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AGRICULTURE

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AGRICULTURE

CONTENT

CHAPTER – 1
INTRODUCTION TO AGRICULTURE

The term Agriculture is derived from two Latin words ager or '*agri*' meaning soil and '*cultura*' meaning cultivation. Agriculture is an applied science which encompasses all aspects of crop production including horticulture, livestock rearing, fisheries, forestry, etc. It is defined as the art and science of producing crops and livestock for economic purposes.

According to Indian Council of Agricultural Research, Agriculture means and includes production, processing, marketing and utilisation of crops, livestock and fisheries as also social and economic aspects of agricultural development.

The term agriculture wherever used includes horticulture, fruit growing, seed growing, dairy farming and livestock breeding and bee keeping, the use of land as grazing land, meadow land, market gardens and nursery grounds, and the use of land for woodlands where that use ancillary to the farming of land for agricultural purposes.

BRANCHES OF AGRICULTURE

The common branches of agriculture are as follows:

i. **Agronomy:** deals with the production of various crops including food crops, fodder crops, sugarcane, oilseeds etc.
ii. **Horticulture:** Deals with production of fruits, vegetables, flowers, ornamental plants, spices, condiments and beverages.
iii. **Forestry:** Deals with large scale cultivation of trees for wood and timber etc.
iv. **Animal Husbandry:** Deals with practice of breeding and raising of livestock.
v. **Pisciculture:** Deals with breeding and rearing of fish and sea food.
vi. **Agricultural Engineering:** Deals with farm machinery used in cultivation.
vii. **Food and Nutrition:** Application of agricultural produce in a better manner for value addition and food preparation.

THE CURRENT SCENARIO

OVERVIEW

Agriculture not only contributes to the overall economic growth but also reduces poverty by providing employment and food security to the major population. Thus it is the most inclusive growth sector of the Indian economy.

More than 60% of the Indian population is dependent on agriculture. However the contribution of agriculture to the GDP is declining and at present, it contributes about 18% of the GDP. During the past five years, the agriculture sector has witnessed spectacular advances in the production and productivity of food grains, oilseeds, commercial crops, fruits, vegetables, poultry and dairy.
India is now the second largest producer of fruits and vegetables in addition to being the largest exporter of cashews and spices. Further, India is also the highest producer of milk in the world.

FARM SIZE

Indian agriculture is characterized by small and marginal holdings. About 85% of the total cultivated land is fragmented into less than 10-hectare land each. About 60% of the farmland is less than 4 hectare in size.
0.1 Agricultural labourer is a person who has no land holding. They derive more than 50% of income from agricultural wages.
0.2 Small farmers is one, who has land holding above One hectare upto Two hectare (5 acres).
0.3 Marginal farmers, a farmer with land holding One hectare (2.5 acres) in un-irrigated area.

BUFFER STOCK

The idea behind maintaining the buffer stock is to meet exigencies of drought or crop failure. Since any shortage in food supply can cause deep social upheavals, the government has decided to keep a certain amount of food as a buffer stock to ensure food grain supply to the poorer sections at subsidized rates.

NATIOAL FOOD SECURITY ACT

The act was introduced in the Parliament to provide the households below poverty line foodgrain at Rs. 3 per kg of rice, Rs. 2 per kg of wheat and Rs. 1 per kg of coarse grains and to general households not less than 3 kg of foodgrains per person per month at prices not exceeding half of the MSP for wheat and coarse grains and derived MSP for rice.

MINIMUM SUPPORT PRICE AND FOODGRAIN PROCUREMENT

The main objectives of the food management policy are the procurement of foodgrain from farmers at remunerative prices, distribution to consumers, particularly the vulnerable sections at affordable prices, and maintenance of food buffers for food security and price stability. The instruments at the disposal of the government are the MSP and central issue price (CIP).

The **MSP** for twenty-three crops is calculated and proposed by the CACP (Commission on Agriculture Costs and Prices) to the Central Government. These prices are then discussed and decided by the Cabinet Committee on Economic Affairs. Although it is called Minimum Support Price, but it is not mentioned in law that the government will in fact purchase these items or ensure their procurement at the prescribed prices. Thus these are just executive orders without the backing of any law.
Recently, MSP has become the focus of farming community after the government enacted three laws related to agriculture permitting private players to enter the procurement of cereals and allowing them to purchase the same directly from the farmers without the intervention of the Agriculture Produce Markets. The laws related to contract farming and removal of ceiling for storage has riled the farmers.

PRODUCTION IN INDIA

The total food grain production during the last few years has been as under:

Year	Production (in million tons)	Year	Production (in million tonnes)
1951-52	52	2017-18	285.01
1961-62	82	2018-19	285.21
1971-72	108	2019-20	296.65

WASTAGE OF AGRICULTURAL PRODUCE

It is estimated that every year, fruit and vegetable produce worth Rs. 40,000-50,000 crore goes waste due to lack of facilities to preserve them.

The government has taken up many initiatives to promote the construction of cold chains and also approved FDI in multi-brand retail so that adequate capital is made available to bring the produce 'from farm to the fork'.

ORGANIC FARMING

The usage of fertilizers and high yielding seeds has increased the yield, but it has led to various problems like soil degradation and high cost of cultivation. Excessive pesticide and insecticides and their intrusion into the food chain has made the people think of their negative ecological effects.

Therefore, it was felt that a new system of cultivation should be adopted, which is eco friendly.

Organic farming prohibits the use of all synthetic inputs and soil health is now the focus of the program. Organic Farming is a system designed to produce crops by methods and substances which maintain their integrity until they reach the consumer.

GENETIC ENGINEERING (GM CROPS)

Genetic engineering is a laboratory technique used by scientists to change the DNA of living organisms. The scientists have been able to select the genes of their choice and insert them into the DNA of other living organisms. For example, tomatoes are sensitive to frost, which shortens their growing season. To counter it, the scientists identified a particular gene resistant to cold and used genetic engineering to insert this 'anti-freeze' gene into a tomato. It has enabled the farmers to extend the tomato growing season.

Similarly, the Indian farmers are using Bt Cotton seed these days. It is resistant to bollworm and has helped them reap rich harvests. Bt stands for Bacillus. Bt cotton is the only transgenic crop approved for use in India till date.

The efforts to introduce Bt Brinjal had met with strong protests in India. The Supreme Court-appointed Technical Expert Committee (TEC) had recommended a 10-year moratorium on all field trials of GM food crops.

LEARNING AND TEACHING IN EXTENSION & COMMUNICATION

1. Extension is an educational process to bring about desirable changes

2. The essential role of an extension worker is to create effective learning situations.

KISAN CREDIT CARD SCHEME

Kisan Credit Card Scheme was introduced in banks in 1998 and revised in 2004. The main objective of the scheme is to provide adequate and timely credit to the farmers under single window including the short term credit needs and reasonable component for consumption needs.

What is Agribusiness?

- An Agribusiness is a Line Of business (LOB) that focuses on processing, warehousing, distribution, marketing and retailing of products used in farming.
- The goal of agribusiness to improve operations in order to keep prices reasonable.
- Many agribusiness products and services feature advance internet of things, technologies that help farmers to raise live stock, grow produce, manage machinery and process and ship product more efficiently.

FARMERS PRODUCERS ORGANIZATIONS (FPOs)

Group of producers, especially small & marginal famers, into producer organizations is the most effective path ways to address the many challenges of agriculture but most importantly, improved access to investments, technology and inputs and markets. FPOs are farmers organization for promotion of their common interest with a long-term plan of action for collective growth. They are required to be registered under Indian Companies Law 1956.

BASICS

1) It is formed by the group of producers for entire farm non - farm activities
2) It is a registered body and a legal entity
3) The producers are share holders in the organizations
4) It deals with the business activities related to the primary produce/products
5) It works for the benefit of the member producers
6) A part of profit is shared among the producers.
7) Rest of the surplus added to the its owned funds for business expansion

WTO

The World Trade Organisation (WTO) is the only global international organisation dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to ensure that trade flows as smoothly, predictably and freely as possible. It was constituted on January 1,1995. Its precursor was GATT (General Agreement on Trade & Tariff), which was dissolved after it came into being.

REGIONAL RURAL BANKS (RRBS)

1. Committee on Rural Banks headed by M. Narasimhan (1975).

2. The RRBs came into existence as a result of the measures taken under the 20- point economic programme in 1975 by Mrs. Indira Gandhi.

i. There were three RRBs in Punjab. Malwa Gramin Bank and Satluj Gramin Bank have been merged with Punjab Gramin Bank.

ii. RRB is mainly focused on credit and other facilities, especially to small and marginal farmers agricultural labourers, Artisans and Small entrepreneurs in the rural areas.

GOVERNMENT SCHEMES IN AGRICULTURE

NATIONAL FOOD SECURITY MISSION (NFSM)

The NFSM, launched in 2007, is a crop development scheme of which aimed at additional production of 10, 8, and 2 million tons of rice, wheat, and pulses respectively by the end of 2011-12.

The Mission was continued during 12th Five Year Plan with new targets of additional production of food grains of 25 million tons of food grains comprising of 10 million tons rice, 8 million tons of wheat, 4 million tons of pulses and 3 million tons of coarse cereals by the end of the Plan.

RASHTRIYA KRISHI VIKAS YOJANA

The RKVY was launched in 2007-08 with an outlay of Rs. 25,000 crore during the 11th Plan to encourage the states to enhance public investment to achieve 4 per cent growth rate in agriculture and allied sectors.

MISSION FOR INTEGRATED DEVELOPMENT OF HORTICULTURE (MIDH)

Mission for integrated development of horticulture, it is centrally sponsored scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root and tuber crops - Mushrooms, Spices Flowers, Aromatic plants, coconut, cashew cocoa and bamboos. The major objective is encouraging aggregation of farmers to enhance horticulture and increase the income of the farmers.

NATIONAL MISSION FOR SUSTAINABALE AGRICULTURE

The NMSA aims at enhancing food security and protection of resources like land, water, biodiversity, and genetic resources by developing strategies to make Indian agriculture more resilient to climate change.

BGREI (Bringing Green Revolution to Eastern India)

The first green revolution was successful in Punjab, Haryana and western U.P. but other fertile areas like Bihar and Madhya Pradesh, Odisha and West Bengal lagged in food grain production. The government has initiated a scheme 'Bringing Green Revolution to Eastern Regions' and the results have been quite encouraging with the production in these states has registered a big jump.

SECOND GREEN REVOLUTION

With the first green revolution, India was able to propel itself into the club of nations which were self-sufficient in food grains. But the gains made are petering out now. What India needs now is a second green revolution so that the next phase of growth can be attained in future. Also while the emphasis in the first green revolution was on wheat and paddy, special attention is required on the production of nutrition-rich crops like pulses, fruits and vegetables. Indian agriculture should diversify from crop farming to livestock, fisheries, poultry and horticulture, besides focusing on productivity with adequate focus on rain-fed areas.

The government had declared to take measures to double the income of farmers by 2022. Apart from the above said schemes it has introduced some new schemes as well as has realigned the existing schemes.

These include implementation of schemes like,

i. Pradhan Mantri Krishi Sinchai Yojana (PMKSY):
It has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop'. The programme also targets the promotion of micro-irrigation in the form of sprinklers, rain-guns, drips, etc. Micro irrigation not only saves water but also reduces the use of fertilizers to a significant level.

ii. Paramparagat Krishi Vikas Yojana (PKVY):
Under PKVY Organic farming is promoted through adoption of organic village by cluster approach. The farmers are motivated to form clusters, will be provided Rs. 20,000 in three years for seed, harvesting and marketing.

iii. Soil Health Card: The government will issue soil health cards to farmers to create awareness about soil fertility and steps required to increase its productivity.

iv. Rainfed Area Development under National Mission for Sustainable Agriculture (NMSA):
It focuses on Integrated Farming System for enhancing productivity and minimizing risks associated with climatic variability.

v. Pradhan Mantri Fasal Bima Yojana (PMFBY):
It aims to provide a solution at the lowest uniform premium to the farmers across the country for loss or damages against any unforeseen circumstances. It will help the farmers stabilise their income.

vi. Mission for Integrated Development of Horticulture (MIDH): It aims to improve the growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. Under MIDH, Government of India (GOI) contributes 60%, of total outlay for developmental programmes in all the states except states in North East and Himalayas, 40% share is contributed by State Governments. In the case of North Eastern States and Himalayan States, GOI contributes 90%.

vii. National Agriculture Market scheme (e-NAM): It provides an online platform to the farmers and the traders to buy and sell the agriculture products online.

viii. National Mission on Oilseeds & Oil palm (NMOOP):
India's vegetable oil economy is world's fourth largest after USA, China & Brazil. The oilseed accounts for 13% of the Gross Cropped Area, 3% of the Gross National Product and 10% value of all agricultural commodities. The main objective of the mission is to increase the production of oil to meet the domestic demand.

In addition, the government regularly promotes through Agri-Clinics Agri Fairs and exhibitions, Kisan SMS Portal etc and also provides Kisan Call Centres (KCCs) to assist and guide the farmers.

CHAPTER – 2
CROPS

A plant cultivated commercially on a large scale is called a crop. Cereal, fruit and vegetable are the main crops of India. The persons who primarily perform these functions to produce these plants are known as farmers.

CLASSIFICATION OF CROPS

Crops can be classified on the basis of usage, anatomy, life cycle, areas where it grown.

On The Basis Of Seasons

KHARIF CROPS: (ਸਾਉਣੀ) The crops grown during the monsoon season i.e. June – July – August e.g. Rice, Maize, Cotton, Groundnut, Moong, Bajra, Urad, millets etc.

RABI CROPS: (ਹਾੜ੍ਹੀ**)**The crops are grown during winter season i.e. October to December. e.g. Wheat, Barley, Gram, Oil seeds.

ZAID CROPS: Crops grown in short summer season between Rabi & Kharif season i.e. February-March–April e.g. Musk Melon, Water-Melon, Gourds, Cucumber, Bitter Gourd etc. Zaid word is derived from zayada (ਜ਼ਿਆਦਾ) in local language means 'more'.

On The Basis Of Area

TROPICAL AREA CROPS: The crops grown in warm and hot climate e.g. Rice, Sugarcane, Jowar etc.

TEMPERATE AREA CROPS: The crops grown in a cool climate e.g. Wheat, Oats, Gram, Potato etc.

On The Basis Of Life Cycle

ANNUALS: The crops whose life cycle is less than one year are called annual crops. E.g.: wheat, paddy, barley.

BIENIALS: The crops which require two years to mature and produce seed, like in the first year there is vegetative growth and in the second year is seed production; e.g. sugarbeet.

PERENNIALS: Those plants which survive for more than two years are called perennials.

On The Basis Of Utility

CATCH CROP: A crop grown in the space between two main crops or at a time when no main crops are being grown. Catch crop reaches maturity in a relatively short time. It is often planted as a substitute for a crop that has failed or at a time when the ground would ordinarily lie fallow as between the plantings of two staple crops.

Cash Crop: That is grown mainly to be sold, rather than to be used by the farmers who grow it.

Plantation crop: Crops which are grown on large areas / estate such as coffee, sugar, and tobacco are grown.

CROP TYPES

1.	Cereals	Wheat, Rice, Maize & Bajra
2.	Pulse / Legume Crops	Gram, Urad
3.	Oil Seeds Crops	Sarson, Til, Groundnut, Peanut, Castor, Rapeseed, Linseed, Sunflower
4.	Forage Crops	Barseem, Guar and Oat
5.	Fibre Crops	Sun hemp, Jute
6.	Root Crops	Cassava, Sweet, Potato, Carrot
7.	Tuber Crops	Potato, Turnip, Onion, Garlic
8.	Sugar Crops	Sugarcane, Beet Root
9.	Starch Crops	Cassava, Guar
10.	Medicinal Crops	Mint, Amla, Aloe Vera, Tulsi, Saffron, Vanilla
11.	Spices & Condiments	Ajwain, Saunf, Mulathi, Chilli
12.	Vegetable Crops	Cauliflower
13.	Green Manure Crops	Dhaincha, Barseem, Guar
14.	Aromatic Plant Crops	Chameli, Geranium, Rose
15.	Fruit Crops	Apple, Mango, Banana
16.	Flower Crops	Gladioli, Carnation, Zarbera, Lilly, Chrysanthemum, Rose

SOME IMPORTANT FACTS
1. Agriculture period in India is July 01 to June 30.
2. Food Crops: Includes cereals such as Paddy, Wheat, Pulses, Vegetables which are consumed
3. Cash crops: Groundnuts, Mustard, Sunflower, Sugarcane, Cotton, Coffee, Tea
4. Plantation crops: Coconut, Arecanut, Oil palm, Cashew, Tea, Coffee and Rubber; the minor plantation crops include Cocoa
5. Kharif season: June to November
6. Rabi season: October / December to May

RABI CROPS

1. CEREALS
- Wheat
- Barley

2. PULSES OILSEEDS
- Gram (Chickpea)
- Lentil (Masar)

3. OILSEEDS
- Raya
- Gobhi Sarson
- Sunflower

4. FODDERS
- Berseem
- Oats

Cereals

a. WHEAT

Wheat is a major cereal crop of Punjab. It was grown on an area of 35.20 lakh hectares during 2018-19 with production of 182.62 lakh tonnes and average yield of 51.88 quintals per hectare (21.0 quintals per acre).

Climatic Requirements: Wheat is a cool season crop. Higher temperature during early phase of the crop results in poor tillering and early heading. Higher temperature at grain filling stage leads to premature ripening and reduction in grain weight.

Soil Type: Wheat can be grown on all kind of soils, except the highly deteriorated alkaline and water-logged soils. Durum wheat should preferably be sown on medium to fine textured soils.

SOWING PERIOD

Time of Sowing: For securing the best grain yield, wheat must be sown at the optimum time. First fortnight of November is the optimum sowing time of wheat crop. However, sowing of long duration varieties can be commenced from the fourth week of October to save these from high temperature near maturity. Delayed sowing causes a gradual decline in the yield of wheat. A delay of one week from optimum sowing reduces wheat yield by about 150 kg per acre.

The following sowing period for different varieties may be observed:

Sowing Period Varieties

From the 4th week of October to 4th week of November
Unnat PBW 343, PBW 1 Zn, PBW 725, PBW 677, HD 3086, WH 1105, HD 2967 and PBW 621(long varieties)

From the 2nd week of November to 4th week of November
Unnat PBW 550

From the 4th week of October to 1st week of November
WHD 943 and PDW 291

After 4th week of November
PBW 752 and PBW 658
Under rainfed conditions grow PBW 660 and PBW 644.

Do not grow durum wheat in light soils

Seed Rate: For securing good yield, use seed-rate of 45 kg per acre for Unnat PBW 550 and 40 kg for all other varieties. The seed should be cleaned and graded thoroughly before sowing. It should be treated properly before sowing.

Harvesting and Threshing

Harvest and thresh wheat as soon as fully ripe, to avoid grain shattering. Delayed harvesting results in high grain losses. Combine harvesters are generally being used for simultaneous harvesting and threshing of wheat. Stubbles can be bruised as fine wheat straw (turi) by using wheat straw combine. Straw recovery is about 60%. Wheat can be harvested manually or by tractor-operated vertical conveyer reaper windrowers. For threshing, use power thresher fitted with proper safety devices to prevent accidents. For good performance, operate these machines at recommended cylinder speed for wheat and also observe safety precautions against accidents. The syndicator type (Toka type) can be used to thresh the wheat crop with moisture content up to 20 per cent. For detailed information and instructions on the use of machines/ implements for various operations, see Appendix III 'Agricultural Engineering'.

Storage

In case the grain contains more than 10 per cent moisture, it should be dried before storing, otherwise it would be spoiled by moulds and excessive heat that develops during storage. Seed-cleaners-cum-graders may also be used at this stage if the produce is to be used as seed. See Appendix V for the control of stored grain insect pests.

b. BARLEY (ਜੌ)

Barley (Hordeum vulgare L.) is generally called "Jau".

Climatic Requirements: Barley requires cool weather during early growth and warm and dry weather at maturity. Being drought resistant, barley suits to areas with scanty rainfall.

Soil Type: Barley can be grown on well drained soils. It can do well even in salt affected soils during the early phases of the reclamation of these soils.

Rotations: Paddy-Barley, Kharif fodder-Barley, Cotton-Barley and Bajra-Barley.

Improved Varieties (irrigated conditions)

DWRB 123 (2019): Two rowed malt barley variety which matures in 141 days.
Yield is 19.4 quintals per acre. This variety is particularly suitable for brewing industry.
PL 891 (2019): It is a two rowed hulless food barley variety. It matures in 144 days.
Yield is 16.8 quintals per acre.

Usage: Hulless barley can be consumed as whole grain cereal, barley flakes, barley flour, etc.
Barley sattu can be used as energy drinks.

Time of Sowing: Between October 15 to November 15.

Harvesting: The crop should be harvested immediately after it ripens otherwise it might lodge and shatter grain because of wind storms.

PULSES

GRAM

Gram is an important rabi pulse crop of Punjab. Gram is a winter season crop but severe cold and frost
are injurious to it. It is primarily a crop of low-rainfall areas, but gives good returns in irrigated conditions as well.

Soil Type: Gram grows best on well-drained, light to medium textured soils. Saline, alkaline or waterlogged soils are not suitable for its cultivation.

Rotations: Gram in rotation with cereal crops helps in controlling soil-borne diseases. The common rotations are: Chari/Bajra-Gram, Rice/Maize-Gram and Rice-Gram-Summer Moong.

Desi gram (Irrigated)

PBG 8 (2020): The plants are tall with semi-erect growth habit. It has medium bold seeds with brownish colour and 100-seed weight is 16.5 g. This variety is moderately resistant to Botrytis grey mould and wilt. It matures in about 158 days. Its average yield is 8.4 quintals per acre.
PBG 7 (2014): The plants are tall, semierect. It has medium bold seeds with brownish colour and 100-seed weight of 16 g. This variety is moderately resistant to Ascochyta blight (Chanani) and fairly resistant to wilt and dry root rot. It matures in about 159 days. Its average yield is 8 quintals per acre.

GPF 2 (1994): It has bold seeds and matures in about 170 days. Its average yield is 7.6 quintals per acre.

Desi gram (Rainfed)
PDG 4 (2000): Its plants are erect with dark green foliage. It bears long fruiting branches arising from the base. It has bold seeds and matures in about 160 days. It is fairly resistant to wilt, foot rot, root rot and Ascochyta blight. Its average yield is 7.8 quintals per acre.

Kabuli gram
L 552 (2011): It is early in flowering and matures in 157 days. It is tall and erect variety. It has large pods and bold seeds (33.6 g/100 seeds weight). The seeds are creamy white in appearance with good culinary properties. Its average yield is 7.3 quintals per acre.

Harvesting: Harvest when the pods mature and the plants dry up. Harvest with a sickle. Do not uproot the plants and deprive the soil of the root residues.

LENTIL (ਮਸਰ)

It is hardy and can tolerate frost and severe winter. It can be grown with the moisture conserved in the soil during the rainy season.

Improved Varieties
LL 1373 (2020): Its plants are short, erect with profuse branching and bear more number of pods. It has light green leaves, pink flowers, non-pigmented light green pods and rudimentary tendrils. It matures in 140 days. It is resistant to rust and possesses good tolerance to pod borer. Its seeds are bold and 100 seed weight is 3.5 g. It has good culinary properties. Its average yield is 5.1 quintals per acre.

LL 931 (2009): Its plants are short, erect with profuse branching and bear more number of pods. It has dark green leaves, pink flowers, non-pigmented green pods and rudimentary tendrils. It matures in 146 days. It is fairly resistant to rust and possesses good tolerance to pod borer. Its seeds are medium bold with greyish brown colour and light flecks. It has good culinary properties. Its average yield is 4.8 quintals per acre.

LL 699 (2001): The plants are short, erect with profuse branching. Its plants are dark green, bear high number of pods and are early in flowering. It matures in 145 days.
It possesses good tolerance to pod borer. It has good culinary properties. Average grain yield is 5 quintals per acre.

Time of Sowing: The crop may be sown in the second fortnight of October in the sub-montane areas and from end of October to first week of November in other areas.
Seed Rate: The optimum seed rate is 18 kg per acre for variety LL 1373 and 12-15 kg per acre for other varieties.

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

OILSEEDS

RAYA\GOBHI SARSON\ SUNFLOWER RAPESEED AND MUSTARD

Toria, gobhi sarson and African Sarson are sown exclusively under irrigated conditions, whereas Raya can be grown under both irrigated and rainfed conditions.
Taramira is grown as rainfed crop only.
The oilseeds are categorised by traders as Rapeseed and Mustard.
Rapeseed: Toria, Gobhi Sarson and Taramira are categorised as rapeseed.
Mustard: Raya and African sarson are categorised as mustard.

Climatic Requirements: The rapeseed and mustard crops grow well in areas having 25 to 40 cm of rainfall. Taramira is preferred in low-rainfall areas, whereas raya, gobhi sarson, African sarson and toria are grown in medium to high rainfall areas.
Soil Type: The rapeseed and mustard grow best on well-drained, light-to medium textured soils. Raya, gobhi sarson and African sarson may be grown on all soil types, toria should be grown preferably on loamy soils. Taramira does well on sandy and loamy-sand soils.
Brassica varieties having less than 2% erucic acid in the oil and less than 30 micro moles of glucosinolates per gram defatted meal are known as Canola. It is one of best oils for heart health, canola oil has less saturated fat than any other oil.
Time of Sowing: The optimum time of sowing for rapeseed and mustard is:

Crop	Sowing time
Toria	First half of September
Intercropping of Toria and Gobhi Sarson	Second to Third week of September
Gobhi Sarson	10-30 October
Raya and African Sarson	Mid October to Mid November
Gobhi Sarson and African Sarson by transplanting	November to Mid December
Taramira	Whole October

Varieties & Maturity Period

Toria

TL 17 (2011):
Yield: 5.2 quintals per acre. Its seeds contain 42.0% oil.
Maturity: 90 days
TL 15 (1978): Early maturity type, fits well in multiple cropping systems.
Yield: 4.5 quintals per acre. Its oil content is 41 per cent.
Maturity: 88 days

Raya

RCH 1 (2019): It is the first canola quality ('00') hybrid of raya in the country. It is recommended for general cultivation in south-western region (Bathinda, Faridkot, Ferozepur, Muktsar and Mansa) of Punjab under timely sown irrigated conditions.
Yield: 9.2 quintals per acre with 39.4 per cent oil content.
Maturity: 152 days.
PHR 126 (2019):
Yield: 9.1 quintals per acre with 40.2 per cent oil content.
Maturity: 145 days.
Giriraj (2017): recommended in irrigated conditions.
Yield: 7.7 quintals per acre, contains 40.3 per cent oil.
Maturity: 144 days
RLC 3 (2015): This is the first canola quality variety of raya in the country.
Yield: 7.3 quintals per acre with 41.5 percent oil content.
Maturity: 145 days.

PBR 357 (2014):
general cultivation in the state under timely sown irrigated conditions.
Yield: 8.5 quintals per acre. It contains 39.0 per cent oil
Maturity: 145 days.

Gobhi Sarson (matures in 145 to 162 days depending on variety)
PGSH 1707 (2020): It is the canola quality ('00') hybrid of gobhi sarson.
GSC 7 (2014): This canola quality variety. Cultivation under timely sown irrigated conditions.

