Beri, Kachnar are chopped for fodder. Mango and Citrus are also grown along timber trees in orchards in this region. To save orchards from wild life Jatropha, karonda and Ipomea like shrubs are grown around the orchards.
2. **Central Plain region**: Poplar, Eucalyptus and dek are grown along with intercrops in this region of Punjab.
3. **South –Western region**: The underground water in this region is saline, which has resulted in salinity and alkanity problems of soil in this region. The trees like Kikar, Tahli, Nim, Jamun, Amb, Dhrek, and Toot are found in this region.

The commercial agroforestry.

Mainly Poplar and Eucalyptus are grown in lPunjab for commercial agroforestry. These trees are suitable for agroforestry in Punjab. There is no problem of marketing of wood of these two trees and return from these trees is higher than wheat –rice cropping system.

Fig. 2 Poplar pure plantation

(A) **Poplar**: The cultivation of Poplar is capable for diversification of agriculture, wood production for small enterprises (Ply, Match sticks, and packing cases) and employment generation. The characters of tree such as straight bole, narrow crown and leaf shedding in winter (deciduous in nature) make it a good choice for agroforestry as it causes meager loss to agricultural crops in *rabi* season. Poplar is more successful in bet areas. The loamy- sand to sandy – loam soil with good drainage and having pH 6.5 – 8.0 is good for cultivation of Poplar. Poplar cultivation is not successful in Kallar and waterlogged soils.

Poplar clones: Punjab Agricultural University, Ludhiana recommends the cultivation of Poplar clones viz., PL-1, PL-2, PL-3, PL-4, PL-5, PL-6, PL-7, L-47/88 and L-48/89 in Punjab. For planting of poplar, dig the pits of 15-20 cm diameter and 3 feet deep in its planting season in the month of January –February. To save the plants from termites and diseases treat them with chloropyriphos and Emisan-6. Irrigate the plants immediately after planting. For boundary

Fig. 3

Agroforestry Model: - Poplar + Wheat

planting of Poplar tree, 3m tree spacing should be kept and for whole field a spacing of 5 × 4 and 8 x 2.5 m is recommended. Approximately 200 trees /acre can be planted. No pruning is required during the first year. But during second year onwards pruning in winter after leaf shedding is carried out to make tree straight and good form. The poplar tree becomes ready for harvest after 5-7 years.

(B) Eucalyptus: Eucalyptus clonal plants needs to be planted in agroforestry to obtain uniform growth in all the trees and to obtain higher yields as the trees of seed origin does not grow uniformly due to cross pollination in Eucalyptus. Eucalyptus based agroforestry is economical due to its straight and fast growing nature, self pruning and use of its wood for multi purposes. It can be planted on boundary or in block plantation.

Eucalyptus plants can be obtained from the nurseries of Department of Forests and Wildlife Preservation, Punjab, Punjab Agricultural University, Ludhiana or private registered nurseries. Planting of Eucalyptus can be done in the months of March-April and July – August. Pit size required is 60 x 60 cm. Dig it and fill it up to 30 cm and expose the pit soil to sun for sterilization. Treat the pit soil with Chlorpyriphos and Emisan-6. At the time of planting keep the earth ball of the plant in the centre of the pit and fill the pit with soil and FYM mixture of 1:1. Irrigate the plants immediately after the planting.

Boundary planting can be done at a spacing of 2 meter. Approximately 500 plants can be planted in a acre for block plantation at a spacing 4 × 2 m. Tree line should be kept in North –South direction. In plantations with this spacing intercropping can be done for 3-4 year. But if intercropping is to be done for a longer period then spacing between lines should be increased from 4 m to 8 m or plantations of 4 × 2 m can be thinned after 3-4 year by removing one alternate row. For timber production eucalyptus can be harvested after 13-15 year, for pulp 6-8 years and for batten 4-6 years.

Exercise

A) Answer in one to two words:

1. How much area should be under forests in Punjab, as per National Forest Policy 1988?
2. How much area is under forests and tree cover in Punjab?
3. How many major agro climatic zones are there in Punjab on the basis of climate?
4. In which season acute shortage of fodder is felt in Kandi region of Punjab?
5. What is the spacing for planting of Poplar on boundary of a field?
6. What types of soils are there in Kandi region?
7. Name two trees used for fodder in Kandi region.
8. What should be the pH of soil for poplar cultivation?
9. Name the trees suitable for commercial agroforestry in Punjab?
10. How many Poplar plants are planted in per hectare?

B) Answer in to one to two sentences:

1. What is the planting time of Poplar in Punjab?
2. Define agroforestry.
3. What type of soil and irrigation facilities are available in Central plain zone in Punjab?
4. What types of trees are found in S-W region of Punjab?
5. Write down planting and spacing requirements of Eucalyptus.
6. Write the clones of Poplar planted in Punjab.
7. What is the planting time of Eucalyptus in Punjab?
8. Write down the names of the industries where poplar wood is used.
9. What is the spacing for Poplar planting?
10. Write the name of trees grown in Kandi region.

C) Answer in five to six sentences:

1. Write down the clones planted and spacing for poplar planting in Punjab.
2. Write down the source of clonal *Eucalyptus* plants in Punjab.
3. How poplar can be planted?
4. Where poplar wood is used?
5. Why Poplar and Eucalyptus are suitable for commercial Agroforestry?

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Chapter -7

CONTRIBUTION OF AGRICULTURE IN ECONOMIC DEVELOPMENT

India is an agricultural country. More than two-third of its population is dependent on agriculture for its livelihood and lives in villages. Agriculture and its allied activities play a significant role in Gross Domestic Product (GDP) and it is thus considered to be the backbone of Indian economy. In the year 2012-13, the share of agriculture in country's GDP was 13.7 per cent.

Agriculture is undoubtedly a big source of employment for the people. In India, it is estimated that 54 per cent of labour force is directly engaged in the agricultural sector. For the economic development of the country, it becomes almost a necessity to reduce the dependence of large proportion of population on agriculture. The people who had to face hardships of seasonal and disguised unemployment should be employed in secondary and tertiary sectors. It is a fact that with the growth and development of a country, the dependence on agriculture automatically decreases and reliance on service sector increases.

