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

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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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