Yield: 8.9 quintals per acre. Oil 40.5%
Maturity: 154 days

African Sarson

PC 6 (2016): This variety is the world's first determinate oilseed Brassica variety. It is recommended for general cultivation in the state under timely sown irrigated conditions.
This medium tall variety is resistant to seed shattering and is suitable for combine
harvesting. It is free from white rust and has better tolerance to Alternaria blight and mustard aphid. Its average yield is 7.7 quintals per acre with 40.1 per cent oil. It matures in 157 days.

Taramira

TMLC 2 (1990): This variety is recommended for cultivation in Bathinda, Sangrur, Ferozepur and Kandi areas of Hoshiarpur, Gurdaspur, Rupnagar and Shaheed Bhagat Singh Nagar districts. It has longer main shoot length, more number of pods on main shoot and more number of seeds per pod.
Yield: 2.9 quintals per acre with 36.6 per cent oil content.
Maturity: 150 days.

SUNFLOWER

The spring season is most suited for assured crop and high yields of sunflower. Availability of honey bees during this season in abundance, also helps in good seed setting. Sunflower oil is very well suited for the manufacture of edible refined oil and vanaspati. Its oil can also be used for making soap and a number of allied products.

Soil Type: It requires well drained, medium textured soil. Avoid salt affected soils.
Rotations: Rice/Maize-Potato-Sunflower; Rice-Toria-Sunflower; Cotton-Sunflower; Sugarcane-Sugarcane ratoon-Sunflower and kharif Fodder-Toria-Sunflower. Basmati-Sunflower is more productive and remunerative as compared to prevalent Basmati-Wheat crop sequence.

Hybrids

PSH 2080 (2019): It is a short duration medium tall hybrid with average plant height of 151 cm. The average seed yield of this hybrid is 9.8 quintals per acre. It matures in 97 days.
PSH 1962 (2015): It is a short duration, medium tall hybrid with average plant height of 165 cm. The average seed yield of this hybrid is 8.2 quintals per acre. It matures in 99 days.
DK 3849 (2013): The average seed yield of this hybrid is 8.4 quintals per acre and 100 seed weight is 4.5 g. The seeds of this hybrid contain about 34.5 per cent oil. It matures in 102 days.
Other varieties: PSH 996, PSH 569, PSH 118, SH 3322.
NSFH-1001: It is medium duration hybrid having high oil content. Its seed size is small.

Other hybrids in cultivation not tested by PAU are:
Pioneer 64 A 57, , Champ, Armony Gold

Time of Sowing: To realize high seed yield and to save irrigation water, the sowing of sunflower should be done in January. However, if the planting is delayed till first week of February, shorter duration hybrids (PSH 2080, PSH 1962, PSH 569 and PSH 996) should be preferred. For further delay in the month of February adopt transplanting because direct seeding causes substantial reduction in seed yield.

LINSEED

Linseed cultivation is mainly confined to Gurdaspur, Hoshiarpur and Rupnagar districts adjoining the main linseed growing area of Himachal Pradesh.
Climatic Requirements: It does well in high rainfall areas.
Soil Type: A well-drained, loamy to clay soil is suitable.
Rotation: Rice-Linseed.

Improved Variety

LC 2063 (2007): It is a tall variety with profuse branching and blue flowers. It is tolerant to wilt, rust, Alternaria blight and moderately resistant to powdery mildew. It has lustrous brown, bold seeds with 38.4 per cent oil content. Its average yield is 4.9 quintals per acre. It matures in about 158 days.

LC 2023 (1998): It is recommended for both rainfed and irrigated conditions. Its seed contains 37.4 per cent oil. Its yield is about 4.5 q per acre. It matures in 158 and 163 days under rainfed and irrigated conditions, respectively.
Harvesting: The crop is ready for harvest in April.

FODDER

BERSEEM
It is a highly nutritious and palatable fodder in repeated cuttings from November to mid-June.
Climatic Requirements: Berseem needs mild temperature for germination and establishment. Its growth is restricted during intensely cold or frosty weather.
Soil Type: It grows well on medium to heavy soils and withstands alkalinity.
Improved Varieties
BL 43 (2017):
Yield: 390 quintals green fodder per acre up to first week of June and gives good seed yield.
BL 42 (2003): It supplies green fodder upto first week of June and yields about 440 quintals per acre of green fodder and has high seed yield.
BL 10 (1983): Yields about 410 quintals per acre green fodder. Its seed crop matures in the last week of June.
Time of Sowing: The last week of September to first week of October is the best time of sowing.
Harvesting: First cutting is ready in about 50 days after sowing and subsequent 51 cuttings at 40 days intervals during winter and 30 days intervals in spring, thus giving 4-6 cuttings in all. Harvesting of berseem can be done with scythe that saves 60% of labour.

OATS (ਜਵੀ)

Fodder *jawi*
It comes second after berseem from nutritional point.
Climatic Requirements: Oats makes best growth in cool and moist weather. High temperature at blossoming increases the proportion of empty spike-lets and reduces the seed yield.
Soil Type: All types of soils, except the alkaline or water logged soils.
Time of Sowing: Second week to last week of October.
Improved Varieties
OL 14 (2020): It is a multicut variety for irrigated areas of Punjab.
Yield: about 307 quintals of green fodder per acre. Its seed yield is 10.9 quintal per acre.
OL 13 (2020): It is a single cut variety for irrigated areas of Punjab.
Yields: about 305 quintals of green fodder per acre. Its seed yield is 9.7 quintal per acre.
OL 12 (2018): It is a single cut variety for irrigated areas of Punjab.
Yields: about 258 quintals of green fodder per acre. Its seed yield is about 8.6 quintals per acre.
Harvesting: The harvesting of single cut oats should be done from boot to milk stage. Multi-cut oats take first cut at 65-70 days after sowing and second cut at boot to milk stage.

KHARIF CROPS

1. CEREALS
a. Paddy
b. Maize
2. PULSES
i. Gram (Chickpea)
ii. Lentil (Masar)
3. OILSEEDS
iii. Raya
iv. Gobhi Sarson
v. Sunflower
4. FODDERS
a. Berseem
b. Oats

CEREALS

RICE
Cultivated on 31.03 lakh hectares in Punjab with total production of 191.36 lakh tonnes (128.2 lakh tonnes of rice) during 2018-19. Average yield of paddy was 61.67quintals per hectare (25.0 quintals per acre).

Climatic Requirements
High temperature, high humidity, prolonged sunshine and assured water-supply. A temperature range of 20 to 37.5oC is required for its optimum growth. The crop requires a higher temperature at tillering but temperature requirement for blossoming ranges between 26.5 and 29.5oC.

Soil Type
Grows well on soils with low permeability and over a wide range of soil reaction viz. pH 5 to 9. Generally, the loamy soils are the best for rice cultivation.

Rotations
Rice-Wheat / Berseem / Linseed / Gram / Barley, Rice-Wheat / Summer Moong/Green manuring, Rice-Celery, Rice-Potato/Peas-Celery, Rice-Potato-Potato/Summer Moong/ Sunflower/Celery/Wheat/Cucurbits, Rice-Toria-Sunflower, Rice-Gram-Summer Moong, Rice-Gobhi Sarson-Summer Moong, DSR-Potato-Mentha/Onion.

Improved Varieties
PR 129 (2020): It is an improved version of PAU 201. Matures in around 138 days. Its' average paddy yield is 30.0 quintals per acre.
PR 128 (2020): It is also an improved version of PAU 201. Matures in about 141 days after seeding. Average paddy yield is 30.5 quintals per acre.
HKR 47 (2020): It is a mid-early maturing variety. It takes about 134 days to mature after
Seeding. Its' average paddy yield is 29.5 quintals per acre.
PR 127 (2018): Matures in about 137 days after seeding. Its' average paddy yield is 30.0 quintals per acre. Do not grow this variety in alkali soils and under brackish water.
PR 126 (2017): It is an early maturing rice variety. It matures in about 123 days after seeding. Its' average paddy yield is 30.0 quintals per acre. Transplant 25-30 days old nursery.

PR 124 (2015): It matures in about 135 days after seeding. This variety is susceptible to brown leaf spot. For its management use recommended fungicides. Its' average paddy yield is 30.5 quintals per acre. Transplant 25-30 days old nursery.
PAU has warned that Pusa 44/Peeli Pusa and HKR 127 should not be grown because they consume more water and are susceptible to bacteria blight. Also demand extra sprays lowering profits.

Sowing:
Nursery Sowing: May 15 to 30 is optimum time for nursery sowing.
Transplanting: Second fortnight of June.
Fertiliser: 50 kg nitrogen, 12 kg phosphorous, 12 kg potassium per acre.

Irrigation:
To keep the crop water ponded for two weeks after transplantation. Apply fertiliser after 2 days. Tensiometer should be installed to check the soil moisture. Stop irrigation fifteen days before harvesting.

Basmati Rice

Climatic Requirements
basmati varieties require prolonged sunshine, high humidity and assured water supply. Basmati varieties with superior cooking and eating characteristics can be produced if the crop matures in relatively cooler temperature. The high temperature during grain filling period reduces the cooking and eating quality features.

Improved Varieties
Panjab Basmati 5 (2017)
Panjab Basmati 4 (2017)
Panjab Basmati 3 (2017)
CSR 30
Basmati 386, Basmati 370
Pusa Basmati 1718 Pusa Basmati 1637, Pusa Basmati 1121

Sowing:
Nursery Sowing: Pusa Basmati 1509: second fortnight of June and for others it is first fortnight of June.
Transplanting: Pusa Basmati1509: second fortnight of July and for others first fortnight of July.

Fertilizer Application
Use organic and chemical fertilizers as under:

a) Organic Manures: Practice green manure before basmati. Do not apply urea if the field has been green manured with 45-55 days old sunnhemp/dhaincha or summer moong straw has been incorporated after picking of pods.

b) Chemical Fertilizers: Apply fertilizers on soil test and crop rotation basis. Skip phosphorus application if the recommended dose of phosphorus has been applied to the proceeding wheat crop.

Diseases
Foot rot : This disease is both seed and soil borne. The infected seedlings turn pale yellow and become elongated. Later on these seedlings start drying from bottom and these usually die.

Blast (*Pyricularia grisea*) : It is relatively more important in Basmati varieties. This fungus causes spindle shaped spots with greyish centre and brown margin on the leaves at maximum tillering stage.

Bacterial blight: Punjab Basmati 5, 4, 3 and Pusa Basmati 1718 are resistant to most of the pathotypes of bacterial blight pathogen. Other practices to control the disease are same as for rice.

Maize
Maize requires considerable moisture and warmth from germination to flowering. The most suitable temperature for germination is 21oC and for growth is 32oC. Extremely high temperature and low humidity during flowering may damage the foliage, dessicate the pollen and interfere with proper pollination, resulting in poor grain setting. Fifty to seventy-five cm well-distributed rain is conducive for good growth. Proper drainage of excess water during rains is essential to get good yield.
The average yield was 36.25 quintal per hectare (14.67 quintal per acre).

Varieties
Long Duration Varieties

JC 12: recommended for Kandi areas. Yield 18.2 quitals per acre. Matures in 99 days.
PMH 11(2019): Matures 95 days and average yield is 22 quintals per acre.
PMH 1(2019): Matures 95 days and average yield is 21 quintals per acre.
Parbhat: Matures 95 days and average yield is 17.5 quintals per acre.

Medium Duration Varieties
Kesri (1992): Matures 85 days and average yield is 16 quintals per acre.
Short Duration Hybrid

PMH 2 (2005): Matures 83 days and average yield is 18 quintals per acre.
Special Purpose Vaieties

Punjab Sweet Corn 1: used for commercial purposes as grain has high content of sugar. Matures in 95-100 days. Average yield 13 quintals per acre.

Pearl Popcorn: High commercial value. Matures 88 days and average yield is 12 quintals per acre.

Maize for Rainfed areas
PMH 2, Parkash, Megha

Climatic Requirements
Maize requires considerable moisture and warmth from germination to flowering. The most suitable temperature for germination is 21^{o}C and for growth is 32^{o}C. Extremely high temperature and low humidity during flowering may damage the foliage, dessicate the pollen and interfere with proper pollination, resulting in poor grain setting. Fifty to seventy- five cm well-distributed rain is conducive for good growth. Proper drainage of excess water during rains is essential to get good yield.

Soil Type
Maize thrives better on well drained, sandy-loam to silty-loam soils.

Rotations
Maize-Wheat / Barley / Potato / *Berseem*, Maize-*Senji*-Sugarcane-Cotton, Maize-Wheat- *Moong*, Maize-Wheat-Green Manure, Maize-Potato/*Toria*-Sunflower, Maize-Potato- Wheat/Sunflower, Maize-Early Pea-Sunflower, Maize-Wheat-Cowpea (fodder), Maize- Raya/*Gobhi Sarson*, Maize-Potato-Summer *Moong*, Maize-Potato-Mentha, Maize-*Gobhi Sarson*-Summer *Moong*

Diseases
Seed rot and seedling blight (Several fungi): Poor germination, unthrifty seedlings and seedling mortality are the symptoms. Use disease free seed.

Maydis leaf blight (***Drechslera maydis***)***:*** This disease is characterized by the presence of spindle shaped, necrotic to brown lesions on the leaves.

Bacterial stalk rot (*Dickeya zeae*): Water soaking and rotting of basal stem especially the leaf sheaths followed by rapid rotting of basal internodes.

PULSES & OILSEEDS

PULSES

Moong
Moong occupied 3.2 thousand hectares and the total production was 2.7 thousand tonnes during 2018-19 in Punjab. Its average yield was 8.34 quintals per hectare (3.38 quintals per acre).

Climatic Requirements
It requires a hot climate.

Soil Type
A well-drained loamy to sandy loam soil is suitable. Saline-alkaline or waterlogged soils are unsuitable.

Improved Varieties
ML 2056 (2016): Its plants are erect and medium statured (78 cm). Pod formation is profuse and each pod contains 11-12 seeds. It is tolerant to mungbean yellow mosaic virus, cercospora leaf spot and bacterial leaf spot diseases.

ML 818 (2003): Its plants are erect and medium statured (75 cm). Each pod contains 10-11 seeds.
It is tolerant to mungbean yellow mosaic virus, cercospora leaf spot and bacterial leaf spot diseases.

Diseases
Yellow mosaic virus : is a viral disease transmitted by whitefly and is more severe on kharif moong

Cercospora leaf spot: It is caused by *Cercospora cruenta* and *C. canescens*. The disease spots are circular, brown and necrotic which coalesce to cover bigger area and cause defoliation.
Root rot: Root rot caused by *Macrophomina phaseolina* produces dark lesions on leaves, branches, stems and roots.
Anthracnose: It is caused by *Colletotrichum lindemuthianum*. Dark brown spots (horse shoe shaped) appear on the leaves and other parts of the plant.
Bacterial leaf spot: Bacterial leaf spots caused by *Xanthomonas campestris pv. phaseoli* are circular to irregular and brown.
Web blight: It is caused by *Rhizoctonia solani*. It starts from leaf margins or petioles or young branches. Eventually, the tops of plants become blighted and patches of such plants are conspicuosly seen in the field.

Mash
Mash was grown on 2.0 thousand hectares and the total production was 1.1 thousand tonnes in the Punjab state during the year 2018-19. The average grain yield was 5.55 quintals per hectare (2.25 quintals per acre).

Climate and Soil Requirements
Mash thrives in a hot and humid season (July to October). However, short duration varieties (70 to 75 days) can be grown in the central and sub-montaneous tracts in summer (March to June). *Mash* can do well on all soils ranging from sandy loam to heavy clay except the saline-alkaline or waterlogged soils. Its cultivation improves soil fertility. The *mash*-wheat rotation is suitable for irrigated areas.

Improved Varieties
Mash 114 (2008) Mash 338 (1993

Soybean
Soybean is a high value crop with multiple food, feed and industrial uses. Edible oil, soymilk and its products, bakery products, antibiotics and fresh green beans are some of its major uses. Soybean has a potential to play an important role in crop diversification in the state.

Climatic Requirements
It requires a hot climate.

Soil Type
Soybean can be grown on a wide range of soils but thrives on fertile, non-saline/ alkaline and well-drained loamy soils.

Rotations
Soybean-Wheat/Barley, Soybean-Peas-Summer moong, Soybean-*Gobhi sarson* (Transplanted)

Improved Varieties
SL 958 (2014 SL 744 (2010 SL 525 (2003

Method of Sowing: Sow the crop in good moisture conditions with a pre-sowing irrigation *(Rauni)* before the monsoon has set in. Heavy rains after sowing adversely affect soybean germination. Sow the seeds 2.5 to 5.0 cm deep in lines 45 cm apart with a plant- to-plant spacing of 4-5 cm. Soybean can also be sown with zero till drill without any tillage operation.

Mulching: The rows should be covered with wheat or paddy straw to ensure proper germination and seedling emergence.

Intercropping: Soybean can be successfully intercropped with maize. Sow one line of soybean between two lines of maize sown at 60 cm.

Irrigation: If the rains are good and well distributed, there may be no need of irrigation. Otherwise crop will require 3 or 4 irrigations. One irrigation at the time of pod-filling is very useful.

Harvesting: Harvest the crop when most of the leaves fall-off and the pods change colour. Do not delay harvesting otherwise the shattering of pods will take place. During threshing, avoid severe beating or trampling as it reduces the quality and germination capacity of the seeds.

Storage: The moisture content of grains should not exceed 7 per cent. The grains should be stored in dry bins or in bags kept on wooden racks.

OILSEEDS

Groundnut

Groundnut was grown on 1.3 thousand hectares during 2018-19 in Punjab. Its production was 2.6 thousand tonnes with an average yield of 19.8 quintals per hectare (8.01 quintals per acre).

Climatic Requirements

A well distributed rainfall of at least 50 cm during July, August and September is essential for successful cultivation of groundnut under rainfed conditions.

Soil Type

A well-drained sandy soil overlaying a loamy sub-soil is considered ideal for the rainfed crop. Where irrigation facilities are available, loamy sand and loamy soil can also be put under groundnut.

Rotation

Groundnut–Late *Kharif* Fodder / *Gobhi sarson+Toria* / Potato / Peas / *Toria* / *Rabi* crops, Groundnut-Peas-Sunflower rotation can be taken up successfully where irrigation facilities exist. Avoid sowing groundnut in the same field year after year, as this practice results in heavy build-up of soil-borne diseases.

Improved Varieties

J 87 (2020) TG 37A (2018) SG 99 (2004)
M 522 (1995) SG 84 (1986)

COTTON, SUGARCANE & FODDER

COTTON

American cotton was grown on 2.63 lakh hectares in Punjab during 2018-19. The total production was 12.06 lakh bales with an average yield of 7.79 quintals lint per hectare (3.15 quintals lint per acre).

Climatic Requirements

A daily minimum temperature of 16^{o}C is required for germination and 21^{o}C to 27^{o}C for proper crop growth. During the fruiting phase, the day temperature ranging from 27^{o}C to 32^{o}C and cool nights are needed.

The cotton picking period from mid-September to November must have bright sunny days to ensure a good quality of the produce.

Soil Type

Cotton can be successfully grown on all soils, except sandy, saline or waterlogged types. Proper drainage of excess water during rains is essential.

Rotations

Cotton – Wheat / Barley, Cotton – Sunflower, Cotton – *Senji* / *Barseem*/ Oats, Cotton– Sunflower-Paddy-Wheat, Cotton – *Raya*

Improved Varieties

Bt cotton variety

PAU Bt 1	Non-Bt cotton	LHH 144 (1998)
F 2228 (2015)	F 2383 (2015	LH 2108 (2013
LH 2076 (2008)		

Irrigation and Drainage

Cotton requires 4-6 irrigations depending upon the seasonal rainfall. The first irrigation should be given 4 to 6 weeks after sowing and the subsequent ones at interval of two or three weeks. However on light soils or in crop sown on ridges, the first irrigation may be advanced, if necessary. Sowing cotton on ridges and irrigation in furrows save considerable amount of water. Under poor quality irrigation water conditions, give pre- sowing irrigation with canal water and subsequent irrigations can be applied with poor quality tube well water in alternate furrows. In soils irrigated with saline water (EC upto 10 dS/m), application of 16 quintal per acre of rice-residue biochar reduces adverse affect of salinity and increases seed cotton yield.

The crop must not be allowed to suffer from water stress during the flowering and fruiting stages, otherwise a lot of shedding of flowers and bolls will take place resulting in low yield. Cotton during its early growth is very sensitive to water stagnation. Therefore, drain out the stagnant water if such a situation arises. To hasten boll opening, give the last irrigation by the end of September.

Diseases

Leaf curl: Disease is caused by whitefly transmitted virus. The diseased plants become stunted and have twisted internodes. Leaves remain small, show cupping and curling.

1. **Parawilt:** Parawilt is a physiological disorder and no pathogen is involved. It generally occurs after droughts when the crop is heavily irrigated or there is heavy rain. Plants show sudden drooping of leaves which ultimately get wilted but the root system remains intact.
2. **Root rot:** This disease is caused by *Rhizoctonia solani* and *R. bataticola*. The main symptom are drying and shedding of leaves leading to complete wilting and death of the plant.
3. **Bacterial blight:** It is caused by *Xanthomonas axonopodis* pv. *malvacearum* which survives in seed and plant debris. Lesions on the leaves appear as minute, water-soaked, angular spots, which subsequently turn brown and then are transformed into black angular dead lesions on both sides of the leaf.

4. **Leaf spots:** Foliar leaf spots are caused by different fungi. Leaf spots caused by *Myrothecium roridum* appear on leaves, bracts as well as on bolls.

SUGARCANE

Sugarcane occupied 96 thousand hectares in Punjab during 2017-18. The average cane yield was 836 quintals per hectare (338 quintals per acre). The average sugar recovery was 9.78 per cent.

Climatic Requirements

Sugarcane is best suited to regions having tropical climate, but it can be grown successfully in sub-tropical areas also. In the Punjab, about 80 per cent of the total growth of the crop takes place during July, August and September owing to favourable temperature and humidity.

Soil Type

Sugarcane can be successfully grown on all types of soils ranging from sandy loam to clay loam. However, it thrives best on well-drained loamy soils. Sugarcane is semi-tolerant to sodicity and salinity. Sustainable sugarcane yields with assured levels of sugar recovery can be successfully obtained in sodic and saline-sodic soil/irrigation water conditions by adopting the following practices:

- If the soil/irrigation water is sodic, apply gypsum @ 50% of gypsum requirement on cumulative basis after the harvest of the previous crop or well decomposed farm yard manure @ 8 tons per acre before sowing. Higher and complimentary benefits can be obtained if both gypsum and FYM are used simultaneously.
- Do not apply gypsum if the soil/irrigation water is saline or saline-sodic. Apply only FYM.
- Under saline water conditions in south-western districts of Punjab, CoJ 88 should be planted.

Improved Varieties

CoPb 92 (2017)	Co 118 (2015)
CoJ 85 (2000)	CoJ 64 (1975)
CoJ 64 (1975)	

Irrigation: Apply first irrigation one month after planting, followed by three irrigations upto February and subsequent irrigations as per the recommendations for the spring crop.

FODDERS

Sorghum

Sorghum *(jowar)* is a very important *kharif* fodder cultivated on 2.72 lakh hectares (2018-19). It remains green and palatable over a longer period than maize and *bajra* fodders.

Climatic Requirements

Sorghum grows well in hot and dry climate. Increased humidity enhances the incidence of the red leaf spot disease.

Soil Type

Sorghum grows on all types of soils, but heavy soils are more suitable. Adequate drainage should be provided.

Improved Variety

SL44 (1974): It is a sweet, juicy and thin-stemmed variety suitable for cultivation in summer and *kharif* in the irrigated areas of Punjab. Its green and sweet fodder is relished by cattle. It has a high content of digestible dry matter. It gives about 240 quintals green fodder per acre.

Multi-cut Sorghum

Improved Varieties

Punjab Sudax Chari 4 (2015)
Punjab Sudax Chari 1 (1991)

Time of Sowing: Last week of April to end of May.
Harvesting: The first cutting is ready in 55-65 days after sowing. Subsequently, cuttings can be taken after an interval of about 35-40 days.

Disease

Grain Smut: Control grain smut (*Sphacelotheca sorghi*) by treating the seed with sulphur dust @ 4 g/kg seed before sowing.

Bajra

Bajra (pearl millet), cultivated on 1.51 lakh hectares (2018-19) is a hardy fodder crop and withstands adverse agroclimatic conditions. It can grow in light soils with low moisture. It can tolerate hot and dry weather.
Rotations: *Bajra*-maize-berseem
Improved Varieties/Hybrid
PCB 165 (2020) PHBF 1 (2009) PCB 164 (2003)

Time of Sowing: *Bajra* can be sown from March to August. The March-May sown crop is the main fodder crop. It can be grown in mixture with cowpea.

Land Preparation: Give 2 or 3 deep ploughings followed by planking.

Irrigation: Two or three irrigations are usually sufficient. In the hot season, however, more irrigations may be required. Standing water is harmful, hence avoid water-logging. It is preferable to give frequent but light irrigation.

Harvesting: The crop should be harvested at ear-initiation or soon after the flag-leaf emergence (45-55 days after sowing). In no case, it should be allowed to go beyond 50 per cent earing. At this stage, the crop has high digestibility.

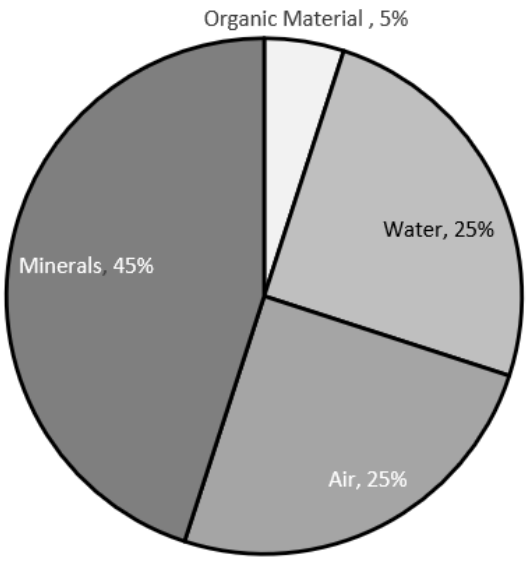
CHAPTER – 3
SOILS

DEFINITION
Soil is the natural body of organic and inorganic material found on the surface of earth. The upper layer of earth meets the requirement for growth of crops is known as soil.

FUNCTION
It provides support to the plant and water and other nutrients needed for growth. It supports the ecosystem for growth of vegetation and provides solid surface for the mankind to survive.

STRUCTURE OF SOIL

Basic Constituents of Soil
Soil is a mixture of organic matter, minerals, water and air. The quantity of minerals and organic matter in a particular soil remain almost stable but that of water and air keep on interchanging.



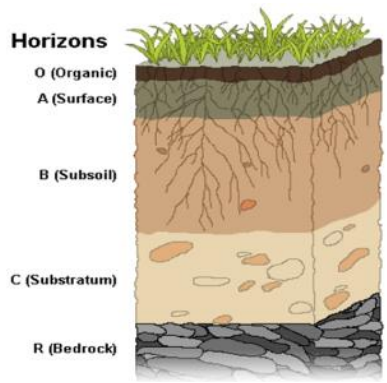
The soil consists of particles like sand, silt and clay, which are grouped together. The type of soils at different places vary on account their composition and the structure of the soil particles.