In our country, people engaged in agricultural sector are also involved doing its allied activities. About 70 million of the households are engaged in dairy farming in India, which is even more than the total population of many countries in the world. Agro-enterprises such as dairy farming, poultry farming, fish farming, piggery, animal husbandry, beekeeping, forestry, etc. are to some extent, dependent upon agriculture. Fodder for animals and trees and flowers for honeybees are the integral part of agriculture. These enterprises, besides providing better and nutritious diet to the people in the form of milk, eggs, meat, fish, honey etc. also supplement the income of those who adopt these agro-enterprises. It helps in capital formation which strengthens the economy of the country.

Agriculture is also important for the industrial development of a country. Many basic industries get raw material from agriculture, for example cotton for textile industry, sugarcane for sugar industry, jute for jute industry etc. Many small and cottage industries like rice-shellers, oil mills etc. too depend on agriculture for

the supply of raw material. Moreover, the industrial sector gets market for its produce in agricultural sector. The marketing of tractors, agricultural machinery, fertilizers etc. which are produced in industries depends upon agricultural growth and income of farmers. Therefore, it can be said that industrial sector grows with the growth and development of agriculture. The development of these two sectors led to the economic development of the country.

Next to the agricultural (Primary) and industrial (Secondary) sectors in an economy, the third and the last sector is service or Tertiary sector. This sector provides services such as banking services, transport facilities, warehouses, insurance, tourism, etc. to agricultural and industrial sectors. This sector, too, registers a growth with the development in agricultural sector. The transportation of foodgrains from the state or place where it is available in abundance to the state or place where it is in short supply, development of means of transportation and to augment the income of the people engaged in it, all depends upon agriculture. Similarly, the railways which transport agricultural produce from one place to another benefits economically and with this the railways expand their network.

Agriculture is a major source of food. India is the second largest populous country in the world. As per an estimate, about 60 per cent of the household consumption is derived from agriculture. Immediately after independence, our country had to rely on import of food grains for decades. The use of high yielding variety seeds, farm machinery, chemical fertilizers and pesticides, constant research by agricultural scientists and tireless work of farmers ushered in Green Revolution in the country. Besides, the increase in production of cereal crops such as wheat and rice, the production of non-food crops like tea, coffee, spices, fruits, vegetables, etc. also increased many fold.

In India, the production of foodgrains was 51 million tones in 1950-51 which increased to 264 million tones in 2013-14. The yield of food grains also increased to about 2125 kilograms per hectare. The country has now become self sufficient in the field of food grains. Despite continuous increase in the population, in the year 2012, the country had a buffer stock of 82 million tones of foodgrains which was itself a record. This stock of foodgrains helps in exercising control on prices in case of its inflation in future under the fear of fall in supply. With the control over foodgrains prices, the prices of other commodities are also controlled.

In our country, the poor and needy get foodgrains every month from this stock under Public Distribution System (PDS). Food security in the country could also be ensured due to buffer stock of foodgrains and agricultural development.

The Government of India has enacted Food Security Act in 2013, by which it is provided that 75 per cent of rural and 25 per cent of urban population will be given 5 kg of foodgrains per person of foodgrains every month. About 61 million tones of wheat would be supplied at a subsidized rate to feed about 82 crores of population ever year. This is a significant scheme for the poor.

India's foreign trade is closely linked with agriculture. Many agricultural products such as tea, coffee, cotton, oil, fruits, vegetables, pulses, cashew nuts, spices and even rice and wheat are now exported. In year 2012, India got first position in rice exports which was previously held by Thailand. As per Economic Survey 2013, India is now placed at number ten in export of agricultural produce and foodgrains in the world. Besides this, cotton textiles, yarn, readymade garments and jute products are also exported. India's gross agricultural exports stood at 42 billion dollar in 2013-14 whereas, during the same period, total agricultural imports were worth 17 billion dollar. During the year 2013-14, India's balance of trade was surplus of 25 billion dollars.

Agriculture is also a major source of revenue for the central and the state governments. The central government levies import duty on the import of agricultural items and thereby earns revenue. The state governments generate their chunk of income through land revenue, irrigation tax, etc. Besides this, the fee imposed on marketing of agricultural crops brings good income to the Government exchequer. The revenue, thus, generated is again spent on economic development of the country in a planned manner which makes economy of the country strong.

Exercise

(A) Answer in one to two words:

1. How much population of our country lives in villages?
2. What proportion of labour force in India is dependent directly on agriculture?
3. What is the contribution of agriculture in gross domestic product in the country?

4. How much food grains were produced in 1950-51 and how much did it increase to in 2013-14?
5. Which are the three sectors of Indian economy?
6. Where does India stand in foreign trade?
7. Which country has been left behind by India in the field of rice export?
8. Name the major industries dependent for raw material on agriculture.
9. In which year the Food Security Act was passed?
10. What is India's agricultural balance of trade?

(B) Answer in one to two sentences:

1. How agricultural development is linked with dependence of population on agriculture?
2. What are the main agricultural exports of India?
3. What are the main agricultural imports to India?
4. Name a few agricultural based enterprises.
5. Why a buffer stock of food grains in the country is maintained?
6. What are the main provisions of Food Security Act, 2013?
7. How development of railways is linked to the agricultural development?
8. Name the industries which depend upon agriculture for marketing of their products.
9. What type of unemployment do we find in agriculture?
10. What are the benefits of allied activities of agriculture?

(C) Answer in five-six sentences:

1. What is the contribution of agriculture in economic development of India?
2. What is the significance of agriculture in India's foreign trade?
3. What were the main reasons of Green Revolution in the Country?
4. Why the pressure on agriculture should be reduced in India? Give reasons.
5. How does agricultural and industrial growth depend on each other?

Activities

1. Visit a nearby market and get the details of fees and taxes imposed on agricultural produce.
2. Visit nearby agro-based industry and get information about the raw material(s) used and produced thereof.
3. How tourism in agricultural sector can be promoted? Collect some beautiful pictures related to agriculture.
4. Make a list of those agricultural items which are exported to other countries from the state of Punjab.

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Chapter-8

AGRO BASED INDUSTRIES

Due to limited opportunities for jobs in government sector, unemployment is increasing day by day. The only and easy solution to this problem is that students should be trained in vocational subjects along with the traditional education, so that they can employ themselves in some productive work after completion of their study. Under the subject of agriculture, the Government has started providing technical knowledge in agro based entrepreneurship development along with providing financial support and other facilities. The Government is providing low interest rate loans and other subsidies for numerous agro based industries. By grabbing such opportunities, the rural youth can start business of his/her choice and unemployment can be eradicated from the society.

Due to lack of good resources for storage and processing in the country, post harvest losses of the crops are quite high. In grains, this loss is approximately 10%, whereas in fruits and vegetables, loss is as high as 30-40 %. To enhance the farm income, there is a need to reduce the post harvest losses and to do the processing of agricultural produce. A lot of emphasis is being given on crops diversification. Farmers are cultivating new crops such as chili, turmeric etc. These crops are to be processed before they reach the consumer. It is the need of the hour, that along with the traditional crops, these crops should be processed at small/ farmers' level. This will provide access to the rural areas to the quality products in rural areas as well as generation of employment and enhancement of farmers' income. Consequently, the migration of the people to the cities will reduce and backward areas will be developed.

The land holdings are reducing day by day, the rural youth can start a number of agro based activities and employ themselves. The activities can be poultry farming, dairy farming, honey production, mushroom cultivation or small scale agro processing. All these works can be successful, if farmer does the marketing himself. Some of the agro based industries, which can be started at village level, are listed below

1. Agro processing complexes
    a. Mini Rice mill
    b. Small Flour mill
    c. Oil expeller
    d. Grinder
    e. Cotton ginning machine
    f. Pulse cleaner and grader
    g. Mini dal mill
    h. Small feed mill
2. Turmeric processing plant
3. Mentha processing unit
4. Jaggery manufacturing
5. Drying of vegetables and their packaging
6. Dehydration and freezing plants for fruits and vegetables

1. Agro Processing complex

For processing of food grains, agro processing complexes are very successful in rural areas of Punjab. These complexes can have machines such as mini rice mill, small atta chakki, oil expeller, grinder, dal mill, cotton ginning machine and feed mill etc. The crops such as paddy, basmati, wheat, oil seeds, spices, pulses and cotton etc can be processed in these complexes. The cost of the machines installed in these complexes may vary from Rs 5 lakh to Rs. 20 lakh, depending upon the number of machines installed. The entrepreneur can earn 10000-50000/- per month and provide employment to 2 to 6 persons. These complexes can be a good source of income in rural areas and also quality products will be available locally.

2. Turmeric Processing Plant

Turmeric is very important and commonly used spice, which has a huge demand in foreign countries. Turmeric is used in different vegetable curries to give taste, flavour and colour. Moreover it is used in medicines, cosmetics and as dye for cotton clothes. In recent years, this crop has attracted attention of the

farmers of Punjab. Along with cultivation, the farmers are also processing it at small scale level.

For processing, first of all the turmeric rhizomes are washed so that soil sticking to it can be removed. For this purpose, Punjab Agricultural University has developed a turmeric washing and polishing machine. This machine can wash 2.5-3.0 quintals of turmeric in one hour. Thereafter, washed turmeric is boiled so that the fingers become soft and colour is uniform. In open vessel, it takes almost one hour for proper boiling. If it is boiled in big pressure cookers, 20 minutes are required. After boiling, turmeric fingers are dried in open sun so that moisture comes below 10 %. It takes about 15 days in good sunshine. Dried turmeric is polished to remove dust and upper brown layer. Then the above mentioned machine can be used for this purpose. This machine can polish one quintal of dried turmeric in one hour. Polished turmeric fingers are grinded in a grinder (hammer mill). About 15-20 kg powder can be obtained from 100 kg fresh turmeric.

3. Mentha Processing Plant

The farmers can install mentha processing plant for extraction of oil from mentha crop. First of all, the crop is dried in open sun for 1-2 days so that some moisture is removed. Thereafter mentha leaves are put into air tight tanks and pressurized steam is passed inside these tanks. The mixture of water vapours and oil are removed from the tank and cooled immediately. The mixture of oil and water is collected in tanks, called separators. Due to low density, oil comes to the upper layer and is removed. This oil is stored in plastic containers. Deoiled mentha leaves are dried and used as fuel. Along with the processing of their own crop, farmers can process the crops of other farmers also on custom hiring basis and enhance their income. Mentha oil is used in medicines, perfumes and cosmetics etc. Such type of plants can be seen near the mentha producing areas of Punjab.

4. Jaggery Manufacturing

Inspite of the bigger sugar mills, lot of sugarcane is still used for making jaggery (*gur, shakkar* etc). Sugarcane can also be processed at village level. For this, farmers can install cane crushing and other machinery (*Kulhadi, velna* etc.) and can make gur shakkar from sugarcane juice. About 10-12 kg jaggery can be produced from 100 kg sugarcane.

5. Drying and packaging of vegetables

Some other crops such as fenugreek leaves (methi), coriander (dhania), chili, garlic and many medicinal plants can be dried in sun to make powder. This powder can be packaged in polythene bags and marketed. Solar dryers can also be used for this purpose. Some progressive farmers and societies are doing this business successfully.

6. Dehydration and freezing plant for fruits and vegetables

For processing of fruits and vegetables, dehydration and freezing plants can be installed. But these plants require huge investment (Rs. 30 lakhs or more). In this plant, many machines such as blancher, washing machine, dehydrator, slicer, pre cooler and freezing units are installed. Technical knowledge is very necessary to operate these machines. It will be better, if such plants are installed at society level, not at farmers' level. One plant can fulfill the need of many villages. The farmers can bring their produce in such plants, get it processed and take it for marketing. Once the farmer is convinced about the financial viability of the plant, then he can have such plant at his own level. During processing, some functions can be done manually and some with machines. By following this method, the initial investment can be reduced.

All these ventures can be done separately or along with agriculture. Before starting any enterprise, basic training is required. Punjab Agricultural University, Ludhiana is an important institute for providing such trainings. The University and Krishi Vigyan Kendras at district headquarters organizes such training courses during different times of the year. The full schedule of such training courses can be obtained from university. The University magazines "Changi Kheti" and "Progressive Farming" also publishes such schedule from time to time.

By establishing such agro based industries, the problem of unemployment can be reduced up to some extent. Quality produce can be obtained through processing. The educated rural youth should come forward for such type of ventures and grab the opportunity.

Exercise

A) Answer in one to two words:

1. Which crops can be dried and powdered at domestic level?
2. From where the training on agro based industries can be obtained?
3. Name any two machines installed in agro processing complex
4. List the items in which mentha oil is used.
5. How much jaggery can be made from one quintal of sugarcane?
6. What is the percentage of post –harvest losses in grains?
7. What is the pre requisite for starting any agro based industry?
8. How much powder can be made from one quintal of raw turmeric?
9. How water and oil are separated during mentha processing?
10. Name any two rural agro-based industries.