The size of these particles varies in different areas. Apart from size of the particles, the proportion of these particles may also be different in different places. This is permanent feature of the soil in a given area and is known as **Soil Texture**. These particles can be separated by the mechanically by Hydrometric method.

Soil texture of soil at a particular place is different at different depths.

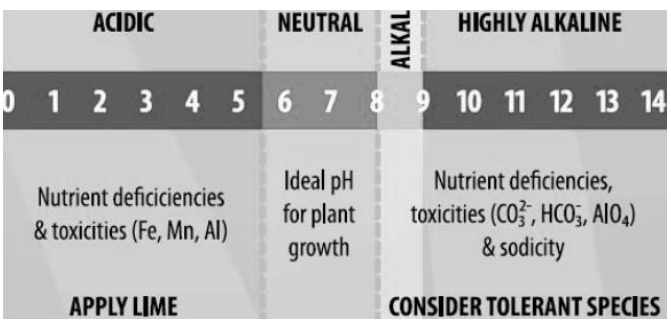
Soil Horizon: While the uppermost layer may be soft and moist the layers underneath may be different on the basis of colour, texture and chemical properties.

The arrangement of soil particles and their aggregates into certain defined patterns is called **Soil Structure**.



Chemical Properties of Soil
Every soil has different chemical properties such as soil content, types of salts present and soil reaction depending upon the salts present in it. The soil may be categorised as alkaline or acidic depending upon the chemicals , which is measured by pH.
pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pH of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH of 6.5 to 8.7 is considered normal for crop production.
Acidic soils are mostly found in areas of heavy rainfall, as the running water leaches considerable amount of bases from the surface layer.

Soil pH	Plant Growth
>8.3	Too alkaline for most plants
7.5	Iron availability becomes a problem on alkaline soils
7.2	6.8 to 7.2 – near neutral 6.0 to 7.5 – acceptable for most plants
7.0	
6.8	
6.0	
5.5	Reduced soil microbial activity
<4.6	Too acid for most plants



SOIL TYPES AND THEIR PROPERTIES
Cultivated soils are classified according to their characteristics and the crops grown. Soils are formed by the weathering of rocks. The amount of sand and clay depends on the rock from which the soil particles have been formed.
Soil is classified into various types based on their appearance and the proportion of size of soil particles:
a) Sandy Soils b) Clay Soils c) Loamy Soils

a) **SANDY SOILS**: Made up of greater proportion of big particles. The pore size is greater than that of clayey soils which results in infiltration of more air and water.

They do not fit closely together and have large spaces filled with air. The water passes quickly through these spaces. These soils are light, well aerated and dry.

The soil when held in hand does not stick to hand.
If a ball of moist sand is squeezed,, it will break down very easily.

b) CLAY SOILS: These soils are made up of a relatively high proportion of fine particles, having very small space between two particles where water can be trapped. The composition of fine particles in such soils is more than 40 percent. Those soils are called heavy soils which hold more water as compared to other soils. Water stagnation is main problem with these kind of soils.
Ploughing of these soils is difficult. In low moisture, the soil develops clods and after drying, cracks appear on its surface.
Ball of moist clay soil can be easily made and it does not break on squeezing.

	SANDY SOIL	CLAYEY SOIL	LOAMY SOIL
PLOUGHING	EASY	TOUGH	MEDIUM
CONTAINS	SAND	CLAY	BOTH SAND & CLAY
WATER DETENTION	LOW	HIGH	GOOD
FOR AGRICULTURE	LITTLE USE	LITTLE USE	VERY GOOD

c) LOAMY SOILS: Mixture of sand, clay and silt. It also contains humus and is considered the best for growing crops. Its water percolation rate is between those of the sandy soil and the dry soil.
When rubbed between fingers, it feels like powder.

SOIL TYPES IN INDIA

Based on composition of soil structure and their utility, the soils are classified as under:

1. **ALLUVIAL SOILS**: The largest and the most important soil group in India. They are composed of sediments deposited by rivers and waves but are deficient in Nitrogen and humus. They can be found in the plains of Punjab to Assam and also in the Valleys of Narmada and Tapi in MP and Gujarat, Mahanadi in MP and Odisha, Godavari in AP and Cauvery in Tamil Nadu. These soils are best for growing rice, wheat, sugarcane, tobacco, cotton, jute, maize and vegetables.
2. **BLACK SOIL**: These soils were formed thousands of years ago by the solidification of lava spread over a large area by volcanic acidity in the Deccan Plateau.
These are black in appearance and are ideal for cotton crops due to the presence of Iron and Aluminium compounds. They have a high capacity for moisture retention but lack in Phosphorus, nitrogen and organic matter.
Apart from cotton cultivation, these fertile soils are suitable for growing cereals, oil seeds, citrus fruits and vegetables, tobacco & sugarcane.
3. **RED SOIL**: Mainly formed from ancient crystalline rocks like granite and are rich in minerals such as iron and magnesium. These are found in Tamil Nadu, Karnataka, Andhra Pradesh, Part of Maharashtra, Chhattisgarh, parts of Odisha, Jharkhand and Bundhelkhand.
They are generally deficient in Nitrogen, humus and phosphorus but are rich in potash. They are most suitable for Rice, Millets, tobacco & Vegetables, groundnut and Potato.
4. **LATERITE SOILS**: Found in areas with monsoon conditions where heavy rainfall and high temperature is experienced with alternating wet and dry periods. These are most suitable for growing Tea, Coffee, Rubber, cinchona and rice and millet cultivation.
5. **FOREST & MOUNTAIN SOILS**: Mainly found on the hill slopes covered by forests. The formation of these soils is mainly governed by the deposition of organic matter derived from forest growth.
These soils are found in the valley basins of Himalayan and peninsular regions. Tea, coffee, spices, rice and tropical fruits are best grown in these soils.
6. **ARID & DESERT SOILS**: A large part of the arid and semi-arid region in Rajasthan and adjoining Punjab and Haryana lying between the Indus and the Aravalli's receives less than 50 cm annual rainfall and has desert-like conditions. The presence of nutrients i.e. phosphates and nitrates make the soil rich enough to grow different crops. These soils are best for crops like wheat, bazra and guar.
7. **SALINE & ALKALINE SOILS**: These soils are found in the drier parts of Bihar, UP, Haryana, Punjab, Rajasthan and Maharashtra. These soils are generally called *Reh-Kallar*, *Usar* etc. These soils are formed by transportation of solution by rivers and canals which travels down to the sub soils of the plains. Due to accumulation of salts, the soil becomes unfit for agriculture.
8. **PEAT & MARSHY SOILS**: They originate in the humid regions due to the accumulation of large amounts of organic matter in the soil. They contain considerable amounts of soluble salts and 10-40% of organic matter. Peat soils are found in Kottayam and Alappuzha districts of Kerala where it is called *Kari*. Similarly, marshy soils which are high in vegetative matter are found in Northern Bihar, Coastal parts of Odisha, Tamil Nadu and West Bengal and parts of UP.

SOILS OF PUNJAB

Following types of soil are found in different areas of Punjab

Forest Soils

The rainfall in these area is above 100 cms and temperature is also temperate.
Area: Parts of Gurdaspur, Pathankot, Hoshiarpur, SBS Nagar and Ropar.

Composition: It is stony and gravelly. Problem of soil erosion due to steep slopes and uneven surface.
These soils are reddish brown to olive brown in colour. Mostly used for plantation and forestry.

Kandi Soils
Area: These soils are found in the areas of Pathankot tehsil of Gurdaspur, larger parts of Hoshiarpur, SBS Nagar and Ropar districts. Like in forest soils, rainfall is heavy in these areas.
Composition: These soils have a sandy, sandy loam, silt loam and clay- silt to gravelly texture. The texture becomes coarser and rougher eastward the Shivaliks hills where gravel, pebbles and conglomerates predominates.
These have been deposited by numerous choes coming from Shivalik hills. The soils are badly eroded and less productive and are suitable from dry farming.

Flood Plain or Bet Soils
Area: Flood Plain or Bet Soils are *Khadar* soils of the periodically flooded or old flood plain areas of various rivers, streams or choes of the state. They are found in the form of elongated belts on the both side of the river channel such as those of Satluj, Ravi, Beas and Ghaghar.
Composition: Depending upon the source of alluvium, the soils are calcareous or non-calcareous.
They are pale to yellowish brown in colour. The soils are well drained and very deep and they vary in texture and these have generally a low and irregular organic matter.
These soils are suitable for the cultivation of paddy, wheat, sugarcane and vegetables.

Loamy Soils
It is the most important, fertile and productive soil group of the state. These soils cover nearly 25% area of the state. The rainfall in these areas is
Area: Found in most of central part of the state covering Ludhiana, Jalandhar, Amritsar, Tarntarn, Kapurthala, parts of SBS Nagar, Moga, parts of Bhatinda, Sangrur, Barnala and Muktsar.
The soils become clayey towards northwest in Amritsar and Gurdaspur districts
Composition: These are deep and fine grained soils, which have developed under sub- moist and cool to warm temperate climate.
These soils are intensively cultivated for wheat and paddy crops.

Sierozems
Sierozems are grey soils of semi-arid parts of Punjab with an average annual rainfall from 50cm to 70cm, the general air temperature ranges from 24°C to 25°C and have grass and deciduous vegetation.
Area: These soils cover nearly 25% area of the state. This type of soil is found in:

i. Eastern half of the Malwa plain in parts of Ludhiana, Sangrur, Patiala, Fatehgarh Sahib, Faridkot districts. i.
ii. Belt extending from Mukerian through Tanda tc Nakodar of Doaba and Majha region.
iii. Western parts of Kapurthala districts and Tarntaran and Patti tehsils of Amritsar districts.

Composition: The soils are overall grey colour which indicates its deficiency in organic matter. Nitrogen and Potash are not sufficient. pH value ranges between 7.8 to 8.5.
Wheat and Paddy are main produce. Excessive irrigation has resulted in some form of salinity.

Sandy Soils
These soils have developed under semi-arid & warm to hot climatic conditions with rainfall ranging from 30cm to 50cm.

Area: These are arid soils of south-western and south central Punjab covering parts of Bathinda, Mansa, southern parts of Ferozepur, Muktsar districts, larger parts of Sangrur, south-central parts of Patiala district and some patches of Ludhiana district.

Composition: The soils are yellowish to grey colour, the overall grey colure reflects the deficiency of organic matter and also is poor in nitrogen, phosphorus and potash.

The pH value ranges from 7.8 to 8.5.
They have low to medium fertility but by artificial irrigation they become much more productive and are capable of producing cotton, citrus, oilseeds, wheat, paddy and fodder crops.

Desert Soils
These are sandy soils and cover around 11% of the total area of Punjab. The average rainfall is up to 30 cm. This soil is dry and deficient in humus. It is poor in nitrogen, phosphorus and potassium.
Area: It covers south -western parts of the state in Abohar, Zira area, parts of Muktsar Bathinda and Mansa district.
These soils have developed under arid and hot climate and thin cover or bush vegetation.

Composition:
The reaction is from normal to alkaline and pH value ranges from 7.5 to 8.5. the fertility with respect to plant nutrient is low to medium.

The soils are light in colour from yellow to light brown. These soils are suitable for the cultivation of cotton, moth, citrus, wheat, bajra and other Kharif fodder. The soils suffer from wind erosion especially in the summers.

Sodic and Saline Soils
Salinity is the presence of high content of soluble salts (more than 0.2 percent) which make it difficult for the plants to absorb water from saline soils. The salt moves up and down in the soil along with soil water.

Areas: This type of soil is found parts of:
Fazilka, Ferozepur, Faridkot, Muktsar, Mansa and some parts of Sangrur and Samana.
Areas along or across Bikaner canal, Abohar, Bathinda, Ghagghar and Kotla branches of Sirhind canal and Bhakra canal.

Composition: The pH value of these soils is generally 7.3 to 8.5 and is neutral in reaction. Sodic soils have a higher percentage of sodium (more than 15 %) salt and high pH value above 8.5 and strong alkaline reaction.
Saline soils of south-western Punjab are of recent origin resulting from surface flooding and or rise in the ground water. During summer period of excessive evaporation, salts accumulate at the surface.

SOIL REGIONS OF PUNJAB

Different types of soil is found in different areas of Punjab. Thus on the basis of soil texture, Punjab can be divided into three broad areas:

1. South Western Punjab: Covers Fazilka, Muktsar, Bhatinda, Mansa and some parts of Ferozepur. Soil found in this area is mostly sandy. The soils are low in nitrogen, phosphorous and potash. Earlier, soil erosion was a problem of the area but now water logging has become main problem. Wheat, rice and cotton are the main crops. The soil is sandy to desert type.
2. Central Punjab: All central districts of Punjab viz. Ludhiana, Patiala, Sangrur, Barnala Kapurthala, Jalandhar, Ropar, Tarntaran, Amritsar are covered under this zone. Texture of soil varies from sandy loam to clayey loam. Main crops are wheat, rice and vegetables. The soil is loamy to Seirozem. Some parts along the Satluj and Beas have bet soils.
3. Eastern Punjab: Pathankot, Gurdaspur, Hoshiarpur and parts of Ropar. Soil erosion is a problem of the area because of seasonal 'choes'. Main crops are rice, maize and fruit crops. The soil is Forest to Kandi type.

What is a Soil Health Card?
SHC is a printed report that a farmer will be handed over for each of his holdings. It will contain the status of his soil with respect to parameters essential for growth of crops. On the basis of this report, the SHC will also indicate fertilizer recommendations and soil amendment required for the farm for better yield.

SOIL CONSERVATION

SOIL CONSERVATION MEASURES
The preservation of soil against deterioration and loss by using it within its capabilities, and applying the conservation practices for its protection and improvement.
Different methods used for soil conservation are:

(a) CONTOUR CULTIVATION
Cultivation of crops along the contours of a slope.
It has the following advantages:

- **(i)** conservation of soil and water
- **(ii)** conservation of soil fertility
- **(iii)** increase crop yield
- **(iv)** much less power required
- **(v)** less wear and tear of implements

Disadvantages: Doing contour farming on an undulating land is tedious.

(b) Mulching
Mulch is any material applied on the soil surface to check evaporation and improve soil water. It is defined as a natural or artificially applied layer of plant residues or other materials on the soil surface. Mulches are used for various reasons but water conservation and erosion control are the most important in dry regions e.g. crop residues leaves manures, straw, plastic films etc.

(c) Management of Problematic Soils
The fertility of the soils can be increased by following different methods for different soils.

Sandy Soils:

i. Addition of green manure of dhaincha/ sunhemp.
ii. Application of well decomposed organic material viz farmyard manure, etc and by its proper mixing with the soil
iii. Cultivation of leguminous crops
iv. Proper levelling and small plot size improves irrigation water efficiency
v. Adding clay soil or village pond soil
vi. Land can also be improved by removing the upper layer of sand with the help of tractor operated scrapper,'karaha' (**ਕੜਾਹਾ**)

Clayey Soils:

i. Application of green manure and organic material
ii. Incorporation of crop residue
iii. Ploughing the field at proper moisture content prevents formation of clods
iv. Proper drainage should be ensured to drain out excessive water
v. Rice cultivation should be preferred in these areas.

Acidic Soils

i. By addition of lime.
ii. Application of press mud and saw dust

Salt Affected Soils
Some factors need to be considered before reclaiming these areas. The factors are: Sub-soil water level, Irrigation water quality, Availability of Canal water, Presence of Hard pan in soil profile, Drainage conditions, degree of salinity and alkalinity.

Reclamation of Saline Soils: Filed should be ploughed in flooded condition to help leaching of salt from upper layer of soil. Ploughing in flooded field is also called 'puddling' (**ਕੱਦੂ ਕਰਨਾ**). If good quality water is not available, the upper layer should be scrapped with scrapper(**ਕੜਾਹਾ**).

Reclamation of Alkaline Soils: Level the field and make bunds around it to prevent the flow of water containing the salts to adjoining fields. Get the soil tested for quantity of gypsum to be required.

Add gypsum and mix it thoroughly with the soil. Irrigate the field to allow seepage of salt from surface.

Adding green manure, organic material and dhaincha also increases the soil productivity.

Reclamation of Water logged Soils: In areas where the water level is high, the soil remains wet due to filling of soil and air pores with stagnant water. Such soils are called 'water logged soils'. Such soils are found in Muktsar area and along river banks. Digging of wells and draining out water is helpful in such cases.

CHAPTER - 4
AGRO FORESTRY

Definition: It is a land management system where trees and crops are grown together along with rearing of animals. It is done on the same farm/ land alternatively and sequentially.

At its simplest level, agroforestry is combining agriculture (crops and livestock) with forestry (trees.) It's a type of intercropping where trees are grown on pastures or among crops to provide a number of benefits.
Agroforestry allows for sustainable, renewable, long-term forest management while also helping the environment, creating more ecological diversity, as well as increasing and diversifying income for farmers.

Objective: The main objective of agro-forestry is to meet the demand of farmer's food, fuel, fodder, fibre and fertilisers along with maintenance and amelioration of natural resources, i.e. land, water and air.

A tree species is considered suitable for agroforestry if it is having majority of the following characteristics:
i. fast growing nature,
ii. straight trunk,
iii. clear bole,
iv. less branches,
v. narrow crown,
vi. self pruning nature,
vii. positive effect of litter fall and its decomposition on soil and with crops,
viii. and good marketability.

In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health.

Benefits of Agroforestry
1. Increase in income of farmers.
2. Helps in environment stability
3. Helps in crop diversification
4. Increases the forest/tree cover

Agroforestry Models
1. Boundary Plantation
2. Block Plantation
3. Scattered Plantation

1. Boundary Plantation
This practice is suitable to all categories of farmers especially the small farmers who can grow trees and supplement their agricultural income without sacrificing any land from agricultural operations. These single or double rows of trees on field bunds and irrigation channels grow quickly and flourish well as they get water and fertilizer applied to crops and do not have any competition for light and crown development.

Boundary row of trees should preferably be planted in north-south direction to minimize the adverse effect of shade on adjoining crops. It is an established fact that the loss in crop yield is often compensated by the income generated from harvesting trees at the end of rotation period. Suitable farm-forestry tree species are: eucalyptus, Poplar, Subabul, Mulberry, Dek, Toon, Shisham (tahli), Sohanjana etc.

2. Block Plantation
This is a practice of growing trees in rectangular or square planting pattern throughout the field. Farmers having large land holding mostly adopt this arrangement of tree planting.
Important tree species for block planting are: Poplar, Eucalyptus and dek.
Many agricultural crops (wheat, potato, mustard, berseem, turmeric, sugarcane, etc.) can be profitably raised intermixed with block plantations of trees.

Intercropping in Block Plantations:

In the interspaces between the trees lines crops such as Sarson, Turnip, Mentha, Ginger, Fenugreek, Carrot, Cabbage, Potato, Spinach and Wheat etc. are grown. Generally, big farmers adopt this type of agro-farming. This is another type of alley-cropping.

3. Scattered Plantation
Sub-mountain region is having scattered trees on farmland. The farmers retain the local trees like khair, kikar, dhak, shisham, mango, amla, phulai, beri on their fi elds wherever they happen to regenerate naturally.
These plants provide fuel, fodder during lean period and also help in soil and moisture conservation. In undulating plain region, where permanent irrigation source is available farmers also undertake block planting of poplar at wider spacing and inter-cultivate the agricultural crops.

Suitable Trees for Different Regions of Punjab

i. Central Plain Region:
Poplar, Eucalyptus and dek are grown as intercrop.

ii. Trees for problematic regions

a. Sub-mountainous Zone:
The surface and the land being uneven and undulating, there is a big problem of soil erosion. Irrigation is mainly rainfed as there is lack of irrigation facilities.

Main trees for this region are : Khair, Kikar, Ber, Toot, Nim, Mango, Dek, Kachnar, Bel, Amla, Phali, Tahli, Suhanjana, Dek, Harar, Behra, Arjun etc.
Inwinter, to meet the shortage of fodder, Dhak, kachnar, Beri, etc are chopped for use as fodder.
Mango and Citrus is also grown along timber trees in orchards. Jatropha, Karonda and Ipomea shrubs are also grown along the boundaries to protect the trees from wild life animals.

b. South-Western Region:
In the south-western region of the state, there are some areas which are either sand dunes, waterlogged, or salt affected soils that need to be reclaimed and put under profitable utilization.
Species that can be grown on these soils are listed below:

a. Water-logged soils –Willows, safeda, jamun, bamboos, kadam, sukhchain, arjun, etc.

b. Saline and alkali soils - The factors responsible for the formation of such soils are: arid and semi-arid climate, hard impervious pan in sub-soil region, high water table, impeded drainage and salt bearing substrate, excessive canal irrigation, and use of saline and brackish water.

In saline soils (white kallar), remove salts from root zone by leaching with canal water and trench/furrow planting of jor-tor, jand, kikar, arjun, safeda etc. is recommended.

In alkali/ sodic (black kallar) soils, apply gypsum, green manuring and ponding with good quality water. Pit auger hole planting of jand, kikar, jor-tor, arjun, farmah, sukhchain, safeda etc. is recommended on such soils.

COMMERCIAL FORESTRY

Poplar and Eucalyptus are mainly grown for commercial use.

POPLAR

Usage: matchsticks, packing. It is more popular in bet areas. It is not successful in Kallar and waterlogged areas.
Varieties: PL-2,PL-3, PL-4, PL-6, PL-7, L-47/88 and L-18/89
Planting: In months of January-February.

EUCALYPTUS

To be planted as clonal plants as seeds do not grow uniformly. Fast growing and useful.

Usage: Source of wood fibre for plywood, paper and other timber based products. Farmers take poplar based agroforestry system as an economically viable option for crop diversification than the natural resource depleting traditional wheat rice rotation.

In addition to fast growing nature, its other qualities such as winter deciduous nature, straight bole, narrow crown, compatibility with agricultural crops, amenability to cultural and management practices have made this tree one of the best options for agroforestry.
Poplar requires loam to sandy loam, deep fertile and well-drained soil with neutral pH. It does not grow well on saline, alkali, water logged and heavy clay soils. Frequent irrigation is required for the optimum growth of trees.

Varieties:
Central plain region: PL–1, PL–2, PL–3, PL–4, PL–5, L–47/88 and L–48/89.
Semi-arid region: PL–3, PL–6, PL–7 and L–48/89.

Planting in March- April and July-August.

Harvesting: For timber 13-15 years.; for pulp 6-8 years; for batten 4 to 6 years.

Plantation of trees in north-south direction.

DEK

It is commonly planted on field boundaries. However, during recent years farmers have started planting dek as blocks in fields along with crops. It is fast growing and deciduous in nature and is viable options for introduction of fast growing tree species on farmlands. It can be grown on variety of soils ranging from light to heavy texture, even in alkaline or saline conditions.
It is a winter deciduous tree; therefore almost all rabi crops like wheat, mustard potato, barley, oats, berseem, etc. can be raised throughout whole rotation of the tree.
During initial 3-4 years, kharif crops such as sorghum, bajra, moong, turmeric can be sown under dek.

Intercropping - Intercropping gives additional economic benefit to farmers in addition to benefiting the trees. The growth of trees improves due to the fertilizers and irrigation applied to the crops. Those crops should be selected which can tolerate the shade effect of trees.

Other important trees suitable for agroforestry:

1. Gmelina arborea (Goomar teak, White teak and local name Gamhar) is a fast growing deciduous tree with a straight trunk that occurs naturally throughout greater part of India at an altitudes up to 1200 meters.
2. Toona ciliata (Burma toon, Indian cedar, Indian mahogany and local name Maha nim, Tun) is a large deciduous tree. It grows well in moist localities up to an altitude of 1500 m with mean annual rainfall of 750-4000 mm.
3. Melia composita (Ghora nim and local name Burma dek) is a fast growing deciduous tree. It grows well at an altitude up to 1800 m and mean annual rainfall 750-2500 mm.
4. Dalbergia sissoo (Indian rosewood, Shisham and local name Tahli) is a medium to large sized deciduous tree. ***It is the state tree of Punjab.*** It can grow at an altitude up to 1500 m and mean annual rainfall 500-4500 mm. It grows well in a wide range of soil types, from pure sand and gravel to rich alluvial soil of riverbanks.
5. Azadirachta indica (Indian Lilac and local name Neem) is a fast-growing evergreen tree of mahogany family. It can grow at an altitude up to 1000 m with an annual rainfall 400–1200 mm. It thrives best on well drained deep and sandy soils. Flowers appear from March to May and fruits usually ripen during the month of June and July. It is a good coppice tree species.
   The tree and its leaves are known for their medicinal value.
6. Salix alba (White willow and local name Willow) is a medium to large-sized deciduous tree. It prefers moist or wet heavy soil in a sunny position but can also grow well on poorly-drained or intermittently flooded soils. The flowers are produced in catkins in early spring and fruits mature in mid-summer.

CHAPTER – 5
IRRIGATION SYSTEM

IRRIGATION

Irrigation is the controlled application of water for agricultural purposes through man-made systems to supply the water needs not satisfied by rainfall. Crop irrigation is very important wherever and whenever crops are grown. Irrigation ensures enough food production for an ever-growing population.

WATER RESOURCES OF PUNJAB

Agriculture in Punjab has a very heavy requirement of water and about 85 percent of the water resources in the state are consumed by agriculture i.e. for irrigation purposes. The major sources of irrigation in the state are its extensive canal system and underground water drawn out by tube wells.

The state surface water resources (three perennial rivers, namely the Sutlej, Beas and Ravi, having water potential of about 14.54 Million Acre Feet) are being fully utilized through the well organised canal irrigation system in sustaining the intensive agriculture practices.

The long canal network consists of six major canals:

i. Upper Bari Doab Canal;
ii. Bist Doab Canal;
iii. Sirhind Canal;
iv. Bhakra Main Canal;
v. Bikaner Canal and
vi. Ferozepur Canal Circle

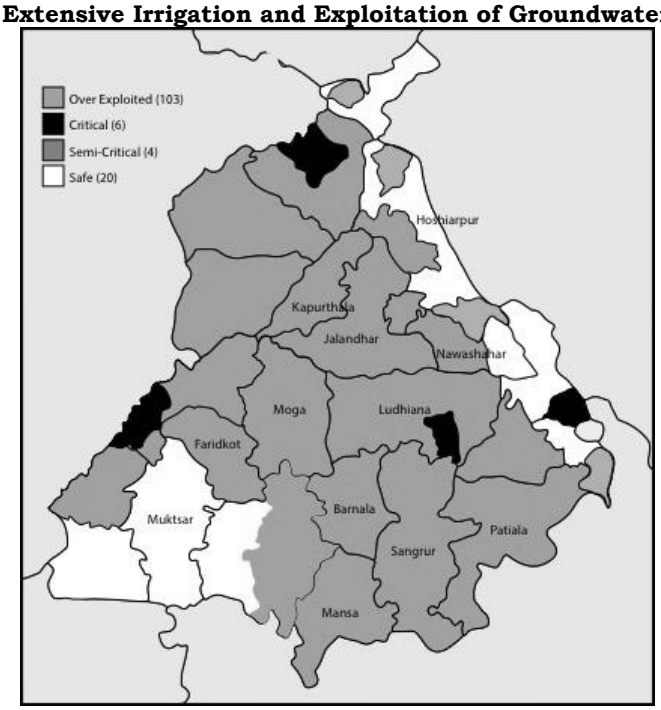
These canals run for about 14.5 thousand km providing irrigation to an area of 1.6 million ha. Most of the canal irrigated area of Punjab lies in Upper Bari Doab (from Ravi river) and Malwa region which include the Sirhind, Bhakra and Bikaner canals from river Sutlej.