B) Answer in one to two sentences:

1. What type of agro based industry can be set at cooperative level?
2. Why post harvest loss is taking place in our country?
3. What should be done to reduce the post harvest losses?
4. How agro based industries can be helpful in enhancing income of the farmers?
5. Discuss the method for processing mentha.
6. Describe the machine developed by PAU, Ludhiana for processing of turmeric.
7. What are the technical operations related with jaggery manufacturing?
8. Discuss any three machines used in agro processing complexes.
9. Why can't the freezing plants for fruits and vegetables be installed at farmers' level?
10. Which agricultural products can be used at home after drying?

C) Answer in 5-6 sentences:

1. Discuss the advantages of setting up of agro processing complexes in Punjab.
2. What type of machinery can be installed in a small agro processing complex and which crops will be processed?
3. What should be done to stop the migration of people from rural to urban areas?
4. What should be the policy for capital intensive agro processing industry?
5. Discuss the various operation involved in turmeric processing.

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Chapter-9

CERTIFIED SEED PRODUCTION

Ever since ushering of Green Revolution with the introduction of semi dwarf Mexican wheat varieties like Lerma Roso & Sonora-64 in 1965-66, farmers became aware about the importance of improved seeds for getting high yields from their crops. As a consequence quality seeds have become a most sought-after agricultural input and their demand is increasing day by day. In spite of all these progressive developments, very few farmers are aware of the genetic basis of quality seeds. Most of them depend on market to meet their seed requirements and many times face frustration and suffer loss due to substandard seed. Young farmers may adopt certified seed production as profitable and farmer friendly venture. In this chapter, we will study the seed quality concept and guidelines for initiating this enterprise.

Certified seed: Vegetative parts of a plant such as roots, stem cuttings, bulbs, suckers which are used to plant new crop are considered and included in seed. Seed which is produced by following various field and seed standards under the supervision of Punjab State Seed Certification Authority(PSSCA) is known as certified seed.

Characteristics of certified seed:

1. Purity of such seeds is confirmed that seed is pure and true to the type as specified in the Seed Act.
2. Certified seed is free from any diseased/weed seed.
3. The germination of such seeds is confirmed through laboratory tests.

These are some of the important features of certified seed. For example for certified seed of wheat minimum germination is 85%, minimum purity is 98% and moisture content not more than 12% .Similarly certified seed of rice/paddy must have minimum 98% purity, minimum 80% germination and moisture content not more than 13%.

Identification of certified seed: A certified seed beg bears two tags, one issued by the PSSCA and the second by the seed producing company. These tags have full details regarding seed quality factors.

Physical factors of seed quality: These factors comprise seed germination, color, size, seed weight, moisture content, presence of inner matter and weed seed in a given sample of seed. If the proportion of broken seed is more, the seed germination will be less. Physical examining of seeds can only ensure physical purity of seed for some parameters such as absence of dust, %age of broken seed or seed color etc. but it cannot judge genetic purity of seed which is more important.

Hereditary traits and Genetic basis of quality seeds: Crop plants express various characters / traits which determine ultimate yield of a crop. Yield contributing traits vary from crop to crop. For instance, number of tillers per plant, ear length, number of seeds in a ear, 1000 seed weight, plant height, resistance to various diseases/insect pests/abiotic stresses etc are all important yield contributing traits in wheat crop. All these traits are determined by the genetic factors or genes whose expression is highly influenced by various environmental factors such as soil type, temperature, humidity and other climatic factors. Such traits are heritable because their contributory genetic factors are transferred from parents to offspring through seed thus expressing such traits in the next crop also. For instance, high yield of wheat varieties such as WH1105, PBW621 and HD 2967 is due to superior genes or genetic factors. Genuineness of a variety therefore, cannot be determined by merely physically judging a sample of seeds because these genetic factors or genes are invisible. Their presence can be seen only through expression of a particular trait in the next generation called progeny. The only option left for the farmers is that they should buy certified seeds which are produced from a known pedigree source by following seed certification norms.

Seed Act 1966:- In order to provide true to type seeds of a recommended / notified variety at affordable price to the farmers, Govt. of India enacted a law known as 'Seed Act 1966'. The objective of this seed act was to regulate various activities relating to seed production, seed certification, seed testing, seed packaging and seed marketing in the country. In the light of this act, seed certification authority and seed testing laboratories were established throughout the country to fulfill mandate of this act. Accordingly, Punjab State Seed Certification Authority whose

head office is at SCO 837-838 Sec 22A, Chandigarh and its regional offices in Jalandhar, Ludhiana and Kotkapura, were established to oversee seed certification work in Punjab. Seed testing laboratories were established at PAU, Ludhiana and Gurdaspur. Farmers / seed entrepreneurs may visit and seek guidelines from a nearby office of seed certification authority before initiating seed production venture.

Classes of Seed: There are four classes of seeds namely nucleus seed, breeder seed, foundation seed and certified seed, identified in this seed act.

1) Nucleus seed of a variety is produced and maintained by the institution or breeder who developed that variety.

2) Breeder seed is seed whose production / maintenance is directly controlled by the sponsoring plant breeder of the originating institution where that variety was developed. Breeder seed is the progeny of nucleus seed.

3) Foundation seed shall be the progeny of breeder seed or can be produced from foundation seed under special circumstances.

4) Certified seed shall be the progeny of foundation seed or it may be produced from certified seed under special conditions. Certification tags shall be of white colour for foundation seed, blue color (Azure blue) for certified seed and yellow colour for the breeder seed. Foundation seed is normally produced by Government seed producing departments like PUNSEED, PAU Seed farms and big private seed companies. The foundation seed so produced is used to produce certified seed in huge quantities at farmers' fields. The seed which is not certified by the PSSCA but otherwise it conforms to all seed and field standards is known as truthfully labeled seed (TL).

Minimum Field and Seed Certification Standards: In order to ensure genetic purity and physical quality of the seed two types of quality standards: Field Standards and Seed Standards are followed for seed production.

1) Field standards include isolation distance, presence of off-type plants / weed plants / diseased plants in a seed crop. Isolation distance and removal of off-types is very essential to keep away any foreign pollen from spoiling the genetic quality of seed.

2) Seed standards like seed germination, physical purity of seed, presence of weed seed/diseased seeds/other crop seeds and moisture percent in seed have also been specified. Seed producing agencies are required to observe and follow these standards for the certification of any seed production programme. It is mandatory to mention seed standards on seed tags and seed bags. Minimum field and seed standards for various crops are also given in the 'Package of Practices' book published by PAU, Ludhiana.