During the year 2018-19, about 98.9 percent agricultural area of state was irrigated from canals and tube wells. The canal irrigated area in the state increased between 1980 to 1990 but a significant reduction has been reported from 1990-91 to 2018-19. Whereas the area irrigated by centrifugal tube wells has increased during the same period i.e. from 2233 Th. ha in 1990-91 to 2907 Th. ha in 2018-19.

Net irrigated Area in Punjab (source-wise)

The State also has an 8 thousand km long drainage network. The major seasonal drains of the state, Chitti Bein, Kali Bein, Sakki and Kiran Nallah, etc. Numerous *choes* of the sub-shiwaliks or the Kandi area are the ephemeral drains. These drains help in quickly dealing with heavy run off in monsoons and in preventing water logging.

Extensive Irrigation and Exploitation of Groundwater



Punjab is a well irrigated state with majority of the cropped area under irrigation. The number of tube wells in the State has increased from 10.73 lac in 2000-01 to 14.76 lac in 2018-19. The tube wells operated on electricity has increased from 7.88 lac to 13.36 lac during the same time period indicating reduction in diesel operated tube wells which is better for the environment, however, excessive extraction of groundwater does not support sustainable agriculture practices.

This has caused the depletion of the underground water table. Groundwater extraction is more than 100 percent in Punjab implying that groundwater consumption exceeds annual extractable sources.

Ministry of Jal Shakti (2019) Report on the Dynamic Ground water resources of India, 2017 reported that Punjab groundwater resources showed, 80% of 138 assessed blocks were 'Over-exploited', 2 blocks were 'Critical', 5 were 'Semi-Critical', and 22 were 'Safe'. It also highlighted that 95 percent of the water extracted in the state was for irrigation purposes.

Further, because of the declining water table, the farmers are compelled to deepen their tube wells at their own cost, as the ordinary tube wells become obsolete due to their inability to draw underground water. Therefore, farmers are increasingly shifting over to submersible pumps. The submersible pumps are expected to raise the cost of cultivation and excessive use of groundwater. With increasing costs of irrigation, the marginal farmers are expected to be left vulnerable to the impacts of a declining water table.

The Government of Punjab is continuously taking steps to give solution to above problem such as by promoting the micro-irrigation system, including sprinkler and drip irrigation to make available the irrigation water to all farming systems in the state in a targeted manner

METHODS OF IRRIGATION

Irrigation of crops is essential to meet their water requirement. The crops or the plants have to regularly and properly irrigated for optimal production. Mainly following methods of irrigation are used to irrigate the crops so that water requirements are met at minimal cost:

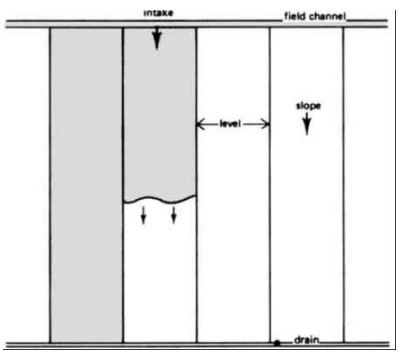
A. Surface
B. Sub-surface
C. Sprinkler
D. Drip / Trickle

A) **Surface irrigation**: There are four variations i.e.
1) Flooding
2) Bed or Border method
3) Basin method (Ring and Basin)
4) Furrow method (Right & furrows, Broad ridges)

1) Flooding: Opening a water channel in a plot or field so that water can flow freely in all directions and corner the surface of the land in a continuous sheet. It is the most inefficient irrigation method as only 20% water is actually used by plants, the rest being lost as a run–off, seepage, and evaporation. Water distribution is very uneven and crop growth is not uniform. It is suitable for uneven land where the cost of leveling is high and where cheap and abundant water is available.

2) Border Strip Method (Sara and Flat beds): In this method, the field is levelled and divided into small beds surrounded by bunds 15-30 cm high.

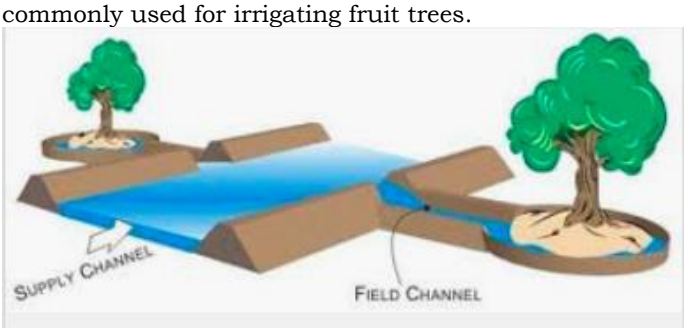
Border irrigation is a method of controlled surface flooding. The field is divided into strips by parallel border ridges, and each strip is irrigated separately. Water is introduced at one end and progressively covers the entire strip.



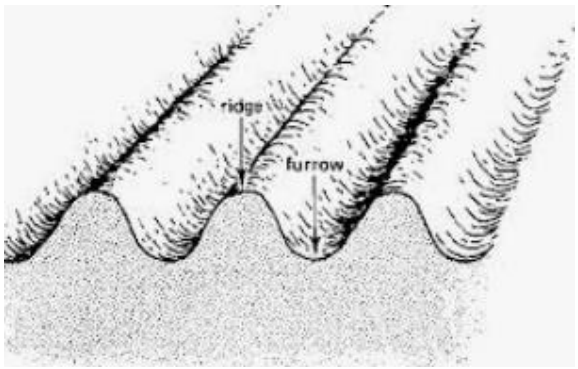
Border Strip Method

This method can be adapted to most soil textures except sandy soils and is suitable for high value crops like wheat, maize, cotton etc. It is more efficient in water usage and ensures its uniform application.

3) Ring Basin irrigation: Suitable for orchids and other high value crops where the size of the plot size is very small. A variation in this method viz. ring and basin is commonly used for irrigating fruit trees.



4) Furrow Method: Row crops like potatoes, cotton, sugar cane, vegetable etc can be irrigated using this method. Water is allowed to flow in the furrows opened in crop rows. It is suitable for sloppy lands where the furrows are made along the contours. It is relatively easy to install and is inexpensive to maintain.



Furrow Irrigation

B) **Sub Surface Method:** Sub-surface or sub-irrigation may be natural or artificial. Natural sub-surface irrigation is possible where water is quite near the soil surface and can be easily taken up by the plants for cultivation of vegetables. For example, cultivation of vegetables by farmer at Dal Lake, Sri Nagar in Kashmir. Water is allowed into the series of ditches, which wets the root zone.


Sub Surface Irrigation

C) **Drip or Trickle Irrigation:** -

The irrigation is provided ear the base of crops drop by drop. Thus. irrigation is provided as per needs of the plant without any wastage.
Mango, lemon, pomegranate, kinnow, ber, guava, and vegetable like tomato, cauliflower, cucumber, brinjal, chilly, capsicum etc.

This irrigation technique is very effective in areas where water is highly deficit.


Drip irrigation

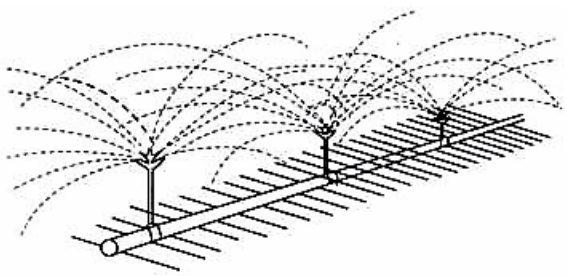
The losses by drip irrigation and evaporation are minimized. A precise amount of water is applied to supply the depleted soil moisture at frequent intervals for optimum plant growth. The system enables the application of water and fertilizer at an optimum rate to the root system. The initial cost of the drip irrigation system is a major limitation.

Merits

(i) Well suited to areas of acute water shortage.
(ii) Deep percolation, surface runoff, evaporation losses are minimum.
(iii) Water is maintained at field capacity all through.
(iv) Salt concentration is less even in salty soils due to high moisture.

D) Sprinkler or Overhead irrigation

Application of water to soil as spray or rain. It is particularly useful for sandy soils because they absorb water too fast. Soils that are too shallow, too steep or rolling can be irrigated efficiently, using sprinklers.


Sprinkler Irrigation

a. Pipes are laid in the fields with nozzles and the water is sprayed into air. It lands on plants or land surface in a uniform pattern with rates lesser than the infiltration rate of the soil.
b. This technique is very effective for areas with irregular topography.
c. This method can also be used to mitigate frost and high temperature.
d. It is very useful in sandy and undulated soil

SOURCES OF WATER IRRIGATION

Ground water source

1) By Canal
   a. Seasonal Canal
   b. Regular Canal

2) By Ponds
3) By Rivers
4) By Springs

Underground water sources

1) Well **2)** Tubewell
3) Aquifer **4)** Hydraulic pump

Water logging (Sem): Water logging refers to the saturation of the soil with water. Soil may be regarded as water logged when the water table of the ground water is too high and conveniently permit an anticipated activity like agriculture. Crop needs air to a greater or lesser depth in the soil.

Critical stages of Water Requirement for Important Crops

Wheat
1) Crown root initiation stage
2) Tillering stage
3) Flowering stage
4) Milking stage

Paddy
1) Tillering stage
2) Flowering stage
3) Grain formation

Sugarcane
1) Tillering
2) Grand growth phase

Maize
1) Silking stages
2) Milking stages

Pulses
1) Shoot formation
2) Flowering

Jowar
1) Flowering stage

Mustard-Rapeseed
1) Shoot formation
2) Flowering

Potato
Early stage of tuber formation

DRAINAGE

Agricultural drainage is the removal of excess water called free water or gravitational water from the surface or below the surface of the farm land to create favourable soil conditions for plant growth.

WATER LOGGING (ਸੇਮ)

- Water logging refers to the situation of soil may be regarded as water logged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail.
- Water logging affects a number of biological and chemical processes in plants and soils that can affect crop growth in the short and long term. Plants need oxygen for all division and uptake and transportation of nutrients.

CAUSES OF WATER LOGGING

(a) Natural
(i) Poor natural drainage of the subsoil.
(ii) Submergence under floods.

(b) Artificial
(i) High intensity of irrigated agriculture irrespective of the soil and the subsoil.
(ii) Heavy seepage of losses from unlined canals, distribution and farm watercourses
(iii) Enclosing irrigated fields with embankments and chocking up natural drainage.
(iv) Hydraulic pressures from upper saturated areas at higher elevations.
(v) Non-maintenance of natural drainage or blocking of natural drainage.

DROUGHT (ਸੋਕਾ)

The Indian Meteorological Department defines Drought as a situation in an area in a year when the annual rainfall received is less than 75% of the normal.
Moderate Drought: If the deficit is between 26-50%
Severe Drought: If the deficit is moe than 50%

Agricultural Drought
When the soil moisture is inadequate for healthy crop growth and causes extreme stress and wilting.
It is the result of moisture deficit on account of non availability of water in the soil.

DROUGHT YEAR
A year is considered to be drought year, in case the area affected by moderated and severe drought, is 20-40% of the total area of the country and the seasonal rainfall deficiency during the south –west monsoon season for the country as a whole is at least 10% or more.
When the drought affects more than 40% of the total area, it is called as All India Severe Drought Year.

WATERSHED MANAGEMENT

Watershed means an area of land where the runoff drains to a common point i.e. in the river or water pool. Watershed may be defined as a natural unit of land where the runoff collects and flows out of the area through a common outlet into a river or other water body.
It is a drainage base demarcated by ridges or gullies. The terms *watershed*, *drainage area* or *catchment area* are interchangeably used. Usually, the catchment area (water collecting area) is larger but the area of the watershed is comparatively smaller.

WATER HARVESTING / RUNOFF CONCENTRATION / RAINFALL PRECIPITATION
In humid climates, the runoff usually occurs only when the rain falls on a saturated soil. Under semi-arid conditions, the total annual precipitation may not be sufficient, but most of the rain falls in a short period causing humid climate and resulting in runoff. In both conditions, the excess rain water should be safely guided and collected in nearby ponds for recycling in drier periods for irrigation.

RUNOFF
That part of the precipitation which is not absorbed by the soil but finds its way into the streams after meeting the persistent demands of evaporation including interception and other losses. In other words, runoff is the excess water from precipitation that moves out of field and finds its way to rivers, lakes and oceans etc.

SOIL & WATER CONSERVATION MEASURES
Soil and water conservation measures on the watershed basis include all measures which are effective in preventing or delaying the movement of soil and rock particles.
The emphasis is given on soil surveying, contour and graded bunding, repairing of old bunds and dams, land reclamation, digging of farm ponds etc.

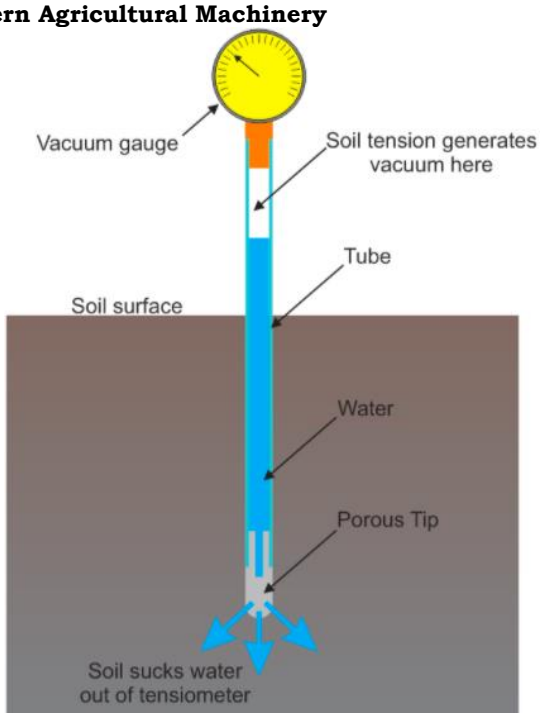
CONSERVATION OF IRRIGATION WATER

Demand and supply should match for optimum management of water resources.
Methods to save water Recharging excess runoff from agricultural fields Selection of appropriate method depending upon crop and soil type Less water consuming crops, Adopting sprinkler and drip irrigation

Crop Diversification
Both wheat and rice require large amount of water. Should grow crops that consume less amount of water like – basmati, maize, cotton, oilseeds, and pulses.

Wheat can be replaced by barley, and oil seed crops

Modern Agricultural Machinery



Computerised Laser Leveler: It is used for land leveling in precise manner. It results in 25 to 30 percent saving in water. Yield is increased by 15 to 20 percent.

Zero Trill Drill
Sowing of wheat can be done by using this method to save pre sowing irrigation.

Use of tensiometer in paddy
After mulching, water should be kept standing in the field during first fifteen days/ Afterwards, water can be applied at two days interval. Irrigation scheduling can be done by using tensiometer.

Tensiometer: Glass tube inserted in the field. Irrigation is applied when water level touches from green to yellow layer.

Mulching

In crops like maize and sugarcane, mulching can be done by using crop residue which results in reduction in evapo-transpiration losses and results in water saving.

It can also be done by using polythene sheet.
Very useful for Capsicum and chilly.

Rainwater harvesting
Can be used to rejuvenate village ponds. Abandoned wells and hand pumps can also be used for recharging.

Lining of Canals & Channels
Use of PVC pipe line system: Ten to twenty percent saving

CHAPTER - 6
AGRO-BASED INDUSTRY

Industries based on agricultural products are called **agro-based industries**, e.g. sugar from sugarcane, bags made of jute, and clothes from cotton.

Industries based on minerals are called mineral-**based industries**, e.g. steel from iron ore.

The Agro-based industry is an enterprise that processes raw materials, containing ground and tree crops as well as livestock. The degree of processing can differ tremendously, ranging from the cleaning and grading of apples to the milling of rice, to the cooking, mixing, and chemical alteration that makes a texturized vegetable food. Agro-industries can be categorized according to the degree the raw material is transformed.

AGRO-INDUSTRIES

AGRO INDUSTRY SECTORS

Agro based industry refers to the subset of manufacturing that processes raw material and immediate products derived from agricultural sector, agro based industry thus means transforming products originating from agriculture forestries and fisheries.

1) Processing of agro based grains etc, rice shellers, dal mills, solvent plants
2) Processing of milk and milk products.
3) Extraction of juices from fruit plants.
4) Meat and poultry processing
5) Establishment of mega food parks, and food parks
6) Cold chains
7) Cotton textiles, jute textiles and sugar industries.

Need for Agro based industry

Punjab lacks natural resources like iron ore or coal etc. which are considered basic raw material for industry. However, it can count on its agricultural inputs for development and growth of industry in the state by adopting the right technology and entrepreneurship. Due to lack of storage space and processing units, the post harvest losses in agriculture are very high. Though in grains the loss is limited to around 10% but in case of fruit and vegetable the loss is as high as 30 to 40%. The farmers need to take to crop diversification as well as invest in agro-based industry to make the best use of the agricultural produce to increase his income and employment opportunities.

The advantage of agro-industry is that it will supplement the income of the small farmers with very little investment. These days farmers have taken to 'gur making' / jaggery in a big way. Similarly, other products like haldi, chilli etc need to be processed before they reach the consumer and the small farmers can undertake these activities to supplement their income.

TYPES OF AGRO-BASED INDUSTRIES

There are four types of agro-based industries.

1. Agro-produce Processing Units
They merely process the raw material so that it can be preserved and transported at cheaper cost. No new product is manufactured. Ex: Rice mills, Dal mills, etc.

2. Agro-produce Manufacturing Units
Manufacture entirely new products. Finished goods will be entirely different from its original raw material. Ex: Sugar factories, bakery, solvent extraction units, textile mills, etc.

3. Agro-inputs Manufacturing Units
Industrial units which produce goods either for mechanization of agriculture or for increasing productivity come under this type. Ex: Agricultural implements, seed industries, pumpset, fertilizer and pesticide units, etc.

4. Agro Service Centres
Agro service centres are workshops and service centres which are engaged in repairing and servicing of pumpsets, diesel engines, tractors and all types of farm equipment.

AGRO INDUSTRIES

1. **Agro-processing Units/ Complexes**
   These units are very popular and successful in rural areas. There is ready availability of raw material required for processing. Examples are:
   Mini Rice Mills, Flour Mills, Oil expeller, Grinder, Cotton ginning machine, Pulse cleaner and grader, Mini dal mill, Feed mill.

2. **Turmeric Processing Unit**
   It is a common household spice and has very high demand in foreign countries as well. It is used to provide flavour, taste and colour to the food. It possess medicinal value and is also used in cosmetics and as dye for cotton clothes. Turmeric is obtained from rhizomes of the plant, which are washed, boiled, dried and grinded and packed for final sale.

3. **Mentha Processing Unit**
   Mentha oil is used in medicines, perfumes and cosmetics. It is derived form the leaves of dried mentha leaves. De-oiled mentha leaves are used as fodder.

4. **Jaggery Manufacturing**
   Jaggery or gur is obtained from sugarcane and is becoming very popular due to high content of potassium in it which improves metabolism and helps weight loss. It is also rich source of iron.

5. **Processing of Fenugreek, coriander, chilli, garlic, ginger and other agri-products.**

6. Processing of Fruit & Vegetable

In India more than 40% of vegetable and fruit production is lost due to non-availability of infrastructure and storage facilities. These industries are capital intensive.

7. Cotton ginning mills

More than 80,000 crore of cotton is sown in India and around six crore persons are involved in textile mills. This makes cotton based industry one of the most important sector of employment in India.

8. Jute Based industry

Jute is an important crop in coastal areas of Bengal and is used to make sacks for storage of food grains.

9. Allied Activities

Dairy farming

It has become the most important component of income for the farmers and accounts for around __ percent of GSDP of the state. After fulfilling the home requirement, the farmer can sell the remaining milk to earn additional income. This is being achieved with the help of cooperatives established in the villages, which procure milk from the farmers and either process it at their centre or supply it to the milk plant.

Mushroom Cultivation

These can be cultivated indoors and do not require land for their growth. PAU has developed five varieties: **Winter Season:** Button mushroom, Oyster mushroom, Shiitake mushroom. September to March. **Summer Season:** Milky mushroom and Paddy straw mushroom. Period is April to August.

Bee keeping

Punjab is a leading producer of honey. This activity does not interfere with any other agricultural activity. It supports agriculture through pollination. Besides honey it also yields bee-wax, bee-venom, bee-brood, royal-jelly etc.

Sericulture

Silk farming, is the cultivation of silkworms to produce silk. Bombyx mori is the most widely used and intensively studied silkworm. The production of silk generally involves two processes:

1. Care of the silkworm from the egg stage through completion of the cocoon.
2. Production of mulberry trees that provide leaves upon which the worms feed.

Vegetable Cultivation

Vegetable cultivation is very remunerative cash crop. With the adoption of latest technology the farmer can produce off-season vegetable, which fetches very good price in the market. Farmers can use Green House technology or Low tunnel technology to grow these vegetable .

Agri Clinics

They help farmer from time to time by providing them required information. They may also provide input services like seed, chemicals, fertilisers, etc.

INSTITUTIONAL ARRANGEMENTS FOR PROMOTION OF AGRO BASED INDUSTRIES

Following Ministries & Departments at the Centre and State level are at present looking after development of agro based industries.

Ministry of Agriculture: Deals with rice mills, oil mills, sugar mills, bakeries, cold storage, etc.

Khadi and village industries board: Covers traditional agro-based industries like "gur", handicrafts, khandasari, etc.

Agro-industries Development Corporation: In each state mainly supply agricultural machinery, inputs and agricultural advisory services to farmers. Some corporations have also undertaken certain manufacturing activities in agro-industries sector.

Small Industry Development Organization: Deals with small agro-industries like hosiery, processing of food products, beverages, food and fruit preservation, agricultural implements, pesticide formulations, etc.

CHAPTER – 7
FOOD PROCESSING

India is home to a large variety of vegetable and fruit. Their production at 320 million tonnes in 2019-2020 has surpassed that of cereals (296.65 million tonnes). The food production is expected to be 97.97 million tonnes and that of vegetable at around199 million tonne. The rest is contributed by floriculture, aromatic and medicinal plants, spices and plantations. After China, India is the largest producer of fruit and vegetable. Both these items being highly perishable, more than 40% of this produce costing more than 44000 crores is lost due to lack of food processing i.e., proper cold chain storage infrastructure, pre and post-harvest handling and management of produce. At present only 2 percent of fruit and vegetable are processed, which brings into focus the importance of food processing industry.

What is food processing?
Food processing is any method used to turn fresh foods into food products. This can involve one or a combination of various processes including washing, chopping, pasteurising, freezing, fermenting, packaging, cooking and many more.
Food processing also includes adding ingredients to food to extend shelf life.

Methods of food processing
Food processing includes traditional (heat treatment, fermentation, pickling, smoking, drying, curing) and modern methods (pasteurisation, ultra-heat treatment, high pressure processing, or modified atmosphere packaging).

Some of the common methods are:
Drying/ Dehydration
It involves removal of water content to prolong the shelf life of the food products. It is one of the traditional techniques employed where the food particles are exposed to sunlight to dry them naturally. This process would result in the evaporation of moisture content from food, thus preventing microorganisms from invading the food.
Moisture from food can also be removed by using cabinet dryers, spray driers, freeze dehydration, solar and sun drying. Removal of water not only extends shelf life, it also their reduces weight thus lowering the transportation cost.

Pickling
It is a process of preserving food in an edible and antimicrobial liquid. Pickling could be categorized into two types, namely fermentation and chemical pickling.
Fermentation
In fermentation pickling, bacteria or microorganisms present in a liquid produces organic agents which would act as preservation agents.
Fermentation is notably used in the production of alcoholic beverages such as wine, beer, and cider, and in the preservation of foods such as dry sausages, and yoghurt, but also for raising dough in bread production.

Chemical Pickling
The food is preserved in a by adding chemical agents that destroys microorganisms and bacteria.

Freezing
It is one of the common method used domestically to preserve a wide range of food products. Food temperatures are reduced to below 0°C to decrease the activity of harmful bacteria. The process can be used to preserve the majority of foods including fruits, vegetables, meat, fish, and ready meals. Peas, Spinach etc.

Pasteurisation
Food is heated and then quickly cooled down to kill microorganisms. For example, raw milk may contain harmful bacteria that cause foodborne illnesses. Boiling it (at home) or pasteurising (on a large scale) is crucial to ensure it is safe to consume.
Apart from dairy products, pasteurisation is widely used in preservation of canned foods, juices and alcoholic beverages.

Canning
The food is heated to a high temperature. This process is called pasteurisation. Then, the food is packaged and stored in an air-tight can. E.g. tomatoes.

Modified atmosphere packaging
In packaging, the air inside a package is substituted by a protective gas mix, often including oxygen, carbon dioxide and nitrogen. They help to extend the shelf life of fresh food products - usually of fruits, vegetables, meat and meat products, and seafood.

Smoking
A process of heat and chemical treatment of food to help preserve it by exposing it to smoke from burning material such as wood. Smoked foods usually include types of meat, sausages, fish or cheese.

Additives
They play an important role in preserving the freshness, safety, taste, appearance and texture of processed foods. Food additives are added for particular purposes, whether to ensure food safety, or to maintain food quality during the shelf-life of a product. For example, antioxidants prevent fats and oils from becoming rancid, while preservatives prevent or reduce the growth of microbes (e.g. mould on bread). Emulsifiers are used for instance in improving the texture or stopping salad dressings from separating into oil and water.

Consequences of Food Processing
Makes food edible
Grain crops, for example wheat and corn, are not edible in their natural state. Processing techniques, such as milling and grinding, turn them into flour, after which they can be made into breads, cereals, pasta and other edible grain-based products. There are different types of flours depending on the processing level, choose wholegrain when possible. Common wheat is used for flour making while durum wheat is used for products like pasta.

Safety, shelf life, and preservation
Processing improves or even ensures food safety by removing harmful microorganisms. The main methods are pasteurisation, air-tight packaging, and the use of preservatives.

Nutritional quality
Food processing can affect the nutritional quality of foods in both ways: it can enhance it, for instance by adding components that were not present, like vitamin D, or by lowering fat, salt or sugar. It can also cause some fibre and vitamins and minerals to be lost, for example through excessive refining, heating or freezing.

Convenience
Processing and packaging technologies provide a range of convenient foods: ready meals, bagged salads, sliced and canned fruits and vegetables that take little time to prepare.

Price
Food processing can decrease the cost of foods. The frozen vegetables have a similar nutritional value as fresh ones, but at a lower price, as they have already been prepared, do not contain inedible parts, can be bought in bulk, and can last longer. The processing increases the shelf life of food, and decreases the amount of waste, reducing thereby the overall costs of food production.