Seed Crop Inspection: After registration of a seed production programme in the nearby office of Punjab State Seed Certification Authority, the officials of this department will visit to inspect seed crop at different stage of crop to ensure sanctity and validity of the seed and to record observation on various aspects of the seed crop and issue a crop inspection report. The seed producers must take care that their crop should be free from off-type / weeds and diseased plant as per certification standards.

How to Initiate certified seed production on commercial scale:

1. The new entrepreneur must have sound knowledge and required expertise in the field of seed certification and seed marketing which can be acquired by joining various training courses on seed production offered by PAU at its KVK centers or by making personal contracts with related departments such as PUNSEED, Seed Certification Authority or department of agriculture.
2. Select a crop which suits to your area. Proper planning for required infrastructure and marketing of seed is very essential.
3. Make a seed firm and got a seed license from Department of Agriculture.
4. Seed production infrastructure such as seed grader for cleaning of seed, threshing flour, stores, bag closer machine are some basic requirements for a seed production enterprise.
5. Procure foundation seed of the variety for certified seed production from Director Seed, PAU Ludhiana.

6. Raise the crop from foundation seed and register this crop with Punjab State Seed Certification Agency (PSSCA).
7. Remove off-type and diseased plants from the seed crop as per guidelines of the PSSCA.
8. Harvesting, cleaning and packaging of seed should be done under the supervision of PSSCA.

Profit and Risks: Seed production is basically a farmer friendly enterprise. Farmers are already producing crops but if such crops are raised by following various field and seed standards, they can convert their general crop produce into valuable seed. Besides generation of employment opportunities, seed production also offers considerable profits. For instance, the minimum support price of wheat during the year 2014-2015 was Rs.1450 per quintal, but the certified wheat seed is being sold at Rs. 2000-2500 per quintal by various seed companies during October 2015. Profits in other cases like hybrid seed production, potato seed production, vegetable seed production and flower seed production are much higher. There are some risk factors such as seed may remain as unsold or due to any lapse seed may fail in laboratory tests. However, in such cases there shall not be a total loss because the unsold seed produce or unfit seed may be easily disposed off as ordinary produce in the market.

In nutshell, certified seed production enterprise may be regarded as highly promising but it requires proper planning and commitment at the part of entrepreneur.

Exercise

(A) Answers in one to two words:

1. Write names of two Mexican wheat varieties which were introduced in India in sixties?
2. Write name of machine which is used for cleaning of seed.
3. Write name of two recently recommended varieties of wheat.
4. How many tags are stitched on a bag of certified seed?

5. What is the colour of tag which is used to label foundation seeds.
6. Write full form of TL.
7. In which year, Seed Act was passed?
8. What is the minimum germination percent of certified wheat seed?
9. Give minimum purity of certified seed of rice.
10. Write one important yield contributary hereditary trait of cotton plant.

(B) Answers in one to two sentences:

1. What are the objectives of Seed Act? When was this regulated?
2. List two important hereditary and yield contributory traits of cotton plant.
3. Define foundation seed.
4. Write full name of agency which certifies the quality of seed.
5. List three important yield contributory traits of wheat plant.
6. Who produces breeder seed?
7. List three parameters of physical quality of seeds.
8. Define a certified seed.
9. What is the importance of isolation distance in seed production?
10. Why removal of off types from a seed crop is so important?

(C) Answer in 4-5 sentences:

1. Differentiate hereditary traits from phenotype or physical quality traits.
2. List three important field standards in seed production.
3. Explain seed standards for a certified seed production.
4. Explain procedure for certified seed production on commercial scale.
5. List important points for starting seed production enterprise.

Chapter-10

BENEFICIAL AND HARMFUL ANIMALS IN AGRICULTURE

Animals are an important part of our ecosystem. Some of them are useful and some are harmful to agriculture. In this article some birds are mentioned which are useful to agriculture. Along with these, the management methods to protect crops from some species of harmful birds and rodents are also described.

(1) Useful animals: Both insectivorous and rodentivorous birds are included in useful animals**.** Ninety eight per cent of total bird species in India are useful to agriculture. Some of these are Drongo, Lapwing, Myna, Blue jay, Owl, Cattle Egret and Hoopoe. A single pair of House Sparrow feeds insects to its young ones about 250 times a day. Predatory birds like owls, falcons, eagles, kites etc. eat a large number of rats and mice. Because of these reasons, these birds should not be killed or harmed. A single owl normally eats 4-5 rats a day. Some of the useful birds are given below:

i) **Blue Jay**: It has rufous-brown breast and pale blue abdomen and is of Blue Rock Pigeon size. Insects form its main diet. It makes its nest in cavities of the trees.

ii) **Red-wattled Lapwing**: Its colour is bronze brown from above and, white from below. The head, breast and neck is black in colour. Its food comprises mainly of insects and snails. It makes its nest on ground.

iii) **Cattle Egret**: The colour of this bird is white with yellow beak. It is often found following ploughing tractor and eating insects. This bird makes its nest in the form of colony on the trees.

iv) **Spotted Owlet**: This bird is of grayish brown colour with white spots. The colour of its eyes is yellow. Its food consists of insects, mice and lizards. It makes its nest in the cavities of the trees.

v) **Hoopoe**: This bird has black and white strips on wings, tail and upper part of the body. It has fan shaped crest and long gently curved bill. It makes its nest in the cavities of the trees. Insects form its main food.

Measures to protect birds in the surroundings are given below:

a) Traditional trees like *peepal, tahli, kikkar* and *toot* should be planted to provide natural habitat.

b) Breeding facilities to birds should be provided by installing wooden and earthen artificial nests on trees and other suitable places.

(2) Harmful animals:

Rats are the most important harmful animals. They cause heavy losses to the crops.These cause more damage at seedling and ripening stages of the crops. The average damage to sprouting and ripening wheat crop have been recorded to be 2.9% and 4.5 % respectively. This damage is 1.1% at ripening stage of pea crop and 10.7% at the sprouting winter maize crop. The rodent damage to the maturing wheat crop fields adjoining to sugarcane fields, canals and roads may be up to 25 per cent. Some important species of rodents and their management methods are mentioned here.

1. Species of Rodents: There are 8 important species of rodents and mice in Punjab. These are Indian mole rat, the soft furred field rat, the Indian bush rat, the Indian gerbil, the short-tailed mole rat, the house mouse, the field mouse, and the brown spiny mouse. Of these, the Indian mole rat is predominant in paddy-wheat and sugarcane growing areas. Bet areas have predominant populations of the Indian mole rat while the kandi region (district Hoshiarpur) has the Indian gerbil and Indian bush rat.

2. Methods of rodent control:

A. Mechanical control

i) Killing: During the irrigation of vacant harvested fields rats coming out of flooded burrows should be killed with sticks.

ii) Trapping: Use double chambered multi-catch trap which is developed by P.A.U. It has tunnel type entrance. With this type of trap many rats can be trapped at the same time. There are many types of traps available in the market. Before use wash the traps to remove any odour in them. In crop fields, place 16 traps/acre

covering runways, damage and activity sites of rodents. In houses, godowns, poultry farms etc., place traps (1 trap/4-8 square meter area) along with walls, in corners, behind the storage bins and boxes etc. For use in cold stores, cover the traps by wrapping paper around them.

iii) **Pre-baiting**: To trap more rodents, pre baiting should be done in these traps. Place 10-15 gm pearl millet, sorghum or cracked wheat or their mixture smeared with 2% groundnut or sunflower oil and 2% powdered sugar for 2-3 days having open entry of traps.

iv) **Trapping of rodents**: After pre-baiting close the traps by placing 10-15 gm of the plain bait on the piece of paper in the main chamber and a pinch of bait on the smaller piece of paper in the trap tunnel. Now kill the trapped rats by drowning in water. Traps can be used in the same location after an interval of minimum 30 days.

B. Chemical control:

Method of baiting: Zinc phosphide and bromodiolone are being used for baiting for rodents.

a) **2% Zinc phosphide bait**: Smear 1kg of bajra, or sorghum or cracked wheat or their mixture with 20 gm of sunflower or groundnut oil, 20 gm powdered sugar and mix it thoroughly with 25 gm of zinc phosphide. Never add water in this bait.

b) **0.005% Bromadiolone bait**: Mix 20 gm of bromadiolone powder, 20 gm of groundnut or sunflower oil and 20 gm of powdered sugar in 1kg of any cereal flour.

Bait placement and timings:

1. **Baiting in May- June**: During this period, the rat burrows can easily be located in the fields. Close the burrows in the evening and on next day in new reopened burrows insert a paper containing 10 gm of zinc phosphide or bromadiolone bait about 6 inches deep in each burrow.

2. **During mid-February and beginning of March**: It is most suitable time for killing of rodents. Due to cool weather before this time and due to milking stage of crops after this time, rats do not eat bait.

3. **Pre-baiting:** Pre-baiting is essential for the use of zinc phosphide bait. For this place 1 kg of sorghum or bajra or cracked wheat or their mixture smeared with 20 gm of oil at 40 bait points for 2-3 days. Bait of 1kg is enough for two and half acres. After this in same manner baiting should be done with 10 gm of bait at 40 baiting points in one acre.

Precautions during baiting process:

1. Keep the rodenticides and poison baits away from the reach of children, domestic animals, pets and birds.
2. Mixing of rodenticides should be done with a stick, spade or wearing rubber gloves. Save the mouth, eyes or skin from the rodenticides touch.
3. Household utensils should never be used for preparation of poison bait.
4. Use polythene bags for storage and carrying the poison bait. Bury them after use.
5. Collect and burry the left over poison bait and dead rats from the fields.
6. Zinc phosphide is toxic and there is no antidote for it. In case of accidental ingestion induce vomiting by inserting fingers in the throat and then rush to the doctor. Vitamin K is the antidote for bromadiolone and can be given to the patient under medical supervision.

c) Environmental control: Weeds, grasses and bushes should be removed as these provide shelter and food to rodents. Highly infested bunds, water channels and field pavements should be periodically rebuilt to destroy permanent rat burrows.

d) Biological Control: Owls, kites, hawks, falcons, eagles, snakes, cats, mongoose, jackals and monitor lizards are the natural predators of rats and mice. These should be protected.

e) Integrated approach: No single method is 100% effective in controlling rats. Therefore adopt an integrated approach by carrying out different methods at

different stages of the crop. The left over surviving rats after zinc phosphide baiting should be tackled with bromadiolone. Zinc phosphide baiting should be carried out in the crop field after a gap of at least two months.

f) Village level Campaign: For better results in control of rats, village level anti-rat campaigns should be organized. The campaign should be carried out both in cultivated and uncultivated areas at the same time.

(3) Harmful birds:

Out of 300 species of birds of Punjab, only a few cause damage to crops, fruits, to grains in godowns, in shellers and in grain markets. Rose-ringed Parakeet is one such bird that is not beneficial to agriculture. It is the most harmful bird. It causes damage to almost all grain and fruit crops. It is exclusively harmful to sunflower crop. Doves, Pigeons and Weaver birds damage rice in godowns and shellers, for nearly two crore rupees.

Management methods:

a) Mechanical Methods

1) **False gun shots:** Make false gun shots at different intervals to scare the birds.

2) **Use scare crow:** Fixing the scare crow i.e. a discarded earthen pot painted to look like human head supported with wooden sticks and clothed in human dress to give a human like appearance is one of the most effective traditional techniques to keep the birds away. Position, direction and the dress of the scare crow should be changed at least at ten day's interval. The height of the scare crow should be one meter above from the crop height.

3) **Hanging of dummies of crow**: Parakeet is the main pest bird of oilseed crops. Hanging of dummy crow on a stick in the crop damage area should be done. Crows and Mynas will leave that place, even parakeets will also not visit that area. The height of stick should be at least one meter above from the crop height and its position should be changed after a gap of seven days.

4) **Use of automatic bird scarer machine**: Use automatic bird scarers by shifting their position periodically and supplementing their noise with actual gun fires. The other simplest method is the use of rope crackers. It involves tying of sets of small fire crackers at the distance of 6-8 inches apart and igniting it from the lower end. The explosions caused by the fire crackers on catching fire at different intervals scare the birds feeding on the sprouting. Fix up the rope crackers in the centre of the field during sprouting stage where as in maturing crops, fix the rope on a stick in the periphery of the field.

b) Cultural practices:

1) The traditional practice of planting 2-3 border rows of less costly crops like millet, *dhaincha* equally preferred by birds will reduce the bird pressure to the inside sown cash crops particularly sunflower and maize etc. Moreover, planting of these crops also act as physical barriers/wind breakers and help in preventing lodging of crop during stormy/rainy days.