Major Categories of Food Processing in Punjab

1. Grain & Oilseed Processing
   i. Wheat is processed into wheat flour.
   ii. It is used in making of biscuits and bread.
   iii. Maize is used for making corn flakes etc.
   iv. Other grains are also processed and branded for sale.

2. Fruit & Vegetable Processing
   Fruit and vegetable being perishable items require delicate handling. A big quantity of these are sold as fresh in the market but their processing increases their shelf life and profitability. It requires proper procurement, Cold storage facilities and cold chains to preserve their quality.
   Some Fruit/Vegetable based products:
   1. Lime/Lemon Syrup
   2. Mango Squash
   3. Malta/Orange/Kinnow squash
   4. Lime and barley Syrup
   5. Tomato Juice
   6. Lime/Lemon Pickle
   7. Mango Pickle
   8. Amla Pickle
   9. Carrot Pickle
   10. Lime, green chilli and ginger pickle
   11. Tomato Pickle
   12. Amla preserve

Canned vegetable is becoming popular these days.
Sugarcane is used for production of sugar and jaggery.

3. Dairy Products
   Milk is a unique food item for mankind having high nutritive value. It supplies proteins, vitamins and minerals apart from lactose(sugar) and fat. Being easily digestible, it is very important for infants, pregnant mothers, growing children, adults and patients. For vegetarians, its importance as source of proteins and minerals becomes even more vital.

Certain legal standards are supposed to be adhered to for sale of milk, like: Cow milk should have 4% fat and 8.5% SNF(solids not fat)

Buffalo milk should have 6% fat and 9% SNF.

The legal standards for other milk fluids are as under:

Milk Type	Fat(%)	SNF(%)	Colour of Pouch
Toned Milk	3.0	8.5	Blue
Double Toned Milk	1.5	9.0	Yellow
Standardised Milk	4.5	8.5	Green

Different Milk Products: Paneer, Ghee, Butter, Khoya, Ice-cream, Lassi, Dahi (curd), Sweets etc.

4.Packaged Food
i. Procurement of raw material
ii. Processing Bakery & Confectionary Snacks, Namkeen etc Papad

Poultry, Meat & Fish Processing

a. In poultry, mostly the farms deal with broilers and on contract basis the same can be supplied to the big processing industrial houses for further supply to retailers and big restaurant chains. In such cases to ensure the quality, the chicks are supplied by the processing houses along with the medicines so that quality of the broilers is well maintained.

b. Fish Farming is being taken up in Punjab in a big way. The farmers can grow carps and 'pangas' variety of fish which gives good income. Patiala has emerged as the highest producer of fish in the state.

c. Meat processing has yet to pick up in the state. There are no good quality slaughter houses in the state. It holds good scope.

CHAPTER – 8
HARMFUL, FRIENDLY INSECTS & ANIMALS

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.

BENEFICIAL ANIMALS

There are a number of animals that are reared by farmers and are highly beneficial to them economically, like cow, buffalo, etc. The animals are reared for milk (cow, buffalo, goat), for use in transport (bullock horses, mules, camel), egg (poultry) and for their meat as well. Chicken, fish, pig, goat, sheep are the common animals reared by the farmers for meat, which is very big source of protein. The animals like sheep also provide fur and wool. Farming animals is an old and respected business. It feeds people and supplies products needed by the farmers.
Dairy
Transport
Poultry
Fishery
These topics have been dealt with separately under Animal Husbandry.

Earthworms: The earthworm is one of the most important creatures that lives to serve the farmers. The earthworm plays an important role in making the soil fertile by circulating the soil underneath. Also upon death it turns as manure for the plants.
Vermicompost is one of the most beneficial organic material for farmers and earthworms is the basic animal used to convert the organic waste into manure.

Snakes: Snakes eat away the rats and thus help the farmers. Most of the snakes are harmless and non-venomous.

USEFUL BIRDS

Most of the birds are friends of farmers and are useful to agriculture in one way or the other. The home sparrow feeds insects to its young ones. The friendly birds include Drongos, Myna, Lapwing, Blue Jay, Cattle egret, Hoopoe etc. The predatory birds like eagle, owl, kite falcon etc. eat a large number of rats and mice. Vultures are natural cleaners as they eat away the dead animals which could have caused infection and spread of disease. However, birds like parrot cause a great loss to the crop and fruit.

Birds which feed on insects are called insectivorous and which feed on rodents are called rodentivorous. 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.

1. Blue Jay:

Colour: rufous-brown breast and pale blue abdomen and is of Blue Rock Pigeon size.

Food: Insects form its main diet. Nest: in cavities of the trees.

2. Red-wattled Lapwing:
Colour: bronze brown from above and, white from below. The head, breast and neck is black in colour.
Food: mainly of insects and snails.
Nest: on ground.

Cattle Egret:

Colour: white with yellow beak.

Food: It is often found following ploughing tractor and eating insects.

Nest: in the form of colony on the trees.

Spotted Owlet:

Colour: Grayish brown colour with white spots. The colour of its eyes is yellow.

Food: insects, mice and lizards. An owl eats three to four rats every day.

Nest: in the cavities of the trees.

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.

Nest: It makes its nest in the cavities of the trees. Insects form its main food.

Drongo

Colour: It has a black plumage. It has a small white spot at the base of the bill gape (base of the bill), called a rictal spot.
Has a forked tail. The mature bird size is around 28 cms. Also called Kotwal for its boldness and attacks foxes and jackals.
Food: Feeds on insects, termites, bees, butterflies, dragonflies and ants. But explores the possibility of preying small birds, reptiles or even bats.
Nest: Suspended in horizontal fork of trees

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.

HARMFUL ANIMALS

Rodents: Rats
Birds: Parrot
Mammals: Cattle, Neel gai, Swine, Deer, Elephant etc.

Rodents

Rats are the most important harmful animals. Apart from causing loss to crops they spread rodent borne diseases. Both also cause allergies and asthma in humans.

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.

Deer and Neel-gai, cattle, swine, elephants etc. may damage and eat a farmer's crop.

Important species of Rats and Mice:

There are 8 important species of rodents and mice in Punjab.
i. Indian mole rat,
ii. Soft furred field rat,
iii. Indian bush rat,
iv. Indian gerbil,
v. Short-tailed mole rat,
vi. House mouse,
vii. Field mouse,
viii. 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.

Methods of rodent control:

Mechanical control
Killing: During the irrigation of vacant harvested fields rats coming out of flooded burrows should be killed with sticks.
Trapping: By use of traps

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

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.

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.

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.

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.

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.

Harmful Birds

Out of 300 species of birds of Punjab, only a few cause damage to crops, fruits, to grains in godown, 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 godown and shellers, worth crores of rupees.

Management methods:

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. 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:** The birds can be scared by use of automatic bird scarers and by shifting their position periodically. Their noise should be supplemented 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 noise and the smoke caused by the fire crackers at different intervals scares the birds.

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.

INSECT PESTS AND DISEASES OF CROPS

The green revolution has been a boon to the farmers as it not only increased the food production but increased their income as well. But the introduction of new varieties increased brought with it the menace of pests and diseases of crops. The new varieties were found to be more vulnerable to disease and attack by the pests. This necessitates the need for protection of crops from insect pest and diseases to protect the crop yields. Despite a sound crop protection technology, about thirty three percent crop yield is reduced by insect pest and diseases every year. These diseases have created famine like situation arises in the past due to failure of plant protection technology.

The brown spot disease of paddy caused famine in Bengal during 1943 and American bollworm of cotton almost destroyed the crop completely in Punjab during 1996-2002.

INSECT PESTS OF CROPS

Mainly four kinds of insect pests attack our food crops. These insects possess the characteristic of adapting to different kind of food and environment.

Sucking insect pests: These insect pests suck sap from leaves and result in loss of chlorophyll and other vital nutrients from plants. Consequently the plants become pale, stunted and photosynthesis process is affected. The common examples of sucking pests are aphids, jassids whitefly and mealy bug.

Table: Sucking insect pests of major crops:

Sr. No.	Insects	Crops	Image
1	Jassids	Cotton, Okra, Maize, Rice, Mango etc.	
2	Aphids	Wheat, oilseeds, peach and Cole crops	
3	White fly	Cotton, pulses, tomato, papaya etc.	
4	Mealy bug	Cotton, mango, papaya and citrus crops	

2. Fruit and shoot borers: These insect-pests enter and feed within different plant parts. The detailed information of these insects is as under:

Shoot borers:

Part Affected: Make holes in shoot/stem of plant and make dead hearts.

Symptoms: Plant dries up and dies.

Crops Affected: Rice and sugarcane stem borers, pink stem borer and maize shoot fly etc.

Fruit borers:

Part Affected: Destroy maturing fruits, vegetables and bolls of plants by feeding inside them .

Symptoms: Symptoms of damage can be identified from the excreta of plants.

Crops Affected: Cotton bollworms, Brinjal fruit and shoot borer etc.

3. Leaf feeders: These insect reduce the photosynthesis process of plant by feeding on leaves. Generally they feed on the leaves in following two ways:

a. Leaf cutting insect: These insects start feeding from the margins of leaves and moves towards the midrib of leaves e. g. Armyworm, Grey weevil, Red pumpkin beetle etc. Leaf cutting grey weevil

b. Leaf mining insect: These insects feed on the green matter between the upper and lower epidermis of the leaf. e.g. Hadda beetle, Cabbage butterfly etc.

4. Root feeding insect pests: These insects feed on the underground plant parts such as roots, lower portion of stem and kill them. e.g. termites, white grub etc. They feed on a number of crops.

INSECTS CAUSING DAMAGE TO STORED GRAIN

Grain Moths: Angoumois grain moth lays eggs on ear-head of the crop in the field. Its population increases after threshing and storage of grains.

The larvae grow out of the eggs it lays on the surface of the stored grains and feed on its internal parts making them hollow from inside.

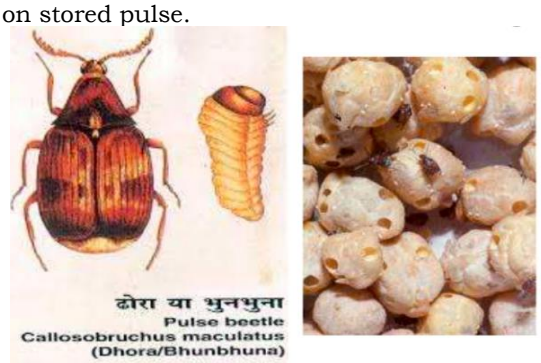
Grain Weevils: Among weevils, rice weevil is most important. It lays eggs within the grains.

The larvae emerging from these eggs feed inside the grains and then converts into pupa within the grain and emerge as adult.

Beetles:(Khapra) It is one of the most destructive pest of stored grains. These have yellow hairy growth on the body.

Normally it is found in crevices of the walls and destroys the grains by its excreta. Khapra beetle feeds on stored grain while Rust Red beetle feeds on broken grain.

Pulse Beetle: (Dhora) It feeds on stored pulse and lays eggs on stored pulse.



Moong and chicken pea-*dhora* are most damaging.

CROP DISEASES

The crops suffer from various kinds of fungal, bacterial and viral diseases at different stage of crop growth. The diseases of crop spread from one place to other by seed, soil, air and heavy rains.

Fungal diseases of crops: Generally, you must have seen cottony fungal growth on stale bread at your home. The fungus produces different kinds of poison and enzymes within the plant by entering through different plant parts. Fungus is of different kinds and these effects the plants in different ways. Various kinds of fungal diseases are as under given in the Table:

Fungal diseases of different crops

S.No.	Disease	Symptoms of Disease	Crop
1.	Blight	Water soaked spots are seen on leaves and stem. White fungus can be seen on under surface of leaves	Rice, Potatoes, moong and cruciferous crops
2.	Seed Rot	The seed rots within the soil	Maize, Rice and different vegetables
3.	Smut	The seeds get turned into black powder	Wheat, Rice etc.
4.	White Rust	White powder like growth appears on different plant parts	Ber, Peas etc

Seed Rot Disease

Bacterial diseases of crops: Like human bacterial disease viz. Tuberculosis, typhoid, Plants also suffer from different bacterial diseases. The bacteria damage the plants by entering through natural openings or cut plant parts. The main bacterial diseases are as under:

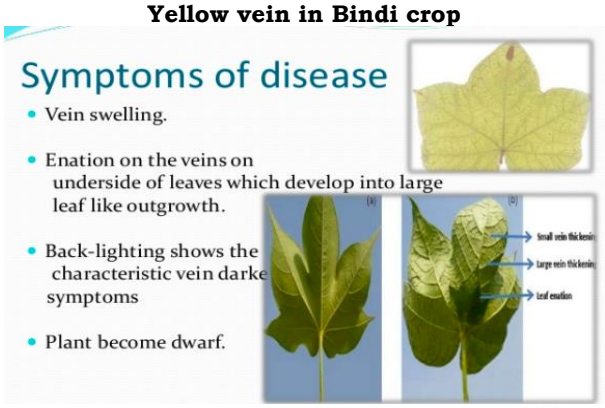
a. **Blight:** The disease occurs on rice, the major *Kharif* crop of Punjab . Yellow green stripes appear on the margins of leaves in this disease.
b. **Stem rot and leaf spot diseases:** The water soaked spots appears on plant parts in this disease.

Viral diseases of crops: In human being, viruses cause dangerous diseases like AIDS. Insect pest spread different viral diseases of plants e.g. white fly spread leaf curl disease. These diseases are more dangerous than other diseases due to difficulty in their management. Symptoms of these diseases are given below in the table and figures.

Table: Viral diseases of plants and their symptoms.

S. No.	Disease	Symptoms	Crop
1.	Leaf curl disease	The leaves bend inwards from corners of leaves .	Cotton, Papaya, Chili and Tomatoes etc.
2.	Mosaic disease	Irregular yellow and green bands appear on the leaves.	Moong, Okra, Papaya and Potato etc.

Yellow vein in Bindi crop



Leaf Curl in Cotton

Integrated management of insect-pests and diseases:

The major plant protection practices includes use of chemical insecticides, resistant varieties, natural enemies, cultural control such as changes in time of sowing and irrigation and mechanical control. The environment friendly, pesticide free, socially and economically beneficial production of food requires integrated use these techniques. Integrated pest management can be divided into two parts.

Preventative measure:

- Selection of crop variety resistant to attack of insect-pests and diseases.
- Seed treatment with insecticides and fungicides.
- Judicious and need based use of fertilizer, insecticides
- By exposing the fields to sunlight
- By removing weeds from fields, bunds and nearby areas

Curative measures:

- Correct identification of insect pest and disease to identify the pest management techniques accordingly.
- By uprooting and destroying the infected plant in initial stages
- Use the recommended dose of insecticides/ fungicides.
- Select insecticide according to nature of insect, symptoms and cause of disease.
- Timely and judicious application of insecticides/pesticides
- Natural enemies and other micro-organism can also be used for control of insect pest

Transgenic are the most recent method of pest management. Bt cotton is a transgenic crop and has played an important role in the management of insect pests of cotton. In this method, the required genes are transferred from different organism to crops for insect pest management.

USEFUL ANIMALS (ANIMAL HUSBANDRY)

ROLE OF ANIMAL HUSBANDRY

Though agriculture is the most conspicuous occupation of Indians, animal husbandry is an important source of income for a majority as it is the most suitable for the ecosystem, their life style as well as it provides additional source of income for the family.

CATTLE REARING

Livestock are valuable assets for the rural poor and are critical in supporting their livelihoods, particularly during unfavourable times. High quality semen and other facilities provided by the new technology have helped the farmers to start cattle-rearing in a scientific way. Cattle are reared not only for milk but also for providing meat for the consumers which is a very good source of protein.

DAIRY FARMING

India ranks first globally in milk production, which went up from 17 million tons in 1950- to 163.7 million tonnes in 2016-17.

As per NDDB, Punjab is one of the leading producer of milk in the country, with availability of 1181 gm of milk per day per person as compared to 394 per day per person for India as of 2018-19. The lowest availability of milk is in Diu and Daman with per capita availability at 11 grams per day only. Daily milk requirement of milk per person is 250 gram.

Late Dr. Kurien Verghese is credited with the success of Operation Flood associated with the increase in milk production. He is also known as White Revolution.

Dairy Research Centre (of ICAR), Karnal

The Research centre is responsible for artificial insemination, pregnancy diagnosis, reproductive health and maintaining reproductive efficiency of the NDRI herd consisting of Cattle and buffalo. It supplies frozen semen (0.25ml French Mini Straws) for sale from the list of bulls. The frozen semen is supplied on first come first serve basis.

WHAT IS A BREED

It is a group of one species of animals, which have the same descent, characteristics and similar body shape, size and structure.

Major Milk Yielding Breeds in India :

Cow : Hariana, Sahiwal, , Tharparkar, Kankrej, Mewati, , Gir, Kangayam,

Buffalo : Murrah and Nill Ravi .

Goat : Sirohi, Marwari, Beetal,

Sheep : Mecheri, Chennai red, Neelgiri

COWS

Indian Breeds : Gir, Sahiwal, Red Sindhi, Tharparkar, Kankrej are some of the high milk yielding varieties of Indian cattle.

Imported Breeds : Holstein, Friesian, Jersey, Swiss breeds have been imported from abroad and are now widely reared in India.

Advantages of cattle rearing

- It is the source of milk
- Provides fuel for cooking
- Used for farming
- Used for transportation
- Provides meat

Lactation Period : It is the period of milk production between the birth of a young one and the next pregnancy. Usually it lasts for around 260 to 300 days for murrah buffalo.

Dry Period : The period when the animal stops giving milk. It lasts upto the delivery or calving i.e. giving birth to calf**.** In case of buffalo it may last from 60 to 100 days.

Heat Cycle : When the animal is ready to be pregnant again is called heat cycle. In case of a buffalo, it lasts for about 12 to 24 hours during which it has either to be mated or artificially inseminated.

Breed Improvement of Buffaloes and Cows

For economical dairy farming the animals must have the following qualities:

Quality parameter	Buffalo	Cow
305 days lactation milk yield (kg)	2500	4000
Peak yield (kg)	12-13	19-20
Age at first calving (months)	36	30
Service period (months)	2-4	2-4
Dry off period before calving (months)	2	2

Selection of Bull: The result of cross breeding is visible after 5-7 years when the next generation starts giving milk after calving. Care should be taken to avoid breeding by keeping the name or number of bull and their genetic potential.

Selection of bull is very important for quality of animal.

Plains: In plains, crossbreeding is advocated with Holsteinv-Friesian. It gives more milk yield.

Sub-Mountainous Areas: Jersey is used as it is short statured and there is shortage of fodder in that area. It has more fat percentage in milk.

Selection of Dairy Animals

The animals should be purchased after ensuring milking it at least three times. The animals should have the following characteristics:

Skin: Thin

Shape: triangular when seen from top, front and hind side.

Udder: Should not have nay lump. These should shrink after milking.

Animals should be purchased in second or third lactation and it is better if it has female calf.

Improved breeds : Some breeds have been developed by cross mating the two desired breeds. The cross between Sahiwal and Freisian is named as Friewal.

Indigenous Breeds of Cows:

i. Hariana

a. Origin: Rohtak, Hisar, Gurgaon and Karnal districts.
b. Colour: White to light grey
c. Size: Medium, Long length and long legs
d. Body: Compact with tight skin
e. Utility: Both male and female are useful. Female give more milk and male are strong bullocks
f. Average Lactation Milk Yield: 1000 kilogram with 4% fat.

ii. Sahiwal

a. Origin: Native of Montgomery now in Pakistan. Also foundin Ferozepur,Fazilka, Amritsar and Tarntaran districts.
b. Colour: Light red to red colour
c. Size: Medium to large
d. Body: Loose skin, short legs and voluminous dewlap. Short hor and large udders
e. Utility: best mulch breed. Male are slow for work and lethargic.
f. Yield: Average lactation milk yield is 1800 kilogram with 5% fat.

iii. Red Sindhi

a. Origin: Sindh Pakistan
b. Colour: Dark red
c. Size: medium size and are docile in nature.
d. Body: Compact body, loose skin and short legs
e. Utility: have good yield of milk
f. Average Lactation Milk Yield: Around 1800 kilogram

iv. Tharparkar

a. Origin: Sindh Pakistan, Kutch Gujarat, Jodhpur, Jaipur (Rajasthan)
b. Colour: White or greyish colour
c. Size: Compact body, broad forehead,
d. Body: Short legs and large udder
e. Utility: Dual purpose, both for milk and use as bullock
f. Average Lactation Milk Yield: 1400 kilogram

Exotic Breeds of Cows:

i. Holstein-Friesian

a. Origin: Native of Holland, but now dominant in almost all the countries.
b. Colour: Dark and white, but red and white also available
c. Size: Long Body with large udder.
d. Body: Heavy and highest milk yield.
e. Utility: Good milk yield
f. Average Lactation Milk Yield: 5500-6000 kilograms with 3.5-4% fat

ii. Jersey

a. Origin: Breed of Jersey Island of England, Second most popular breed in the world
b. Colour: Brown to brownish red colour (fawn)
c. Size: Short statured
d. Body: carry long, straight top lines,
e. Utility: Milk yielding variety, protein and calcium rich, creamy milk
f. Average Lactation Milk Yield: 3000-5000 kilogram with 5% fat

New Breeds developed by NDRI

(National Dairy Research Institute, Karnal)

By crossing, high yielding milch breeds of cattle i.e., Holstein-Friesian and Brown Swiss with indigenous breeds i.e., Tharparker and Sahiwal, NDRI has developed two starins of crossbred cattle named as Karan-Fries and Karan Swiss. These cross bred animals are high milk producers and well adapted to our climatic conditions.

BUFFALOES

Indian buffalo is the best in the world. There are around fifteen breeds of buffaloes in India.
Important breeds are :

i. Murrah

a. Origin: Rohtak
b. Colour: Jet black but the switch of the tail may be white.
c. Body: Horn are tightly curled. Neck and head are slim. Udder large and long teats.
d. Average Lactation Milk Yield: 1700-1800 kilogram with 7% fat

ii. Nilli Ravi

a. Origin: Montgomery in Pakistan, also known as 'panj-kaliani'.
b. Colour: Black with white forehead, white legs below knees and white tail.
c. Body: Horn are short, curled. Eyes are blue and stature is medium.
d. Average Lactation Milk Yield: 1600-1800 kilogram.

Other breeds are Pandharpuri, Jaffrabadi, Mehsana, Surti, Banni apart from Gir, Toda. Godavari is a cross of local breed found in Godavari delta belt with Murrah.

iii. Pandharpuri

a. Origin: Kolhapur, Solapur districts in south Maharashtra.
b. Colour: varies from light black to deep black.
c. Body: Medium sized animal having long narrow face, very prominent and straight nasal bone, comparatively narrow frontal bone and long compact body. Typical characteristic of this breed is its horns which are very long, curved backward, upward and usually twisted outwards.

iv. **Jaffarabadi**

a. Origin: Massive animals found in their pure form in Gir forests. The breeding tract of this breed is Kutch, and Jamnagar districts of Gujarat.
b. Colour: Is usually black
c. Body: Head and neck are massive. The forehead is very prominent, wide with a slight depression in the middle. The horns are heavy, inclined to droop at each side of the neck and then turning up at point, but less tightly curved than in Murrah (drooping horns).

Milk Yield: The average milk yield is 1000 to 1200 kg. These animals are mostly maintined by traditional breeders called Maldharis, who are nomads. The bullocks are heavy and used for ploughing and carting.

v. **Surti**

a. Origin: Kaira and Baroda district of Gujarat.
b. Colour: Varies from rusty brown to silver-grey. Skin is black or brown. It has two white collars, one round the jaw and the other at the brisket.

c. Body: Well shaped and medium sized; the barrel is wedge shaped. The head is long with prominent eyes. The horns are sickle shaped, moderately long and flat.
d. Milk Yield: 900 to 1300 kg. Fat percentage 8-12%

vi. **Mehsana**
a. Origin: Mehsana town in Gujarat and adjoining Maharastra state. Evolved out of crossbreeding of Surti and Murrah
b. Colour: Mostly black; a few animals are black-brown in colour.
c. Body: Longer than Murrah. Head is longer and heavier. The horns usually are less curved at the end compared to Murrah breed but are longer and could be of irregular shape.
d. Milk Yield: 1200-1500 kg.

vii. **Godavari**
a. Origin: Result of crossing of native buffaloes with Murrah bulls. The home tract is Godavari and Krishna delta area.
b. Colour: The colour is predominantly black with a sparse coat of coarse brown hair.
c. Body: Medium stature with compact body.
d. Milk Yield: Reputed for high fat with daily average milk yield of 5-8 litres and lactation yield of 1200-1500 litres.

viii. **Bhadawari**
a. Origin: Agra and Etawah district of Uttar Pradesh and Gwalior district of Madhya Pradesh.
b. Colour: Light or copper coloured is a peculiarity of this breed. Eye lids are generally copper or light brown colour.
c. Body: Medium size and wedge shaped. The head is comparatively small, the legs are short and stout, and the hooves are black. The hind quarters are uniform and higher than the forequarter. Horns are black, curling slightly outward,
d. Milk Yield: 800 to 100 kg. Fat content is 6 to 12.5 per cent.

ix. **Nagpuri (Or) Ellichpuri**
a. Origin: Nagpur, Akola and Amrawati districts of Maharashtra. This is also called as Elitchpuri or Barari.
b. Colour: Black coloured animal with white patches on face, legs and tail.
c. Body: The face is long and thin. The neck is somewhat long. The horns are long, flat and curved, bending backward on each side of the back almost to shoulder.
d. Milk Yield: 700-1200 kg per lactation.

x. Toda
a. Origin: Toda of Nilgiris of south India.
b. Colour: Generally fawn at birth. In adult the predominate coat colours are fawn and ash-grey.
c. Body: have long body, deep and broad chest, and short and strong legs. The head is heavy with horns set well apart, curving inward outward and forward. Thick hair coat all over the body.

Feeding of Cows and Buffaloes:
Feed components of animals : Energy, protein, minerals and vitamins They meet their energy requirement from carbohydrates, protein and fats. Plant cellulose and starch, which is supplied through fodder and concentrated feed are the main source of carbohydrates. An average cow or buffalo with 400 kg weight require 35 kilogram of green fodder (berseem, lucerne, maize, bajra, sorghum) for their daily requirement. Two to three kilogram of 'hay' should be added to in lush green berseem. Good quality green fodder and balanced ration is required to be given to the animal of milk production.


Mehsana


POULTRY

The poultry sector covers a range of farming systems from highly industrialized and export-oriented at one end to backyard, small and marginal models, addressing livelihood issues at the other end. The per capita availability was around 53 eggs per year in the year 2010-11.

The exports of poultry products were valued at Rs. 372 crore in 2009- 10 as per the Agricultural and Processed Food Products Export Development Authority (APEDA).

Poultry includes all type of birds e.g. chicken, turkey, ducks, geese, Japanese quails, emu, etc. In Punjab, mostly hens are reared for commercial purpose.