2) As far as possible, sowing of maize and sunflower crop should be avoided at sites most frequently visited by birds or where there are more resting sites like trees, electric wires, building etc.

3) To prevent parakeet damage in sunflower and maize crops sowing should be done in bigger area (at least 2-3 acres). Parakeets avoid feeding/venturing in the core of the field, so it helps in lessening bird damage pressure.

Exercise

(a) Answer in one - two words:

1. How many species of rodents are there in Punjab?
2. In which areas of Punjab Indian Bush Rat is found?
3. How much damage is caused to germinating winter maize by rodents?
4. At how many locations poison bait should be placed in one acre.
5. Name the two rodent eating beneficial birds.
6. Name the bird causing maximum damage to crops?
7. How much should be the height of scare crow from the crop?

8. Name any one chemical used for killing rodents.
9. Where does lapwing make its nest?
10. What does Hoopoe eat its diet?

(b) Answer in one-two sentences.

1. Why we need to protect the agricultural products from harmful animals?
2. Describe the method of pre-baiting for rodents.
3. How to reduce the ill effect of Bromadiolone in human being?
4. How the anti rat campaign can help in eradication of rats at village level?
5. What do you mean by scare crow? What is its role in crop protection?
6. How the oil seed crop can be protected from parakeet damage?
7. Why the crop should not be sown at the places having dense trees?
8. How the beneficial birds help the farmers in protecting the crops?
9. How do you identify the Cattle Egret?
10. What do you know about the precautions to be taken during use of poison bait?

(c) Answer in five –six sentences:

1. How many types of rodents are there in Punjab? Describe the rodent species found in various areas of Punjab.
2. Describe the two methods of preparation of poison bait.
3. How to manage rodents by integrated management methods?
4. Describe the traditional methods used for protection of crops from birds?
5. Describe the mechanical method of protecting crop from birds.

Activities:

1. Prepare the model of scare crow.
2. Prepare the chart of beneficial and harmful birds.
3. Eradicate the rats in school through anti rodent campaign.

Chapter-11

PLANT CLINIC

PAU has established a plant clinic at University Campus under the adminstrative setup of Directorate of Extension Education to provide the diagnostic services to the farmers about the plant health problems. Plant Disease Clinic was earlier established in 1978 under the Department of Plant Pathology with the main objective of providing diagnostic service about plant diseases. In 1993, it was re-designated as Plant Clinic under the control of Directorate of Extension Education to cover all aspects of plant health problems. After realizing its importance, it was made a part of Farmers Service Centre(FSC) in a separate building during 1999 and presently FSC is known as Agricultural Technology Information Centre (ATIC). At present twenty two Plant Clinics are functioning in the Punjab State for the benefit of the farmers under the control of PAU. Among these, one is located at PAU, seventeen in the Krishi Vigyan Kendras (KVKs) at Amritsar, Bahowal (Hoshiarpur), Bathinda, Faridkot, Fatehgarh Sahib, Goneana (Sri Muktsar Sahib), Gurdaspur, Kapurthala, Kheri (Sangrur), Langroya (SBS Nagar), Mallewal (Ferozepur), Mansa, Moga, Nurmehal (Jalandhar), Rauni (Patiala), Ropar, Samrala (Ludhiana) and four at Regional Research Station, Abohar, Bathinda, Gurdaspur and Department of Fruit Science, PAU, Ludhiana.

Plant Clinic

Plant Clinic is a place where diagnosis and remedial measures for plants are provided to the farmers. This building is also famous among the farming community under the name of PAU Clock Tower or *Ghanta Ghar*, located near the gate No. 1 at PAU premises. A multi-disciplinary team of expert scientists of Plant Pathology, Entomology, Soil Science, Agronomy and Animal Science are available at all times in the Plant Clinic for the quick redressal of day-to-day problems of the farmers. The main objectives of Plant Clinic are to address the field problems, deliver improved agricultural knowledge and inputs under single window delivery system. Proper remedial measures are suggested to the farmers after thorough examination of the plant sample by the team of expert scientists. The various activities of Plant clinic are listed below:

1. Live Sample Diagnosis
2. Telephone helpline
3. Mobile helpline
4. E-mail service
5. Whats App. diagnosis
6. Blow-ups / Flex charts
8. Mobile Diagnostic-cum- Exhibition Van
9. PAU Doots
10. Preserved live sample
11. Kisan Mobile Advisory Service (KMAS)

7. Touch Screen Kiosk

Farmers can also get their problems resolved while sitting at their home through telephone helpline 0161-2401960 Ext. 417, Mobile No. (94630-48181) and e-mail plantclinic@pau.edu . Farmers can also use Whats App facility on mobiles for quick solution of their problems by sending picture of the problematic parts of plant.

The KVKs are also providing Kisan Mobile Advisory Service (KMAS) to the farmers for the adoption of agricultural related practices at their field. Eight messages per week are sent to fellow farmers on mobile for the faster spread of technology.

For the dissemination of improved agriculture knowledge to the farmers, the technology developed by the scientists of the university has also been exhibited in the form of colored blow ups/flex charts of the live specimen of the disease/ insects /deficiencies/ weeds problems and preserved life samples for the proper understanding of queries of the farmers. Pictures depicting the symptoms of diseases and pests etc. are also available in plant clinic for quick diagnosis of problems of the visiting farmers.

The Clinic also has a Computerized Touch Screen Kiosk called Information Booth, which depicts the production and protection technology of *rabi* and *kharif* crops from sowing till harvesting. In addition, the specialists also provide the information on production and protection technologies of various fruit, vegetable and flowers grown under Punjab conditions. The most peculiar and important

feature of this Clinic is that these services are being provided to the farmers free of cost by the University.

Recently, a new service has been introduced in the Clinic for the quick dissemination of agriculture technology in which the farmers have been enrolled as 'PAU Doots'. In this, 2-3 messages per week regarding production and protection technology to be followed well in time are regularly communicated through e-mails. These doots are further requested to disseminate the information to the fellow farmers through public address system/loudspeaker of the *Gurudwaras* or Temples for the faster and timely spread of technology. One can also avail this service by sending their email address to plantclinic@pau.edu .

In addition, the expert scientists also disseminate the information regarding the appearance of any insect or diseases in the area along with remedial measures through news papers, magazines, TV or radio for the timely adoption of control measure by the farmers.

The Plant Clinic is also equipped with Mobile Diagnostic-cum- Exhibition Van for dissemination of different technologies of field, fruit and vegetable crops to the farmers with the help of KVKs and Farm Advisory Service Scheme (FASS). It is provided with all kind of audio visual aids crop wise, enterprise-wise, CD's of different crops, Liquid Crystal Display (LCD), microscope, soil and water testing kits and literature for sale so that farmers may be well conversant with the need based technology from time to time. It is being sent to the different districts of Punjab for the benefit of the farming community. For better understanding of problems, the small documentary movies are shown to the farmers and inspection and solution to the queries of the farmers are addressed on the spot. Agricultural literature is also sold to the farmers from this van.

Clinic is also imparting training to the B.Sc. (Agri.) students for the diagnosis of field problems of the crops. The training is also imparted to the extension functionary of State Department of Agriculture, Horticulture and other development departments for the quick diagnosis of plant problems on symptom basis.

The decision regarding spray of insecticides for control of insects should be taken on Economic Threshold Level (ETL). The ETL is the level or minimum

population of insects at which sprays should be initiated to avoid economic damage to the crop. The decision regarding spray of insecticide for control of insect on ETL helps the farmers from unnecessary use of insecticides. For example sprays against whitefly on cotton should be done before 10 AM only when their population reaches six adults per leaf in the upper canopy of plants. A performa for referring sample to Plant Clinic, PAU, Ludhiana for diagnosis of disorder has also been developed for the benefit of the farmers. The farmers must fill the performa while bringing the plant sample to plant clinic. The farmers can also download the necessary Performa from PAU website i.e. *www.pau.edu*

VARIOUS EQUIPMENTS AND TOOLS USED IN PLANT CLINIC

The major equipments and tools used in plant clinic are as follows:

1. **Microscope:** It is used to look the things that are too small or invisible to human eye. After dissection of the plant in order to see the various symptoms of disease, we need a microscope. It helps in precise identification of insect and disease.

2. **Magnifying lens:** A transparent piece of glass used to see the smaller things of various specimens of plant, insects and other micro-organisms.

3. **Knife/Forceps/Needle/Scissor:** These tools are used in collection and dissection of plant specimens for examination under microscope.

4. **Incubator:** A piece of equipment used for keeping plant specimen or media after inoculation with pathogen under controlled temperature and humidity for the proper growth of pathogen. It is further used for identification of causal organisms.

5. **Disinfectants:** Various chemicals like potassium dichromate solution, mercuric chloride, ethyl alcohol, formaldehyde, sodium hypochloride, silver nitrate are used for disinfecting the glassware, soil, diseased bits from plant parts prior to isolation and certain equipment. The material for sterilization is dipped for 1-5 minutes in either of the chemicals and then washed with sterilized distilled water. Inoculation needles, scissors, scalpels, forceps etc. may be dipped in 95 per cent ethyl alcohol and passed through a flame.

6. **Preservation of wet/dry specimens:** Various types of wooden boxes or cabinets are required in which various wet/dry specimens are preserved for further use. Various chemicals are also used to preserve fresh symptoms of various plant diseases in glass containers or jars. These specimens play an important role in training and teaching of students and staff. Formaldehyde, copper chloride, copper acetate, glacial acetic acid, ethyl alcohol, uranium nitrate are required for preservation of specimens. The fresh diseased specimen are put in boiling mixture of 1 part of glacial acetic acid and saturated with copper acetate crystals and 4 parts of water till the green colour reappears and then kept in 5 per cent formalin in glass jars/ containers. These solutions preserve the disease specimens more or less in normal condition.

7. **Computer:** It is electronic device used for storing and processing information. Various types of specimens especially showing deficiency symptoms cannot be preserved in wet or dry condition Therefore, either their images are taken or they are scanned by a scanner to save them in computer for further use. The computers and its accessories are also very important part of plant clinic.

8. **Camera and projector:** These are used to take the images or prepare the slide of diseased plants which are stored in clinic itself. Scientists usually use these images and slides for correct identification for diseased specimen for education purposes. Presently, this is important means of Information and Communication Technology (ICT) in which these images are displayed through projector for teaching the students.

   Various laminated coloured photographs and flex charts are also prepared from the live specimen of diseased plants/ parts and displayed in the clinic for the benefit of the visiting farmers.

9. **Books:** Various books like *rabi, kharif*, fruits and vegetables crops are available in the form of Package of Practices at plant clinic. The books are available in English and Punjabi languages for the benefit of the farmers. These books serve as hand tool for the identification of symptoms of various plant problems. The important information regarding identification and

management strategies of various diseases, insect pests, nutrition deficiency in plants, etc. is available in these books.

Exercise

(A) Answer t in one to two words:

1. In which year plant clinic was established at Punjab Agricultural University, Ludhiana?
2. How many plant clinics have been established by Punjab Agricultural University, Ludhiana in Punjab?
3. Where is plant clinic located at PAU?
4. Name any two instruments/tools being used in the plant clinics.
5. Name the principle based on which the exact quantity of pesticides is calculated to control insect pests on different crops.
6. Name the instrument with the help of which one can observe the pictures on slides.
7. Name the tool used to observe the small disease specimens under field conditions.
8. Name any two chemicals used for preservation of diseased plant specimens.
9. Mention the email address of plant clinic located at Punjab Agricultural University, Ludhiana.
10. Mention the telephone number of plant clinic situated at PAU, Ludhiana.

(B) Answer in one to two sentences:

1. What is plant clinic?
2. What are the advantages of plant clinic?
3. How plant clinic differs from human hospitals?

4. Mention the disciplines/subjects used for the identification of plant specimens?
5. Enlist the equipments being used in plant clinic?
6. What is the importance of microscope in plant clinic?
7. What do you understand from the term "Economic Threshold Level"?
8. Comment on the use of computer in plant clinic.
9. How incubator is useful in diagnosis of microorganisms in plants?
10. Enlist the chemicals required for the preservation of plant specimen in glass jars.

(C) Answer in five-six sentences:

1. Describe the mobile diagnosis cum exhibition van.
2. What is the use of camera and Liquid Crystal Display (LCD) projector in plant clinic?
3. Define PAU *doots* and KMAS service of Plant clinic.
4. What is touch screen kiosk and farmer service centre?
5. Describe the services provided by plant clinic to the farmers.

Activities:

1. Prepare an album on nutrient deficiency in plants.
2. Prepare a chart on the equipments/tools and other materials used in plant clinic.
3. Prepare a herbarium of insect pest of different crops.
4. Download and fill the form required for dispatch of plant specimens to plant clinic for identification of disorders.