Breeds of hen

i. **Sutlej Layer:** Punjab Layer-1 and Punjab Layer 2 are two types of this breed. Sutlej Layer gives about 255-265 eggs annually. Average egg weight is 55 gm. Hen starts laying eggs at the age of 160 days. It is the number one breed in egg laying.
ii. **IBL-80 Broiler:** This breed is reared for meat purpose. It attains a body weight of 1350-1450 gm at the age of 6 weeks.
iii. **White Leghorn:** It is an exotic breed of layer. Its colour is white and gives white eggs. It gives 220-250 eggs annually. Due to small size, its feed consumption is also less.
iv. **Rhode Island Red:** It is also an exotic breed of layer. Its colour is red. It gives about 180 eggs annually. Egg colour is brown. It consumes more feed than White Leghorn as it is heavier in weight. It is dual purpose breed and can be used for meat purpose also.
v. **White Plymouth Rock:** It is an exotic breed used for meat purpose. Its colour is white. It consumes more feed and gives about 140 eggs annually. Its chicks attain a body weight of 1 kg at the age of two months.

PIG, SHEEP, GOAT AND RABBIT REARING

Pig, sheep, goat and rabbit rearing is undertaken by farmers to augment their farm income.

Piggery

Pigs reproduce at a very rapid pace and their marketing is relatively easy. Pig produces more meat by eating less and cheap feed. Hence, piggery can be adopted with small investment to earn more profit.

Breeds of pig

Local indigenous breeds have poor growth rate and produce less number of piglets while exotic breeds grow at much faster rate and produce more number of piglets. There are mainly two exotic breeds.

White Yorkshire: Main characters of this breed are medium in size, white colour, long body and erected ears. Animals of this breed can easily be reared in Punjab. This breed is very popular in North India.

Landrace: Animals are of white colour and have long body and drooping ears. It is native of Denmark. Its meat has less fat and is known as lean meat.

When man started rearing animals for milk and meat for his requirement, then these included sheep and goat also. These animals can meet their nutritional requirement from green fodder and thus require less concentrate feed. Concentrate feed is required only in case of shortage of fodder. Every family member can play an important role for successful sheep and goat rearing. Goat is known as poor man's cow. Goat milk is very valuable for patients and old persons.

BREEDS OF GOAT

Indigenous breeds:

Beetal: Animals of this breed are found in Gurdaspur, Amritsar, Tarntaran and Ferozepur districts of Punjab. Its colour is black- brownish with white spots. It has convex forehead and long, drooping and twisted ears. Its udder is large. Its first kidding occurs at the age of 1 ½ years.

Jamnapari: Animals of this breed of goat are very beautiful and are found in Western Uttar Pradesh. Its colour is white and light brown. It has light brown spots on face and head, has long, flat and drooping ears and convex nose. It has long body and long legs.

Exotic breeds

Saanen, Alpine and Boer are the exotic breeds of goat which produce more milk than local breeds. Saanen goat is also known as milk queen. It is the largest breed of goat in the world.

BREEDS OF SHEEP

Merino and Corridale are the exotic breeds of sheep. These breeds produce more quantity of good quality wool than local breeds. Exotic breeds are used for improvement of local breeds.

Ram: Male Sheep **Buck Goat:** Male

RABBIT REARING

Rabbits are reared for wool and meat production. These animals require less space for rearing. They use feed very efficiently. Female can become pregnant at the age of 5-9 months for the first time. Rabbit can produce kitten for 6-7 times in a year and every time, produces 5-7 young ones (kids). Average age of rabbit is 5 years. Rabbit farming can be started with few animals and expanded.

Breeds of rabbit
Wool type: Russian Angora, British Angora, German Angora.

Meat type: Soviet Chinchilla, Grey Giant, Newzealand White, White Giant.

All these breeds are exotic. At 3 months of age, body weight of rabbit is 1-1.5 kg. Its meat is a lean meat having less fat.

FISHERIES

Fishing, aquaculture and other allied activities are a source of livelihood for over 14.5 crore people and a major foreign exchange earner. India ranks second in aquaculture and third in fisheries production.

Fisheries contributes to 1.07% of the Total GDP of India.
About 8,118 km of coastline gives the geographical basis for the development of marine fisheries in India.
Commercial fisheries include wild fisheries and fish farms, both in fresh water and the oceans

Fishery is an important agriculture related subsidiary occupation and is more profitable than agriculture. Fish can be reared in low lying and water logged areas by using crop residues and waste of farm animals, pigs and poultry.

Breeds of fish for farming:
Indian : Katla, Rohu and Mrigal
Exotic: Common carp, Silver carp and Grass carp

Selection of site for pond:
Select clayey land for making fish pond as it results in less seepage of pond water. In case of light soils, puddling may be done. Pond should be near to the water source so that water can easily be filled in the pond as and when required. If canal water is to be used, then wire mesh should be put at the mouth of inlet to prevent entry of carnivorous fish (which eat fish) in the fish pond.

CHAPTER – 9
CONTRIBUTION OF AGRICULTURE TO ECONOMIC DEVELOPMENT

Indian economy at the time of independence was an agriculture economy constituting around fifty percent of GDP of the country. More than eighty percent of its population was dependent on it. With the growth of industry and services, the share of agriculture in the GDP of the country has come down to around 17%. However, the share of population dependent on agriculture is still around fifty percent which is not a good sign for economy. Still around sixty five percent of Indian population lives in villages and is in one way or the other still dependent or attached to agriculture. The dependence on agriculture leads to seasonal unemployment and disguised unemployment.

Though the share of agriculture in the economy has reduced considerably but it fulfils the basic need of society in providing food to the mankind.

Sectoral Growth Rate, Share & Employment in Punjab GSVA

	Share in GSVA	Growth Rate	Share in Employment
	2019-20	2019-20	2017-18
Agr. & Allied	28.1	2.3	26.0
Industry	25.2	4.0	33.1
Services	46.7	7.0	40.9

Developments since 1947
Role and Usage of Agriculture
Industries Associated with Agriculture
Allied agricultural Activities and their role in economy

Developments since 1947

The British were hardly concerned with the development of the nation. The population of the country was increasing but there was no substantial increase in the agricultural production. By the year 1965, India was faced with serious food shortage and was being tagged as a 'begging bowl'. The food was imported from US under PL-480 programme which was laced with many conditions.

Dr. C. Subramaniam, the then Union Minister of Agriculture (1964-66) laid the foundation of Green Revolution in India with the active support of Dr. M.S. Swaminathan, the legendary agriculture scientist. (Dr. C. Subramaniam was honoured with Bhart-Ratna and M. S. Swaminathan (former Director General of ICAR) with Padma Vibhushan for their contribution in bringing in green revolution in India.)

With the help of. Dr. Norman Borlaug (known as Father of Green Revolution in the world and awarded Nobel Prize for Peace in 1970), they imported high variety hybrid wheat seeds. They provided hybrid variety of wheat seed to farmers where Punjab was able to take the lead. This led to increase in yield and total overall produce of cereal in the country and is aptly called 'green revolution'. Within a few years, the country became self-sufficient in meeting food requirement of the nation. Later, dwarf varieties of paddy developed by International Rice Research Institute, Manila (Philippines) were also introduced. It proved to be miracle rice and their production increased manifold in a few years.

Who coined the term Green Revolution?
William S. Gaud, the administrator of USAID (US Agency for International Development)
Father of Green Revolution:
Dr. Normaun Borlaugh

India's agricultural production which was only around 51 million tonnes in 1951, increased to around 200 million tonnes in the year 2000. In 2019-20, total agricultural production in India was around 295.67 million tonnes.

Production of Food-grains (India)

Year	Food-grains	Rice	Wheat
1950-1951	50.82	20.58	6.46
1960-1961	82.02	34.58	11.00
2000-2001	196.81	84.98	69.68
2010-2011	244.49	95.98	86.87
2019-2020	295.67	117.94	107.18
(million tonnes)			

The wheat production of Punjab in 1960-61 which was 1742 thousand metric tonnes has gone up to 18262 thousand tonnes in 2018-19.

Agricultural Production -Punjab

(in thousand metric tonnes)		
Crop	**2017- 18 (R)**	**2018- 19 (P)**
Rice	13377	12822
Wheat	17830	18262
Maize / Barley	427 / 30	396 / 27
Total Cereals	**31666**	**31507**
Oilseed	60	59.6
Sugar-cane	8078	7774
Cotton*	1284	1223
1000 Bales, R-Revised, P-Provisional* *(Source: Economic Survey of Punjab, 2019-20)***		

Negative Side of Green Revolution

Most of the states having adopted the usage of hybrid seeds, fertilisers and pesticides have on one side increased the production, but have brought with it the negative face of Green Revolution in the form of degradation of soil, over-usage of water, fertilisers and insecticides/pesticides.

Contribution to GSDP & Employment in Economy of Punjab

Agriculture contributes around 28.1% of the total GSDP of the state and around 26% of the workforce is engaged agriculture. The ratio of GSDP to workforce engaged in agriculture is at quite variance with that of all India figure, where the agriculture GDP of agriculture is only 17% but workforce engaged is 44%. This is explained by the adoption of high mechanisation in Punjab. It should also be noted that rank of farmers of Punjab state is at the top in among all farmers in the country.

Contribution to the Central Pool: Punjab has been a major contributor of food-grains to the central pool. In 2018-19, it contributed 25% of rice and 35% of wheat of the total procurement made by the government agencies.

Other Usage of 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.

Sub-Sectors of Agriculture:

In 2019-20, agriculture and allied sectors contributed 28.1% of Punjab's GSVA. In 2018-19, the sector grew at rate of 2.3% and the trend is likely to repeat for 2019-20.

Crop Husbandry (Crop Farming): Crop husbandry contributes around 15% of state GSVA and over half of agriculture GSVA. This is expected to shrink in future. Also, the scope for growth is negligible now as state has almost used the whole of available land. Of late, this sector is on the wane and the sectors like live stock are making major contribution to this sector.

According to another study by PAU, recently published in The Hindu, Punjab is going through 'de-peasantisation', as more and more peasants are moving away from agriculture. This study shows that in 1987 of the hundred families in village, 88 percent were completely dependent on agriculture, while 12 percent were mixed households with at least one member engaged in non-farm activity. However, the proportion of solely 'agriculture labour households' has declined from 88% to just 7% in 2018-10 while for mixed households, this increased from 12% in 1987-88 to 37% in 2018-19.

a. Contribution to GSDP & Employment: As compared to the rest of country, where the contribution of agriculture in GDP is around 16% but the persons employed are 44.14%, the data for Punjab is more even. Here agriculture contributes around 28 percent to GSDP and provides employment to 26% of workers aged 15 and above.

This can be explained by high level mechanisation. Punjab has a tractor for every 8.71 hectare of cultivable land in comparison to national average of one tractor per 62 hectare.

Cropping Intensity: With multiple sowing on same land, the cropping intensity has already reached its peak at 190 percent. *(the number of times the land is used for cultivation is called cropping intensity)*

Land Use pattern: More than 83 percent of land is used for cultivation with hardly any scope for any further addition.

Cropping Pattern: Most of the cultivated area is used for food-grain cultivation, especially rice and wheat. In 2018-19, approximately 93% of the total cultivated land was used for cultivation of food grains which include cereals and pulses. Cotton was cultivated on 5.1% of the total cultivated land and sugarcane and fruits were each grown on approximately 1% of the total cultivated area, respectively.

Due to the assured income from the production of wheat and rice, their share in the total cropped area has increased over the years. Area under paddy in 1960 was only 4.8% which has now increased to 39.6%, while for wheat the area has increased from 27.3% to 44.9%. But this pattern of wheat and paddy cycle is becoming unviable because of depleting groundwater table and increase in cost of cultivation due to higher price of pesticides and fertilisers.

Animal Husbandry (Livestock)

As per Livestock census 2019, Punjab has 1.3% of the total livestock of the country. 57.4% of these are buffaloes, while the ratio of crossbred cattle is around 29.3%. Punjab accounts for 2.1% of total poultry in the country.

In Punjab, livestock is a promising sector of Agriculture and Allied activities. More than 90% of income from animal husbandry is contributed by milk production.

Other subsectors include poultry, fisheries, shrimp and goat rearing. However, due to scarcity of land, scope for these sectors is very limited in Punjab.

Contribution to GSDP & Employment: The sector is the second largest contributor to agricultural GSVA. According to Economic Survey of Punjab 2019, the expected share livestock rearing is going to be over 36.93% in 2019-20.

Milk Production: Milk is a primary product of animal husbandry and is also a major food supplement. Though India has the largest number of cattle in the world, the per capita availability of milk is as low as 394 gm. per person per day. However, in Punjab, it is 1181 gms per person(2019). It implies that increase in milk production has a huge potential for growth and becoming a source of additional income for farmers, especially small and marginal farmers.

Apart from milk, poultry, its by-product eggs, meat, piggery, goat rearing for milk and meat etc. have a very good potential to add to the income of farmers.

Horticulture

Area under horticulture has increased over the years and the agro-climatic zones are favourable for growth of Kinnow, Guava, Pear, Litchi, Mango, and Peach.

The production of horticulture in India has surpassed that of food grains as it reached 320.5 million tonnes in 2019-2020, making India the second largest producer of fruit and vegetable in the world, after China.

a. Estates- Citrus, Grape, Litchi (not added here)

- Five Citrus estates have been established at Bhunga (Hoshiarpur), Abohar, Tahlian walan Jattan (Fazilka),. Badal (Muktsar Sahib) and Ferozepur.

b. State government initiatives

The state is taking initiative to promote horticulture as there is need to diversify the cropping pattern in agriculture away from the current cereal-centric focus to high value and commercial horticultural crops. Also the income derived from horticulture per hectare of land is generally higher than in cereals and pulses.

- College of Horticulture at Gurdaspur is being set up to promote it.
- Post Graduate Horticulture Institute for Research at Attari is to be set up on 100 acre land. It will be set up by Indian Council of Agricultural research in collaboration with Punjab government.

Recent Developments

Agriculture at Crossroads: Though agriculture is still the main pillar of the economy of the state but of late it is becoming unsustainable because of over exploitation of the resources.

Apart from this, country's dependency for food grains on Punjab is on the decline. The states like Madhya Pradesh and U.P. are chasing Punjab at its heels and are making large contribution to Central Pool for Public Distribution System under National Food Security Act. In 2020, Punjab for the first time has been surpassed by Madhya Pradesh in contribution of wheat to the central pool.

What needs to be done:

i. Crop diversification

This is needed in the backdrop of over-dependence on rice and wheat and the seemingly flattening yield of these crops, even though Punjab still records the highest yields in the country. Additionally, paddy cultivation is water intensive. Combined with the availability of free power, it has caused over-exploitation of Punjab's ground water resources.

Horticulture, as well as pulses and oilseeds can act as alternative avenues for diversification.

ii. Move to 'allied sectors'

The livestock sector has been a source of promise, largely on the back of robust growth in recent years. This sector is also less vulnerable to the vagaries of climate. The potential of poultry, beekeeping, floriculture, pisciculture needs to be explored.

Marketing

a. Mandi System: Punjab State Agricultural Marketing Board is a corporate body established in 1961, under the Punjab Agricultural Produce Markets Act, 1961 with an objective to control and supervise the marketing network of sale, purchase, storage and processing of agricultural produce. This is being handled by Punjab Mandi Board.

Punjab Mandi Board: Established as a autonomous board by Punjab government. It is responsible for Mandis and Market Committees are established at different places with the primary object to establish modern markets for efficient marketing of agricultural produce by providing modern facilities in the mandis to farmers.

Largest Grain Market: Khanna, in Ludhiana district is the largest grain market in Asia. Other important Centres are Jagraon, and Mandi Ahmedgarh, Sangrur. *(Sangrur is the largest foodgrain producing district in the state).*

e-NAM: The government of India launched a new programme called e-NAM in 2016 to digitally link all existing mandis on a common online market platform, with the aim of providing facility to farmers as well traders, to sell their agriculture produce across the country. The idea was to have 'one nation- one market' for agriculture commodities.

It involves the registration of the produce on the portal by the seller/ farmer which calls forth a price quote from the buyer interested to purchase it. Once the trade match takes place, and the produce is quality checked, an online payment is made to the seller, and the produce delivered to the buyer. The market also provides access to a larger national market for commission agents to make secondary trades.

19 mandis in Punjab have been linked to the portal. Punjab has permitted sale of seven commodities on the platform. These include basmati rice, maize, potato, kinnow, cotton, peas (green) and moong dal

CHAPTER – 10
INSTITUTES RELATED TO AGRICULTURE DEVELOPMENT

IMPORTANT AGRICULTURE INSTITUTES IN INDIA

Indian Agricultural Research Institute (IARI):

commonly known as the **Pusa Institute** is India's national Institute for agricultural research, education.

1. The name Pusa Institute is derived from the fact that the institute was originally located in Pusa Bihar as the **Imperial Institute of Agricultural Research** in 1911. It was then renamed as the **Imperial Agricultural Research Institute** in 1919. it was relocated to Delhi in 1936, The current institute in Delhi is financed and administered by the ICAR.

2. Lala Lajpat Rai University of Veterinary and Animal Sciences

Lala Lajpat Rai University of Veterinary & Animal Sciences (**LUVAS**) is a university located in Hisar, Haryana. It is named after the freedom fighter Lala Lajpat Rai.

3. The Punjab Agricultural University (PAU)

Situated in Ludhiana, it is the largest agriculture university in Asia.

It was established in 1962 and is the nation's third-oldest agricultural university, after Govind Ballabh Pant University of Agriculture & Technology, Pantnagar and Orissa University of Agriculture and Technology, Bhubaneshwar

It was formally inaugurated by the then Prime Minister of India, Pandit Jawaharlal Nehru, on July 8, 1963. PAU pioneered the Green Revolution in India in the 1960s. It was bifurcated in 2005 with the formation of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU).

4. Indian Council of Agricultural Research

The **Indian Council of Agricultural Research** (**ICAR**) is an autonomous body responsible for co-ordinating agricultural education and research in India. It reports to the Department of Agricultural Research and Education, Ministry of Agriculture.[2] The Union Minister of Agriculture serves as its president.[3][4] It is the largest network of agricultural research and education institutes in the world

5. G. B. Pant University of Agriculture and Technology

G. B. Pant University of Agriculture and Technology, also known as **Pantnagar University**, is the first agricultural university of India. It was inaugurated by Jawahar Lal Nehru on 17 November 1960 as the "Uttar Pradesh Agricultural University" (UPAU). Later the name was changed to "Govind Ballabh Pant University of Agriculture and Technology" in 1972.

6. Guru Angad Dev Veterinary and Animal Sciences University

Guru Angad Dev Veterinary and Animal Sciences University is a veterinary university in Ludhiana Punjab. It was a part of Punjab Agricultural University and was established on 9 August 2005 to serve the society by promoting the livestock production, health and prevention of diseases through integrated teaching and extension programs.

Dr. Yashwant Singh Parmar University of Horticulture and Forestry

Dr. Yashwant Singh Parmar University of Horticulture and Forestry (**YSP UHF**), known by the abbreviation **Dr. Y. S. Parmar University of Horticulture and Forestry**, is a state university located in district Solan, Himachal Pradesh, India. It has exclusive mandate of education, research and extension in horticulture and forestry.

7. Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya

Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, also known as **CSK Himachal Pradesh Agricultural University** (**CSK HPKV**), formerly **Himachal Pradesh Krishi Vishvavidyalaya**, is an agricultural university at Palampur in the Indian state of Himachal Pradesh. It was established on 1 November 1978 as an expansion of the existing College of Agriculture established in May 1966. Hill agriculture is the focus of this university. The university is accredited by the Indian Council of Agricultural Research

8. University of Agricultural Sciences, Bangalore

University of Agricultural Sciences, Bangalore (**UAS Bangalore**) is located in Bengaluru, India. It was established in 1964 as UAS Bangalore by a legislative act.

9. National Dairy Research Institute (NDRI) Karnal

National Dairy Research Institute (NDRI), Karnal was originally started as Imperial Institute of Animal Husbandry and Dairying in 1923 at Bangalore. It was expanded and renamed as Imperial Dairy Institute in 1936 and was known as National Dairy Research Institute after independence in 1947. Subsequently, in 1955, NDRI headquarters was shifted to Karnal. Facilities at Bangalore were retained to function as a Regional Station to serve the Southern States.

10. Odisha University of Agriculture and Technology, Bhubaneswar

This University is located in Bhubaneswar, India. It was established in 1961 as Agriculture and Veterinary College in 1961. It is a second oldest agriculture university in India.

Magazine	Published by
Kheti	ICAR
ICAR Reporter	ICAR
ICAR Indian Horticulture	ICAR
ICAR News	ICAR
Agriculture world	Krishi Jagran
Phal Phool	ICAR
Krishi Chayanika	ICAR
Shetkari Marathi	Maharashtra State Govt. Agriculture Department
Kreeshi Panan Mitra	Maharashtra State Agricultural Marketing Board
Annadata	Eenadu Group
Pasumai Vikatan	Vikatan Publication
Valarun Velanmai	Tamil Nadu Agriculture University
Kerala Karshankan	ICAR
Krishi Bndhu	Krishak Bandhu
Krishi Mitra	Maharashtra State Agriculture Market
Kheti Ni Vat	Agriculture talk India
Krushi Vigyan	Krushi Vigyan
Kurukshetra	Ministry of Information and Broadcasting, Govt. of India
Progressive Farming (Monthly in English) ਚੰਗੀ ਖੇਤੀ	Punjab Agriculture University, Ludhiana
Indian Farmers' Digest	G. B Pant Nagar University
Kisan Bharti	G. B Pant Nagar University

CHAPTER -11
MISCELLANEOUS

IMPORTANT INFORMATION ABOUT INDIAN AGRICULTURE

- Total area of India – 32,87,263 km^2; only 2.4% of world's area of 135.79 million Sq. Km.
- Arable land in India - 159 million hectares (11.3% of the world)
- It provides shelter to nearly 17.5% of humans and 14% of the world's cattle
- India is the 7th largest country in the world.
- India lies entirely in the northern hemisphere.
- India's mainland extends between latitudes 8°4' and 37°6' north; longitudes 68°7' and 97°25' east. India's length – about 3,214 km (North to South) between extreme latitudes; breadth – about 2,933 km (East to West) between extreme longitudes.
- Per capita per day milk availability in India is 394g (2019), in Punjab per capita availability is 1181 g/ per day.
- High Yielding Varieties (HYV's) Programme - started in 1966.
- Father of India's Green Revolution in Agriculture – Dr. M.S. Swaminathan – Ex-DG- ICAR
- This revolution started from 1966 & continued up to 1976-77 in wheat and rice.
- Nobel Peace Prize (1970) for **'Green Revolution'** awarded to U.S. Scientist Nobel Laureate Dr. Norman Borlaug)
- Father of White Revolution – Dr. Verghese Kurien, First – Director Chairman, NDDB, Anand (Gujarat)
- First Director General (DG) of ICAR – Dr. B.P. Pal (Benjamin Peary Pal)
- AGMARK – According to the Agriculture Production Act, 1937 – AGMARK is used as a National Mark for quality and purity of Agriculture and Animal products.
- The Seed Act, 1966 has been modified into Seeds Act, 2004.
- National flower – Lotus (*Nelumbo nucipera*)
- Bonsai i.e. miniature tress in pots have 5-20 cm height.
- The optimum time for planting a lawn is February-March and July – August.
- Radish, Tomato and Chilli are rich in Vitamin C.
- Chilli is pungent-tasting due the active Capsaicin alkaloid.
- The red colour of tomato is due to *Lycopin*.
- *Cardamom* is called Queen of Spices.
- Carrot, bitter gourd, onion and tomato are the best sources of iron.
- Heart rot disease in sugar beet is caused due to boron deficiency.
- The potato tuber contains Vitamin B and Vitamin C.
- Potato is called a wholesome food.
- The principles of genetics was explained by Mendel.
- Charles Darwin gave the Theory of Natural Selection.
- The mating or hybridization between individuals from the pedigree of a parent is called 'Inbreeding'.
- Cross pollination is the process, wherein the pollen grains of a flower are transferred to the stigma of another flower.

Some of the key outcomes of the 20th Livestock Census is summarised below:

- The total Livestock population is 535.78 million in the country showing an increase of 4.6% over Livestock Census2012
- Total Bovine population (Cattle, Buffalo, Mithun and Yak) is 302.79 Million in 2019 which shows an increase of 1.0% over the previous census.
- The total number of cattle in the country is 192.49 million in 2019 showing an increase of 0.8 % over previous Census.
- The Female Cattle (Cows population) is 145.12 million, increased by 18.0% over the previous census (2012).
- The total buffaloes in the country is 109.85 Million showing an increase of about 1.0% over previous Census.
- The total milch animals (in-milk and dry) in cows and buffaloes is 125.34 Million, an increase of 6.0 % over the previous census.
- In 20th Livestock Census, 35.94%-Cattle, 27.80%-Goat, 20.45%-Buffaloes, 13.87%-Sheep, 1.69%-Pigs.
- Mithun, Yaks, Horses, Ponies, Mules, Donkeys and Camels taken together contribute 0.23% of the total livestock.

SEED DEFINITION

- Seed may be defined as fertile ovular consisting of intact embryo, stored food and seed coat which is visible and has the capacity to germinate.
- The term seed is also used for any propagating material, often called as seedlings, tubers, bulbs rhizomes, roots cutting and all types of grafts and other vegetative parts, tissue culture generate material etc.
- Seed means any type of living embryo or propagate used for sowing, or planting that is able to regenerate and gives rise to an agriculture plant i.e. true to its type.

GERMINATION

Germination means the capacity of a seed to produce normal sprouts within a period fixed for each crop under optimum field conditions.

FACTORS AFFECTING GERMINATION

Quality soil and seeds are the two most important farming inputs. High yield and good produce is achieved only when soil and seeds are used wisely. So it is necessary to test the soil and the seeds to find out what needs to be added for optimum output.

The following factors have profound effect on germination of seeds:

1. Capacity of the seed to germinate
2. Moisture
3. Temperature
4. Oxygen supply

SEED DORMANCY
Dormancy is the arrested development and reversible rest period of a seed or any vegetative part.

SEED MOISTURE
The water content in a seed is called seed moisture. Germination occurs when seed moisture is above 40-60 percent.
The moisture determination in seed is done by
I. Traditional bite test
II. Electric moisture meters
III. Infrared Moisture meters

BREEDER SEED
A seed which is the result of hybridization, selection and mutation. It has all the desired genetic characters 100% purity and is called breeder or nucleus seed.

FERTILIZERS

Fertilizer is an organic/inorganic material of natural or synthetic origin which is added to a soil to supply one or more plant nutrients essential for plant growth. Fertilizers are responsible for 40% to 60% of average crop yields. So they are essential for high yield harvest.
The fertilizers are **organic**, when these are derived from the natural available resources. However, with the advances in science, the fields are sprayed with nutrients which are synthetically produced; these are called **inorganic** fertilizers.

A. ORGANIC FERTILIZERS
These are safe and are easily available e.g. Manure, Slurry, worm castings, peat moss, sea wood and sewage. Vegetation material called mulch, such as bay, peat moss, leaves, grass, bark, wood chips, seed hulls and corn husks all help to aerate the soils, insulate the ground against temperature change, and add the required nutrients.

Humus is a complex and rather resistant mixture of brown or dark brown, amorphous, colloidal substances modified from the original tissues or synthesized by various soil organisms. Fulvic acid, humic acid and humin - all come under humus. Humus is always in a dynamic condition.

FARM YARD MANURE (FYM)
A decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or fodder is fed to the cattle. The manure prepared from this mixture is a very good source of nutrients for the soil. FYM contains O.5% N, 0.2% P_20_5 and O.5% K20. Urine contains 1% N &l, 35% K_20. The N present in the urine is mostly in the form of urea.

The manure is prepared by making a heap of the mixture up to a height of 45-60 cm above the ground level, dome-shaped and plastered with cow dung earth slurry. The manure becomes ready for use in about 4 - 5 months after plastering. Chemical preservatives are used to reduce losses and enrich the FYM e.g. gypsum, kainite, and superphosphate. Gypsum absorbs urine and prevents volatilization loss of urea and also adds Ca and S. Superphosphate also acts similarly and increases the 'P' content. Bacteria play an active role in decomposition.

COMPOST
Composting is the process of reducing vegetable and animal refuse (rural or urban) except dung to a quickly usable condition for improving and maintaining soil fertility. The decomposed material is called compost, which looks like well- decomposed cattle manure. It is more powdery and lighter in colour. The compost made from town refuse like night soil, street sweepings and dustbin refuse is called *Town compost* (1.4%N, 1% P_20_5 1.4% K_2O).

GREEN MANURE
Green, un-decomposed plant material used as manure is called green manure. It is obtained in two ways:

I. By growing green manure crops in the field and incorporating it in the green stage in the same field. It is called green manuring.
II. Green leaf manuring is the application of green leaves and twigs of trees, shrubs and herbs collected from elsewhere especially wasteland fields, bunds and forests. Forest tree leaves are the main sources for green leaf manure e.g. neem, mahua, etc.

ADVANTAGES OF ORGANIC FERTILIZERS
1. Improve the structure of the soil.
2. Retain soil moisture.
3. Release nitrogen slowly and consistently.
4. Do not burn the plants like chemical fertilizers do.
5. Less prone to leaching.
6. Increase nutrient availability.

DISADVANTAGES OF ORGANIC FERTILIZERS
1. These are contaminated with pathogens because they contain animal and plant faeces.
2. The composition of organic fertilizers is variable. Thus it becomes dilute and an inaccurate source of nutrients as compared to inorganic fertilizers.
3. These fertilizers do not meet all the requirements of the farmers.

B. INORGANIC FERTILIZERS
Inorganic/chemical fertilizers are primarily derived from chemical compounds like Ammonium Nitrate, Ammonium Phosphates and Potassium Chloride, Chilean sodium nitrate, mined rock phosphate and limestones.

ADVANTAGES OF INORGANIC FERTILIZERS
1. Higher and accurate amount of nitrogen promotes protein and chlorophyll activity and encourages the growth of stems and leaves.
2. More phosphorus results in more flowers, larger fruits, and healthier roots and tubers.
3. Potash fosters protein development, thick stems and leaves.
4. Rapid release of nitrogen.

DISADVANTAGES OF INORGANIC FERTILIZERS

1. Inorganic fertilizers, if used carelessly, can damage the crop.
2. Excessive use can distort the quality of soil-leading to cadmium poising.
3. Strict watering schedules have to be adopted to retain the soil moisture.
4. They contain potassium and phosphorus which come from mines or saline lakes. Thus they use up the limited natural resources.

ROLE OF SOIL TESTING

Mostly the farmers are ignorant and find it difficult to know which fertilizer would match his soil. For this he must know the requirement of his crops and the characteristics of the soil.

The idea of soil testing is to provide right information to farmer for economic use of fertilizer based on type of soil. Need of each crop is different and is dependent on the type of crop being grown. In some cases excessive use of fertilizer may infact reduce the productivity. Soil testing is essential and is the first step in obtaining high yields and maximum returns from the money invested in fertilizers.

HORTICULTURE

India has a great potential in horticultural crops, which include fruits, vegetables, spices, flowers, and plantations. The area under horticulture is around 20 million hectares. India is the second largest producer of both fruits and vegetables in the world. It occupies the first position in the production of cauliflower, the second in onion, and the third in cabbage**.**

PLANTATION

Tea, coffee, and natural rubber are the main plantation crops in India which contribute to Indian exports in a considerable manner. India is the largest producer and consumer of tea in the world. It contributes 4% to the global coffee production and enjoys a niche market in both *arabica* and *robusta* coffees. In rubber too, it ranks third in production and fourth in the consumption of natural rubber in the world.

HORTICULTURE (FRUITS, FLOWERS & VEGETABLES)

- Horticulture – Originates from Latin words *Hortus* and *Coleur* or 'culture', meaning garden and cultivation, respectively.
-
- **Branches of Horticulture**
  Olericulture – Vegetable Science
  Pomology – Fruit Science
  Floriculture – Flower Science
  Fruits and Vegetables Preservation

Major Fruits and Vegetables grown in the State of Punjab

Fruits	Vegetables
Kinnow	Potato
Sweet Orange	Onion
Lime Lemon	Tomato
Mango	Garlic
Litchi	Brinjal
Guava	Cauliflower
Pear	Cabbage
Peach	Okra
Plumb	Chilies
Grapes	Peas
Bar	Muskmelon - Watermelon
Amla	Vine crop
Banana	Root crops

FRUIT-GROWING STATES OF INDIA

TEMPERATE FRUITS – J & K, Kangra Valley (Punjab), Nahan (Himachal Pradesh) and Kumaon Hills (Uttaranchal)

TROPICAL FRUITS – Madhya Pradesh, West Bengal, Maharashtra, Odisha, AP, Karnataka, Tamil Nadu, Kerala

SUBTROPICAL FRUITS – Plains of Punjab and Uttar Pradesh, North Bihar, Madhya Pradesh, Rajasthan, Assam

GROWTH REGULATORS FOR FRUITS & VEGETABLES: - Auxins, Gibberellins, Cytokinins

GROWTH INHIBITORS

Those substances which check the growth of plants e.g. Abscisic Acid, (ABA), Phenoles, Malic Hydrozoide (MH), 'CCC' (Cycocel), B-9, Phosphon-D etc.

MISSION FOR INTEGRATED DEVELOPMENT OF HORTICULTURE (MIDH)

Horticulture mission 2022, the Prime Minister has set a target before the nation to double the income of the farmers by the year 2022.

FLORICULTURE

Loose flowers: Flowers which are harvested from the base of flowers without their stems / branches, e.g. marigold, chrysanthemum, rose, jasmine. These are used for making garland, worshiping and decoration.

Cut Flowers: Flowers which are marketed along with their stems. They are used for making flower arrangements and gifts. E.g. gladiolus, chrysanthemum, gerbera, rose and Lilium (Lily).

REVENUE TERMINOLOGY

The land holding record is a very important functional duty of a Patwari or the revenue officers, as the land is a valuable asset and has always been a source of conflict between the two claimants. It is required that every person should be aware of the exact measure of land held by him and the same should be legally recognized in the records of the government.

COMMON TERMS

***Khasra* Number or Field Number or Survey Number or *Kila* Number**	A field is a parcel of land to which a separate number is assigned in the map. Usually, any parcel of land in one spot in the occupation of one person/ persons jointly and held under one title, should be treated as a single field.
***Shajra Kistwar* (*Latha*)**	The map showing the position of every field of each village is known as *Shajra Kistwar*.
***Khatauni* Number**	The number of the holding (*Khata*) of the person responsible for the cultivation.
Khatauni	A statement of proprietors and tenants holding with the details of the fields and a note of the rent paid by each tenant.
***Khewat* Number**	The number of the owner's holding.
Khewat	A share/portion of an estate held by a land owner or by two or more land owners, showing the area and revenue of each proprietor's holdings.
Jamabandi	The list of holdings cultivated by owners/ tenants at will, with the fields in each and the sum payable as rent or revenue.
Khasra	A register, showing for each field, its number in the maps, the area, the soil or class of land, the owner and the person who cultivates it.
Khasra Girdawari	The register where crop data is maintained by patwari or the register of crop inspection.
Shajra Nasb	Genealogical tree of the land owner.
Chak Bandi	Amalgamation and redistribution of land to reduce the number of plots in the holdings.
Banjar Gadim	Land which has remained unsown for eight successive harvests.
Banjar jadid	Land which remained unsown for four successive harvests.

A village's common land is called 'Shamlat'.

LAND REVENUE RECORD

To know the exact location of the land and its complete record, every tehsil or taluka is divided into few revenue estates. PATWARI is the in-charge of each such area and maintains certain important registers called the 'revenue documents' which are mentioned herein below:

1) Field book
2) Jamabandi (Record of rights)
3) Kharsa girdauri (Harvest inspection register)
4) Mutation register (Intakal register)
5) Akas/Latha/ Shajra/ Kishtawar (Village Map)
6) Fard Bedar
7) Parcha Registry

FARAD JAMABANDI (ਫ਼ਰਦ ਜਮਾਂਬੰਦੀ)

This document is a record of areas called Khasra/Khata and field No., containing the name of the owner / cultivator. From its scrutiny, details of total land of the land owner, the name of the cultivator and mortgagee's name along with the interest in the property is established. It gives the information as to whose name the land stands and what happened afterwards the Fard can be seen on website of Punjab land record society.

Khasra Girdawari (ਖਸਰਾ ਗਿਰਦਾਵਰੀ)

This document contains the detail about each piece of land, name of the owner and cultivator of land, crops grown in Rabi and Kharif seasons and also the source of irrigation. It is prepared biannually. Sometimes, the record of the jamabandi may have difference with that of the Girdawari Register. For example, land may be shown in the record of jamabandi as unirrigated but in the girdawri as irrigated because the farmer may have installed the tubewell lateron.

Aks Latha (Shajra / KIshtawar) (Shajra / Kishtawar)

This is the map of the village on field wise basis after actual measurements. Normally this is revised after every four years but can be delayed under unavoidable circumstances or the reasons. The original copy of this map may be with the Patwari or the Lambardar. The word Latha is used to denote that the map is prepared on the latha cloth or it may be pasted on the latha cloth. Any change in the land would be indicated on the map itself. All the fields on the map are numbered. These numbers appear in Jamabandi and other revenue records.

Mutation Register

It is a book maintained by the Patwari to record the change in ownership or otherwise forward it for ratification by Kanoongo or Tehsildar.

In the mutation register all changes which take place in any property are recorded. Such changes cannot be effected without entering into the mutation register. However, mutation does not pass any transfer authority to the transfrees. It is simply an entry to show that something (transaction) has taken place. But still getting mutation is of utmost importance. The mutation is prepared in two copies, one is retained with the Tehsildar Headquarters & one copy is with the Patwari. Initially the reference of Mutation number is entered in the remarks column of the Jamabandi in pencil and lateron confirmation by Tehsildar is made in red ink. Therefore, remarks column of Jamabandi indicate the change in ownership/charge of land.

Fard Badar (ਫ਼ਰਦ ਬਦਰ)

Any clerical omission or commission, which might have been occurred during the preparation of Jamabandi can only be rectified by preparing Fard Badar. In the Fard report of Kanoongo or Patwari final order of the authority is taken and the same is noted in red ink in the Jamabandi register.

Types of Mutation (ਇੰਤਕਾਲ)

1) Bai (ਬੈ)	Sale of land
2) Rehan (ਰਹਿਣ)	Mortgage of land
3) Ad Rehan (ਆੜ ਰਹਿਣ)	Mortgage without possession
4) Hiba (ਹਿਬਾ)	Gift
5) Fak-ul-Rehan (ਫਕ - ਉਲ - ਰਹਿਣ)	To redeem the mortgaged land
6) Tamleek (ਤਮਲੀਕ)	To divide land among sons during the life of the father
7) Tabdeel (ਤਬਦੀਲ)	Any change in ownership on court order.
8) Warast (ਵਿਰਾਸਤ)	Division of land after the death of the father
9) Takseem (ਤਕਸੀਮ)	To divide

Sale/Purchse/ Gift

Baya (ਬਾਇਆ)	The person who sells his land
Mushtri (ਮੁਸ਼ਤਰੀ)	The person who purchases the land
Wahib/Mahub (ਵਾਹਿਬ ਮਹੂਬ)	The person who gives the property in the gift.

Kinds of land

Abpas (ਆਬਪਾਸ)	Irrigated Land
Gherabpass ਗੈਰ (ਆਬਪਾਸ)	Unirrigated land
Majrooa (ਮਜਰੂਆ)	Cultivable land
Ghermumkin (ਗ਼ੈਰਮੁਮਕਿਨ)	Not covered under cultivated area comes under road, or the dwellings
Banjar Jadid (ਬੰਜਰ ਜਦੀਦ)	Such lands which were taken up for cultivation but are temporarily out of cultivation for a period not less than one year or more than 5 years
Banjar Kadim (ਬੰਜਰ ਕਦੀਮ)	Such land which were taken as cultivable but not taken for cultivation for more than five years and is occupied with shrubs and jungles

Measurements of land

Normally, the total revenue state is divided into rectangles and each rectangle into 25 sub-rectangle known as Killa numbers.

Every bigger rectangle is numbered and run continuously from one onward for the whole village.

The killas are numbered from 1 – 25 and repeated in every rectangle. The number of the bigger rectangle is written in red ink and the small rectangle in black ink. On the boundary of the village, the rectangle may not be in shape or regular but the number continues.

The agricultural land is measured into two main systems, one the bighas and biswas and the other is kanals and marlas system. The former is called as Biswasi and the latter is called Sarsahi.

Measurement of Bighas (Biswasi)

20 biswasis	=	1 biswa
20 biswas	=	1 bigha
4 bigha 16 biswas	=	1 acre

Measurement in Kanals (Sarasahi)

2 sarsahi	=	1 marla
20 marlas	=	1 kanal
8 kanal	=	1 acre

The Kila system is measured with the

1 karam	=	66” or 5.5 feet
1 kila	=	96 biswa

REVENUE AUTHORITIES

Patwari: For a village/group of villages

Kanungo: The patwaris work under him.

Naib Tahsildar: To assist the tehsildar at the tehsil level

Tehsildar: Revenue officer for a tehsil

Deputy Collector: Overall in charge of revenue functions for a district

Patwaris, Kanugos and Lambardars are called Village Officers.

The Periodical record is prepared once in every Four years.

Khewat is the name of list of owner’s holding.

Khatauni is prepared by patwari.

Record of Khatauni is kept under the custody of Halqa patwari.

A person liable for an arrear of Land Revenue is called Defaulter.

A piece of cloth on which the village map is drawn showing the position and boundaries of every field is known as Shajra Parcha.

Lal Kitab is prepared for each Estate. Village note book is also known as Lal Kitab.

Khatauni register is used for all persons cultivating or otherwise occupying land in a village. It contains entries regarding Ownership, Cultivation and Various rights in land.

PATWARI

The number of *patwari* circles into which each *tehsil* is divided is regulated by the Financial Commissioner and the limits of each circle are fixed by the Commissioner. A *patwari* is appointed to each circle, and for special reasons, an assistant *patwari* may also be there, with the consent of the Financial Commissioner.

PATWARI - GENERAL DUTIES

As part of job, a *patwari* is supposed to

i. conduct surveys
ii. make field inspections
iii. make a record of crops
iv. revise maps/ reports on mutations, partitions, rent, takavi, or other circumstances of his circle as ordered by the revenue officers.

He must also give such assistance as may be required for relief in agricultural distress, or in elections. Such orders are issued through the *kanungo*, to whom he is a subordinate. Besides, he has to render all possible assistance to the village postman, while he spends the night in the village in safeguarding the cash and other valuables he carries.

He is also required to keep a record of the pensioners' deaths and to inform the higher authorities. He is also given certain duties with regard to irrigation of the area and to keep a record thereof.

REPORT ON CALAMITY OR DISEASE

It is the *patwari's* duty to submit at once a report in writing regarding:

(a) The outbreak of plague, cholera, small pox or any other epidemic disease

(b) Calamities affecting crops including crop pests

(c) The our break of any epidemic among livestock

The *patwari* should give a confidential report to the Excise Inspector concerned or the Sub Inspector of the Police Station concerned regarding any illicit distillation or sale of liquor in his circle.

Patwaris' diary (ROZNAMCHA) He keeps up a diary and a work-book. The first part of the diary, which is renewed annually, should contain a record of all facts of importance regarding the cultivation of the land, the state of the crops, the condition and relations of landowners and tenants, and the interests of government.

The entries should be made on the day on which the events come to the notice of the patwari. At the end of each sambat month of careful general note on the crops and the cattle of the circle should be added.

Orders received by the patwari from kanungo or from any revenue officer should also be entered in part 1 of the diary. Where, however an order consists of directors of a general nature it should be inserted in part ii which is not renewed every year. The diary, like all other revenue record, is kept by the agricultural year beginning on 16th bhadon, corresponding to the 1st September.

REVENUE COLLECTIONS

The *patwari* prepares each year a *bachh* paper showing the demands due from each contributor to the village *bachh*. In all other villages, the *bachh* papers must be prepared by the *patwari* for every village immediately after the *kharif girdawari*. And the *patwari* must, if necessary, correct the *bachh* paper at the second harvest of the year to make it agree with the events occurring since its preparation.

The *patwar* is bound to supply to every owner and cultivator, on demand, a *parcha* book, containing a copy of the *jamabandi* entries in which the applicant is interested and printed receipts.

MUTATION

The change in ownership i.e. sale or any event which leads to a change in land ownership e.g. mortgage, is required to be put down in the official records, is called **mutation**. It is a general notice to the public of land ownership. The *patwari* is the record keeper of the land register and is supposed to provide the public with the information on land ownership.

The official document of land ownership is called *fard nakal* and the government has started providing the public with its computerized copy.

All mutations of the rights of ownership including voluntary partitions, shall be entered by the *patwari* in the register when they are reported to him by the transferee, as required by Section 34 of the Land Revenue Act, if not so reported, as soon as they appear to have been acted upon.

When he enters a mutation affecting the *shajra nasb* the *patwari* shall write in pencil the number of the mutation against the entry. If and when the mutation is sanctioned, he will amend the shajra *nasb* in red ink in line with the mutation order.

The field *kanungo* must attest, by personal examination, every entry made by the *patwari* in the counterfoil and the foil, noting briefly that he has done so. He should mention the date below the report. He must sign the entries on both the counterfoil and the foil.

DUTIES OF THE DISTRICT KANUNGO

The District *Kanungo* shall receive in the Deputy Commissioner's office all returns and records due from the *tehsil* offices related to the work of *kanungos* and *patwaris*, submitting them to the Deputy Commissioner, or the officer in charge.

He shall issue all orders passed in regarding this work. He shall prepare all statistical statements related to his department required by the Deputy Commissioner.

REGISTER MAINTAINED BY KANUNGO

The registers of revenue-free tenures (*Muafi* and *Jagir* registers) should be maintained by the district *Kanungo*, but in some districts, owing to the large number of *muafis* and *jagirs*, these registers are under the charge of a *muafi* or *Jagir Moharrir*, who works the District *Kanungo* and not under any other official.

He keeps for each assessment circle, for each *tehsil*, and for the entire district, note books in the same form as prescribed for office *kanungos* at tehsils, any other registers prescribed by the Financial Commissioner and also all statistical returns furnished to the Deputy Commissioner by the *Kanungo* and *patwari* agency.

CHAPTER – 12
FACTS & FIGURES

CROP TYPES

1.	Cereals	Wheat, Rice, Maize & Bajra
2.	Pulse / Legume Crops	Gram, Urad
3.	Oil Seeds Crops	Sarson, Til, Groundnut, Peanut, Castor, Rapeseed, Linseed, Sunflower
4.	Forage Crops	Barseem, Guar and Oat
5.	Fibre Crops	Sun hemp, Jute
6.	Root Crops	Cassava, Sweet, Potato, Carrot
7.	Tuber Crops	Potato, Turnip, Onion, Garlic
8.	Sugar Crops	Sugarcane, Beet Root
9.	Starch Crops	Cassava, Guar
10.	Medicinal Crops	Mint, Amla, Aloe Vera, Tulsi, Saffron, Vanilla
11.	Spices & Condiments	Ajwain, Saunf, Mulathi, Chilli
12.	Vegetable Crops	Cauliflower
13.	Green Manure Crops	Dhaincha, Barseem, Guar
14.	Aromatic Plant Crops	Chameli, Geranium, Rose
15.	Fruit Crops	Apple, Mango, Banana
16.	Flower Crops	Gladioli, Carnation, Zarbera, Lilly, Chrysanthemum, Rose

SOME IMPORTANT FACTS
1. Agriculture period in India is July 01 to June 30.
2. Food Crops: Includes cereals such as paddy, wheat, pulses, vegetables which are consumed
3. Cash crops: Groundnuts, mustard, sunflower, sugarcane, cotton, coffee, tea
4. Plantation crops: Coconut, arecanut, oil palm, cashew, tea, coffee and rubber; the minor plantation crops include cocoa
4. Catch crop: Crop grown between rabi and kharif
5. Kharif season June to November
6. Rabi season November / December to May

CLASSIFICATIONS OF CROPPING SYSTEM:
Based on climate different crops are sown in different areas at the same time.

Cropping season	Major crops cultivated	
	Northern States	**Southern States**
Kharif June-September	Rice, Cotton, Bajra, Maize, Jowar, Tur	Rice, Maize, Ragi, Jowar, Groundnut
Rabi October-March	Wheat, Gram, Rapeseeds and Mustard, Barley	Rice, Maize, Ragi Groundnut, Jowar
Zaid April-June	Vegetables, Fruits, Fodder	Rice, Vegetables, Fodder

Weeds & Pests

Affected Area	Weed
Total root parasite	Orobanche
Total stem parasite	Cuscuta
Semi root parasite	Stiga
Semi stem parasite	Loranthus

Livestock Population - Major Species

Category	Population (In million) 2019
Cattle	192.49
Buffalo	109.85
Sheep	74.26
Goat	148.88
Pig	9.06
Mithun	0.38
Yak	0.06
Horses & Ponics	0.34
Mule	0.08
Donkey	0.12
Camel	0.25
Total Livestock	**535.78**

REVOLUTIONS IN AGRICULTURE SECTOR & RELATED FIELDS

Revolution	Related Sector
• Green Revolution (1966-67)	Foodgrain Production (especially Wheat / Rice)
• White Revolution	Milk Production
• Yellow Revolution	Oilseed Production
• Grey Revolution	Fertilizer Production
• Blue Revolution	Fish Production
• Red Revolution	Meat / Tomato Production
• Round Revolution	Potato Production
• Silver Revolution	Egg Production / Poultry
• Pink Revolution	Prawn Fish Production
• Golden Revolution	Fruit Production (Apple)
• Brown Revolution	Non-Conventional Energy Sources

NEED FOR REVOLUTIONS IN FUTURE IN INDIA

• Black Revolution	Bio-diesel Production for self sufficiency in Petroleum & Mineral Oil.
• Food – Chain Revolution	Mandate is to double the average income of Indian farmers.

DISEASES	DUE TO
• Cotton (Black arm)	Due to bacteria
• Groundnut (Tikka)	Due to fungus
• Maize (Charcol rot)	Due to fungus (*Mecrophomina phaseolli*)
• Rice (Khaira) (Blast) (Leaf Brown)	 Zn Due to fungus Due to fungus
• Pearl millet – (Ergot & Smut)	Due to fungus
• Sugarcane – (Red rot)	Due to fungus
• Sorghum – (Poisoning)	HCN (Hydro Cynic Acid / Prussic Acid / Dhurin / Oxalates)

DISEASES OF FARM ANIMALS

Animal Diseases	Symptoms	Animal Affected	Control
Food & Mouth (Virus)	Blisters in mucous lining of mouth	Cattle	Isolation, Killing, burying chronic animals and vaccination
Rinderpest (Virus)	High fever, weakness, choking of breath,	Cattle sheep & goat	Regular vaccination, allowing only healthy animals

	diarrhea, formation of lesions with discharge		in the herd, Restriction of animals
Newcastle (Virus)	Sneezing, coughing, diarrhea, paralysis and muscular tumor	Fowl	Vaccination, good sanitation and disinfection of houses
Anthrax (Bacteria)	High fever, stupor staggering and sudden death	Cattle, sheep, goats and pigs	Isolation of sick animals, proper sanitation and giving of clean water
Brucellosis (Bacteria)	High fever, diarrhea, wobbling gait, arthritis and death	Swine	Isolation of sick animals, proper sanitation and giving of clean water
Tuberculosis (Bacteria)	Constant coughing, loss of weight and sudden death	Cattle, poultry and pigs	Good sanitation, isolation, and vaccination
Aspergilosis (Fungi)	Mouldy appearance, feeds on food saprophytically	Farms animals and man	Good sanitation and use of fungal spray
Trypansomiasis (Protozoa)	Intermittent fever, anaemia and loss of weight	Domestic animals and man	Drugs like trypanosomide, clearing of bush around livestock

Major Fruits and Vegetables grown in the State of Punjab

Fruits	Vegetables
Kinnow	Potato
Sweet Orange	Onion
Lime Lemon	Tomato
Mango	Garlic
Litchi	Brinjal
Guava	Cauliflower
Pear	Cabbage
Peach	Okra
Plumb	Chilies
Grapes	Peas
Bar	Muskmelon - Watermelon
Amla	Vine crop
Banana	Root crops

COMMON TERMS

***Khasra* Number or Field Number or Survey Number or *Kila* Number**	A field is a parcel of land to which a separate number is assigned in the map. Usually, any parcel of land in one spot in the occupation of one person/ persons jointly and held under one title, should be treated as a single field.
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INSTITUTIONS IMPARTING EDUCATION IN AGRICULTURE

Name	About	Location	Magazine (If Available)
Central Agricultural Research Institute	Agri-horticulture, livestock and fisheries	Port Blair, Andaman and Nicobar Islands	Agro-forestry Newsletter
Central Arid Zone Research Institute	Multidisciplinary research	Jodhpur, Rajasthan	Newsletter
Central Institute for Cotton Research	Cotton	Nagpur, Maharashtra	Indian Cotton Farmers
Central Institute for Research on Cotton Technology	Cotton	Mumbai, Maharashtra	Newsletter
Central Institute of Agricultural Engineering	Modernization of Agriculture	Bhopal, Madhya Pradesh	कृषि अभियांत्रिकी दर्पण
Central Institute for Arid Horticulture	Improvement of Horticultural crops	Bikaner, Rajasthan	–
Central Institute for Research on Buffaloes	Buffaloes	Hissar, Haryana	Nili-Ravi Buffalo
G.B.Pant University	Agriculture	Pantnagar, Uttarakhand	Indian Farmers' Digest, Kisan Bharti (Hindi)
National Dairy Research Institute	Dairy Farming	Karnal, Haryan	Dairy Samachar
Central Institute of Post Harvest Engineering & Technology	Agriculture	Ludhiana, Punjab	CIPHET News

Guru Angad Dev Veterinary and Animal Sciences University	Veterinary	Ludhiana, Punjab	Infectious Animal Diseases, Karap Machhi Palan
Central Potato Research Institute	Potato	Shimla, Himachal Pradesh	Newsletter
Central Rice Research Institute	Rice	Cuttack, Orissa	Newsletter
Central Soil Salinity Research Institute	Soil Salinity	Karnal, Haryana	Krishi Kiran
Indian Agricultural Research Institute	Agriculture	New Delhi	IARI News
Indian Agricultural Statistics Research Institute	Agriculture / Computer Application	New Delhi	IARI Newsletter
Indian Institute of Horticultural Research	Horticultural	Bangalore, Karnataka	Arpan
Indian Institute of Soil Science	Soil	Bhopal, Madhya Pradesh	Takneek Ek Drishti Mein, Mitti Parikshan : Kyo, Kab aur Kaise
Indian Institute of Sugarcane Research	Sugarcane	Lucknow, Uttar Pradesh	Forty Five Years of AICRP on Sugarcane
Indian Institute of Vegetable Research	Vegetable crops	Varanasi, Uttar Pradesh	Vegetable Newsletter
National Bureau of Animal Genetic Resources	Animal	Karnal, Haryana	Yak Production, Animal Genetic Resources of India Cattle and Buffalo
National Bureau of Fish Genetic Resources	Fish	Lucknow, Uttar Pradesh	मत्स्य लोक
National Bureau of Plant Genetic Resources	Plants	New Delhi	–
National Centre for Agricultural Economics & Policy Research	Agricultural Economics	New Delhi	–
National Research Centre for Agroforestry	Agroforestry	Jhansi, Uttar Pradesh	Agroforestry Newsletter कृषिवानीकी समाचार पत्र
National Research Centre on Equines	Equines	Hissar, Haryana	शालिहोत्र
National Research Centre for Integrated Pest Management	Pests	New Delhi	–
National Research Centre for Mushroom	Mushroom	Solan, Himachal Pradesh	White Button Mushroom Cultivation
National Research Centre for Weed Science	Weed	Madhya Pradesh	Alien invasive weeds, Medicinal weeds, Weed Management
C.S.A. University of Agriculture & Technology	Agriculture	Kanpur	Krishak Bharati Magazine
CCS Haryana Agriculture University	Agriculture	Hisaar	Haryana Kheti
Punjab Agriculture University	Agriculture	Ludhiana	ਚੰਗੀ ਖੇਤੀ, Progressive Farming

Some Other Publications

Publication	Published by
Indian Farming	ICAR
Indian Horticulture	ICAR
Kheti Sandesh	PAU, Ludhiana
Kheti Bulletin (Agriculture Bulletin)	PAU, Ludhiana

- Krishi Jagran (Hindi, Marathi, Gujarati, Punjabi & English)
- Kheti Ni Vat
- Modern Kheti
- Krishak Jagat
- Kheti Duniya (Punjabi & Hindi Magazine)
- Agriculture Today
- Changi Kheti (Punjabi News)

VARIETIES OF CROPS GROWN IN PUNJAB

Wheat	Rice	Maize	Gram
HD 2967	PR124	**Winter I, Buland**	jl!lpsG5
PBW 621	PR123	Partap 1	GPF2
PBW 550	PR122	Kharlf / Spring/Summer	jPBG1
DBW17	PR121	**i) Long duration**	POG4
PBW502	PR118	PMH1	**Gram (Kabuli)**
TL 2908 (Triticale)	PR116	Parbhat	BG 1053
/I) Late sown	**Basmati Rice Punjab Basmati2**	**ii) Medium duration**	Lentil U931
PBW509	Pusa Basmati 1121	Kesri	lL 699
PBW373	Super Basmati	**iii) Short duration**	ll147
TL 1210 (Triticale)	Basmati 386	Parkash	Field Pea
Rainfed	Pusa Basmati1	Megha	Field
PBW527	Basmati 370	Punjab Sathi 1	PG3
PBW175			

Durum Wheat WHD943 PDW291	**Aromatic rice** Punjab Mehak 1	**Special Purpose** Pearl Popcorn	

Cotton
American cotton, **Bt hybrids:** RCH 650, NCS 855, Ankur 3028, MRC 7017 **Non-Bt hybrids:** LHH 144, **Varieties - LH 2108**
Desl Cotton PAU626H, Varieties: FDK 124, LD 694
Sugarcane
Early season: CoJ85, Co,J83 | **Mid-season:** CoPb 91, CoJ88 | **Late maturing:** CoJ89

Bajra	PHBF 1	FBC 16			
Arhar	PAU881	A1201	AL15		
SOYABEANS	11S1744	Ta525	st295		
Summer moong	SML832	SMS668			
KHARIF MOONG	PAU911	ML818			
SUMMER MASH	Mash 1008	Mash 414	Mash 218		
KHARIF MASH	Mash 114	Mash 338	Mash = 1-1		
Lantil	U931	IL699	11147		
Field Pea	ea48	pg3			
Raya	RLC1	PBR210	PBR97	PBR91	RLM619
Oil Seeds	Torla	TL17	PBT37	TL-15	
Sunflower	PSH569	PSFH118	SH3322	GKSFH2002	Jawalamukhi
Groundnut	SG99	SG84			
Seasame	RT346	TTC289	Pb. Til No. 1		
Guara	80				
Cowpea	CL367	Cowpea 88			
Oats	OL9	Kent			
Lucerne	Lucerne No.9	LL Composite 5			
Sunnhamp	PAU1691	Narendra Sanai - 1			
Berseem	PL42	BL10	PL1	Shaftal-69	
Rye Grass	Punjab Rye	Grass No. 1	Senjl	Senji Safed 76	YSL 106
Kharif Forage	J1006				
Sorghum	SL 44	Punjab Sudax			

IMPORTANT DAYS & DATES

World Watershed Day	2nd February
National Science Day	28th February
World Forestry day	21st March
World Water Day	22nd March (by UNO)
World Earth Day	22nd April
International Labour Day	1st May
International Bio-Diversity Day	22nd May
World Environmental Day	5th June
Rose Day	25th June
National Nutrition Week	1st – 7th September
World Coconut Day	2nd September
Pumpkin Day	29th September
World Animal Day	2nd October
World food day	16th October
Kisan Diwas	23rd December (Ch. Charan Singh Birthday)
National Consumers Rights Day	24th December

ENGLISH AND COMMON NAMES OF THE VEGETABLES

English Name	Common Name	English Name	Common Name
Bitter Ground	Karela	Okra	Bhindi
Sponge Ground	Kali Tori	Sweet Pepper	Shimla Mirch
Bottle Ground	Ghia Kadoo	Tomato	Tamatar
Squash Melon	Tinda	Garlic	Lassan
Summer Squash	Chappan Kadoo	French Bena	Phallian
Muskmelon	Kharbuza	Potato	Aloo
Watermelon	Tarbooz	Cowpeas	Lobia
Brinjal	Baingan	Radish	Mooli
Chilli	Mirch	Turnip	Shalgum
Cucumber	Kheera	Pea	Matar
Cauliflower	Phulgobhi	Coriander	Dhania
Cabbage	Bandgobhi	Carrot	Gajar

DISEASES OF FARM ANIMALS

Animal Diseases	Symptoms	Animal Affected	Control
Food & Mouth (Virus)	Blisters in mucous lining of mouth	Cattle	Isolation, Killing, burying chronic animals and vaccination
Rinderpest (Virus)	High fever, weakness, choking of breath, diarrhea, formation of lesions with discharge	Cattle sheep & goat	Regular vaccination, allowing only healthy animals in the herd, Restriction of animals
Newcastle (Virus)	Sneezing, coughing, diarrhea, paralysis and muscular tumor	Fowl	Vaccination, good sanitation and disinfection of houses
Anthrax (Bacteria)	High fever, stupor staggering and sudden death	Cattle, sheep, goats and pigs	Isolation of sick animals, proper sanitation and giving of clean water
Brucellosis (Bacteria)	High fever, diarrhea, wobbling gait, arthritis and death	Swine	Isolation of sick animals, proper sanitation and giving of clean water
Tuberculosis (Bacteria)	Constant coughing, loss of weight and sudden death	Cattle, poultry and pigs	Good sanitation, isolation, and vaccination
Aspergilosis (Fungi)	Mouldy appearance, feeds on food saprophytically	Farms animals and man	Good sanitation and use of fungal spray
Trypansomiasis (Protozoa)	Intermittent fever, anaemia and loss of weight	Domestic animals and man	Drugs like trypanosomide, clearing of bush around livestock

CHAPTER – 13
AGRICULTURE BYTES

1. PAU established close ties with CIMMYT for improvement of wheat varieties. What is full form of CIMMYT: **International Wheat and Maize Development Centre Mexico**
2. Which wheat varieties made significant contribution in Green Revolution: **Kalyan Sona and WL 711**
3. Which rice variety made significant contribution in Green Revolution: **PR 106**
4. _____ introduced Italian honey bees in the country for the first time: **Punjab Agriculture University**
5. For which crop the first ever hybrid was developed in India: **Pearl Milet (H.B.-1)**
6. Which climate is required during early stage of growth of wheat plants: **Cool Climate**
7. The major insect pests of wheat are: **Termite, Aphid, Gram Pod Borer**
8. **The major disease of wheat are:** Leaf rust, yellow or stripe rust, loose smut, yellow ear rot, Karnal bunt
9. Which state is the largest producer of pulse in India: **Rajasthan**
10. Gram and Lentil are major pulse crops of Punjab of: **Rabi Season**
11. Which crop is known as King of Fodders: **Berseem**
12. Which is the best time of sowing of Barley: **15 October – 15 November**
13. Which is the optimum sowing time of Desi gram under rainfed conditions: **October 10 – October 25**
14. Sowing time of gram under irrigated condition is: **October 25 – November 10**
15. Parakeet is a bird which is _____ to the agriculture? **Harmful**
16. Owl is a bird which is _____ for agriculture? **Useful**
17. _____ (bird) normally eats 4-5 rats every day? **Owl**
18. _____ method of irrigation is useful for crops like cotton, potatoes, etc.: **Furrow**
19. Border method of irrigation is not suitable for _____ soils? **Sandy Soils**
20. Which method of irrigation is suitable for undulated areas? **Sprinkler**
21. The study of fruit science is known as: **Pomology**
22. The method used by farmer to prepare the soil for seed germination and growth of crop is known as: **Tillage**
23. Which organization was created to remove hunger and starvation in the world? **Food and Agricultural Organization**?
24. Which organization was created in 1995 for smooth functioning of international trade? **World Trade Organization**
25. Which organization was created 1963 to produce certified seeds? **National Seed Corporation**
26. Which organization is associated in procurement and distribution of foodgrains through Public Distribution System in India? **Food Corporation of India**
27. Which is the largest Co-operative organization in the world? **IFFCO-Indian Farmers Fertilizer Co-operative Ltd.**
28. Which organization was created in 1966 with the main objective of bringing diversity in farming through processing and marketing of agriculture produce? **PAIC – Punjab Agro Industries Corporation**
29. GPF 2, PBG 1, PDG 4 and PDG 3 are varieties of: **Desi Gram**
30. The type of Gobhi Sarson which has less erucic acid in oil is called: **Canola**
31. Which type of trees are found in south west region of Punjab? **Kikar, Tahli, Nim, Jamun, Toot**
32. Which trees are used for fodder in kandi area? **Kachnar, Beri, Dhak**
33. Mentha oil is used in the: **Medicines, Perfumes and Cosmetics**
34. Rodenticides mainly used for killing: **Rats**
35. _____ climate is most useful for growth of Sugarcane: **Tropical**
36. What is the India's rank in Milk production in the world? **1st**
37. Indigenous breeds of cows are: **Hariana, Sahiwal, Red Sindhi, Tharparkar**
38. Exotic breeds of cows are: **Holstein Friesian, Jersey**
39. _____ is a cross breed of Tharparker and Holstein Friesian: **Karan Fries**
40. Surti, Nili Rabi, Murrah, Jafarabadi are varieties of which animal: **Buffalo**
41. Which breed of buffalo has very long horn? **Pandharpuri**
42. The crop which is grown in between two main crops is known as: **Catch crop**
43. How much contribution of foodgrain was made by Punjab to the central pool in 2018-19: **Rice 25%, Wheat 35%**
44. Which state has overtaken Punjab in making maximum contribution of wheat to the central pool in 2020: **Madhya Pradesh**
45. What is the contribution of Agriculture in the total GSDP of Punjab: **28% approx.**
46. Who coined the term green revolution: **William S. Gaud**
47. What is the contribution of agriculture and allied activities in the GDP of the India? **17% approx.**
48. Pusa has warned that Pusa 44/Peeli Pusa and HKR 127 should not be grown because: **They consume more water and are susceptible to bacterial blight.**
49. Punjab Basmati 5, Punjab Basmati 4, CSR 30, Basmati 370 are improved varieties of: **Basmati Rice**
50. _____ is recommended to sow wheat in combine harvested paddy field without any straw burning: **Happy Seeder**
51. If pH of soil is high _____ is applied for rice cultivation: **Gypsum**
52. Which type of soil is not good for growth of cotton? **Saline or waterlogged types**
53. The most harmful insect which attacks cotton in Punjab? **Bollworm**

54. In May 2020 a swarm of locusts affected large number of districts in Rajasthan and destroying the crops. Locusts a type of_____: **Grasshopper**
55. What is Zero Budget Natural Farming (ZBNF)? **A method of chemical free agriculture based on traditional Indian practices**
56. Raya is a variety of _____ grown in medium and high rainfall areas: **Oilseed**
57. The main objective of agro forestry is: **To meet the demand of farmers, food, fuel, fodder alongwith maintenance of natural resources**
58. Which is a toll-free number, where the farmer can call to seek information about agriculture: **1551**
59. Which flower is known as the king of flowers: **Rose**
60. Central Potato Research Institute is situated at: **Shimla**
61. Central Food Technology Research Institute situated at which place: **Mysore**
62. Central Institute for Sub-tropical Horticulture is situated at: **Lucknow**
63. Central Arid Zone Research Institute located at which place: **Jodhpur**
64. Forest Research Institute is situated at: **Dehradun**
65. When soil is ploughed and cultivated, the natural state of the upper 12-18 cm is modified and this manipulated portion is referred to as _____ **(Surface soil or Top Soil)**
66. The arrangement of sand, silt and clay particles within the soil is termed as _____**,** while their relative amounts as soil texture. **(Soil Structure)**
67. A _____ is often a continuation of a flood plain (its front) and is clayey in nature and likely to be swampy as well**. (Delta)**
68. Vegetative cover reduces the natural soil _____, thereby slowing down the rate of mineral soil removal. **(Erosion rates)**
69. Which is the largest cooperative institute in the world: **IFFCO**
70. Which organization was setup in 1963 to produce certified seeds: **National Seeds Corporation**
71. Covering the soil surface with organic residues to keep surface soil cooler and prevent evaporation of water from soil is called _____ **(Mulching)**
72. Nematodes, commonly called _____ are found in almost all soils.**(Roundworms)**
73. Among all the carbon products, _____ is by far the most abundant and most important for plants **(Carbon dioxide)**
74. Surface runoff water from heavily fertilized lands may contain levels _____ toxic to livestock. **(Nitrates)**
75. Inclusion of a close-growing forage crop in rotation with crops helps to control both _____ and runoff. **(Erosion)**
76. _____ are used to control runoff of the water. **(Bench terraces)**
77. The technique used by scientists to change the DNA of plants with the purpose of improving the production is known as: **(Genetic Engineering)**
78. _____ commonly carry significant quantities of inorganic and organic chemicals that can have harmful environmental effects. **(Sewage sludges)**
79. Acid rain (acid precipitation) water contains nitric and _____ acids**. (sulphuric)**
80. The planting of a desired crop among the native trees (plants) without their complete removal has been termed as _____ system: **(Mixed tree crop)**
81. Sowing time of Lentil (Masar) is: **2nd fortnight of October**
82. _____ occurs for the most part in regions of arid or semi-arid climate. **(saline soil)**
83. _____ methods of irrigation should be favoured, if salinity constitutes a serious problem. **(Flooding)**
84. When trees and crops are grown together on the same farm, it is known as: **Agroforestry**
85. _____ sector covers fruits, vegetables, root and tuber crops mushrooms, spices, flowers, aromatic plants, etc.: **(Horticulture)**
86. Drip or trickle method of irrigation is the most _____ of all the methods. **(efficient)**
87. Drainage in _____ is the process of removal of excess water from soil. **(agriculture)**
88. Sugar beets are very salt-tolerant during later growth stages, but are extremely sensitive during _____. **(germination)**
89. _____ is not merely growing crops, but it is more a form of applied ecology**. (Agriculture)**
90. Well drained volcanic soil are _____ than other types of soils. **(more fertile)**
91. Both runoff and soil erosion depend upon **: Steepness of a slope**
92. _____ is a better method of irrigation on sloping fields. **(Sprinkler irrigation)**
93. The potential crop-producing capability of a given area is mainly dependent on _____ and soil conditions. **(climatic)**
94. The ideal conditions for dew formation are calm weather_____ during the day, low temperature at night and greater amount of water vapour in the atmosphere. **(warm temperature)**
95. The average rainfall is equal to the _____ over a given period divided by the total number of hours/rainy days. **(total rainfall)**
96. Saline – alkali soils are formed as a result of the combine process of ____ and alkalization: **(Salinisation)**
97. The largest producer of milk in the world is : **India**
98. The green revolution in India started with which crop: **Wheat**
99. Atmospheric moisture is measured with the _____**. (hygrometer)**
100. The major pest of cotton is: **Bollworm**
101. The water requirement of wheat increases from 30% to 100% due to _____ infection. **(leaf rust)**
102. The term _____ refers to a deficiency of soil moisture, which produces water deficits in the plant, sufficient to cause a reduction in growth. **(drought)**
103. Wind speed is measures by the _____**. (anemometer)**
104. Of the world's sugar production, approximately 60 percent comes from _____ and 40 percent from sugar beet. **(sugarcane)**
105. _____ is the world's largest producer of sugar cane. **(Brazil)**

106. A rice plant can transport _____ from the leaves to the roots and thus lives in a normally aquatic environment. **(oxygen)**

107. _____ is planted in September and October and is harvested the following year in early summer. **(Winter wheat)**

108. _____ means direct or indirect changes (usually but not always brought about by man) in one or more components of the ecosystem which are harmful to the system or at least undesirable to humans. **(Pollution)**

109. Among the pesticides, _____ used to control mosquitoes and agri-pests has become the most serious pollutant of soil and water. **(DDT)**

110. The maximum permitted limit of chromium in _____**,** as recommended by the WHO, is 0.05 mg/litre. **(drinking water)**

111. Copper sulphate mixed with calcium carbonate is one of the commonest fungicides known as _____ **(bordeaux mixture)**

112. _____ is among the most dominant air pollutant of the present day industrialized world. **(Sulphate)**

113. Besides bacteria, viruses and fungi, a large variety of _____ are also found in polluted waters and cause disease among humans and animals. **(nematodes)**

114. Several gases naturally present in the atmosphere absorb radiating infra-red heat waves and reflect them back to the earth' surface causing (air) warming known as _____**. (greenhouse effect)**

115. _____ is considered as the natural sink for carbon monoxide pollution. **(Vegetation)**

116. The primary pathway of CO_2 entry in the plant body is through _____**. (stomata)**

117. Approximately _____ per cent of the earth's surface is covered by submerged soils or sediments. **(72)**

118. In Northern India, the damage from flooding is counteracted by increased soil fertility as a result of _____. **(deposition of silt)**

119. In a flooded soil, the _____ between the soil and air is drastically reduced. **(gas exchange)**

120. Which plant / tree grown in the non-forest areas has been excluded from the definition of tree: **(Bamboo)**

121. When an acidic soil in flooded, its pH increases whereas the opposite happens in _____**. (alkaline soils)**

122. Flooding _____ a soil's capacity to fix nitrogen biologically. **(increases)**

123. The most conspicuous chemical change that takes place when a soil is flooded is the reduction in _____. **(iron)**

124. Flooding increases the availability of _____ but decreases that of zinc and copper. **(phosphorus)**

125. Saline soils contains sufficient salts in the _____ to interfere with plant growth. **(root zone)**

126. Mostly, root growth and function are dependent on _____ respiration. **(aerobic)**

127. In soils flooded for long periods, _____ soil microorganism may produce toxins. **(anaerobic)**

128. Trees are injured much more by _____ water than by flowing water. **(standing)**

129. Which Act has been amended to exclude Bamboo from the definition of a tree: **(Indian Forest Act, 1927)**

130. Excessive nitrogen fertilization _____ the sugar content in sugar beet. **(reduces)**

131. Fertilization helps to offset soil conditions that _____ the movement of nutrient ions to roots. **(retard)**

132. The finer the texture of the soil, the less rapid will be the movement of _____. **(soil moisture)**

133. In _____**,** crop residues are allowed to remain on the soil surface rather than being worked into the soil. **(zero tillage)**

134. The physical nature of loose, coarse accumulations of _____ is also not ideal for rapid turnover of organic materials and release of nitrogen and sulphur. **(crop debris/residues)**

135. The term ferti-herbicide, ferti-insecticide and ferti-fungicide respectively refer to the fertilizers containing a herbicide, insecticide and a _____**. (fungicide)**

136. Lime is seldom needed in those areas where rainfall is low and _____ is minimal. **(leaching)**

137. _____ weeds need some stimuli from their host plants for germination. **(Parasitic)**

138. Sowing of seeds in furrows at a predetermined distance and depth in soil is called _____. **(drilling)**

139. Growing of two/more crops in alternate rows in the same field during the same period is known as . **(Inter-cropping)**

140. Classification of insects and rules of their nomenclature comes under the branch: **(Taxonomy)**

141. _____ refers to the seed or the propagating material directly controlled by the originating or sponsoring plant. **(Breeder's seed)**

142. A certified seed is the seed certified by the certification agency under Section 8 of the _____. **(Seed Act)**

143. The minimum genetic purity of certified seed should be : 99 per cent

144. The minimum genetic purity of foundation seed should be : as against 99.5 per cent

145. 'Indian Institute of Sugarcane Research' is located in : **(Lucknow)**

146. The saturation of soil with water, when the ground water level is to high is known as: **(Water logging)**

147. *Phalaris minor* is a: **weed**

148. Phalaris minor came to India with: **Imported wheat**

149. Long term agricultural credit is provided by : **Land development Bank**

150. Wind speed is measures by the: **Anemometer**

151. Soybean grows well in _____ and moist climate. **warm**

152. Central Dryland Research Institute is located in: **Jodhpur**

153. Punjab Selection, PUSA Red, and Arka Kalyan are the varieties of _____ onion. **Red**

154. Garlic is supposed to have originated from Central Asia and ____ regions: **Mediterranean**

155. 'Ganga 101' and 'Ranjit Deccan' are the varieties of: **Maize**

156. Ring budding is practiced with jujube and peach on _____ . **(Commercial lines)**
157. Which type of soil is found on the largest part in India: **(Alluvial soil)**
158. Art and knowledge of growing flowers is known as: **Floriculture**
159. The animal disease characterized by blisters in mouth udder, testis, toes and above hoofs is known as: **(Foot & Mouth Disease)**
160. Pasteurisation of milk process was firstly known by: **(Louis Pasteur)**
161. ____ is the mass slaughter of domestic poultry birds such as chickens and ducks to check the spread of bird flu: **Culling**
162. In carnation, rooted ____ have been found to give better results **(cuttings)**
163. Mostly, root, growth and function are dependent on _____ respiration: **(Aerobic)**
164. The northern slope of the Himalayas drain into Indus, Sutlej and Brahmaputra, while the southern slopes drain into the mighty _____ **(Ganga system)**
165. The Central AGMARK lab is located at: **(Nagpur)**
166. The large _____ plain between Himalayas in north arid peninsula plateau in south and extending through whole of India support a major part of country's population. **(Indo-Gangetic)**
167. _____ and its tributaries drain the heavy rainfall areas of the India lying in the eastern and north eastern regions **(Brahmaputra)**
168. Study of active physical events and analytic study of equipment of atmosphere, including forecasts of weather, is called: **(Meteorology)**
169. _____ is the temperature, on which, the amount of present water vapours in any volume of air, are enough to saturate of similar volume air: **(Dew Point)**
170. National Bank for Agricultural and Rural Development (NBARD) came into existence on: **(July 12, 1982, Head Office Mumbai)**
171. _____ is formed, when air masses of high moisture content close to the surface are cooled: **(Fog)**
172. Water infiltrates into soil and spreads laterally in ____ methods of irrigation. **(Furrow)**
173. When relative humidity in atmosphere is below 70% and dust particles are dried, it is called: **(Haze)**
174. When rain-drops fall on the ground, after having very old and converted into ice in the sky, is called as: **(Hail)**
175. _____ is the first hybrid cross between Wheat (Triticum aestivum) x Rye (Secale cereal): **(Triticale)**
176. Kallar soils are reclaimed by addition of: **Gypsum**
177. Vitamin A is abundantly found in _____ vegetables. **(Leafy)**
178. Making of pickle is a form of: **Food Processing**
179. Ganga, Kaveri and Yamuna are ____ of cabbage. **(hybrids)**
180. Central Rice Research institute is located at: **(Cuttack)**
181. Cucumber (kheera) is one of the oldest ___ vegetable crops having its origin probably in India. **(Cultivated)**
182. Carrot is an excellent source of vitamin ___ and is rich in sugar. **(A and iron)**
183. Main crop of potato in Hills of Himalayan region (India) is planted in ____. **(March-April)**
184. The method used by farmers to prepare soil for seed germination is known as: **(Tillage)**
185. Which breed of goat is called 'Milk queen' of goat world? **Saanen**
186. First Agriculture in India is: **G. B. Pant Nagar University**
187. Headquarters of ICAR – Indian Council of Agriculture Research situated at**: New Delhi**
188. Punjab Agriculture university was established in year: **1962**
189. Removal of access water from the field is known as: **Drainage**
190. Karan Swiss is a cross breed of Sahiwal cow with: **Swiss Bull (Developed by NDRI, Karnal)**
191. Most popular buffalo species of Punjab are: **Murrah and Nili Ravi**
192. Buffalo meat is known as: **Beef**
193. The meat of pig is known as: **Pork**
194. Haryana is dual purpose breed of: **Cow**
195. Indian Veterinary Institute is situated at: **Izzatnagar, Uttar Pradesh**
196. Which breed of goat is better for milk production: **Jamunapari**
197. The origin place of Holesien Friezen Cow: **Holland**
198. Which animal is known as poor mans cow: **Goat**
199. The total foodgrain production during the year 2019-20 was: **296.65 million tonnes**
200. Progressive Farming (ਚੰਗੀ ਖੇਤੀ) magazine is published by: **Punjab Agriculture University, Ludhiana**

CHAPTER – 14
MULTPLE CHOICE QUESTIONS

1) What is planting time of Poplar trees in Punjab?
a) March- April b) January – Febraury
c) October – November d) June – July

2) The major problem in the Kandi region is
a) soil erosion b) undulated area
c) both of these d) None of these

3) Which are the major rabi oilseed crop in Punjab?
a) Sunflower and Gobhi Sarson
b) Castor and Soyabeen
c) Niger and Linseed
d) Groundnut and Sesame

4) The largest producer of rice in India is
a) Punjab b) West Bengal
c) Uttar Pradesh d) Andhra Pradesh

5) The optimum time of nursery sowing of paddy is
a) Oct 1 – Oct 15 b) Nov 30 – Dec 10
c) June 1-15 d) May 15-30

6) The major grass weeds of paddy are:
a) Swank and mothas b) Ghrilla and Sanni
c) Cuscuta d) Chatri

7) Deforestation has an alarming affect on
a) Weed Control b) Soil Erosion
c) Pest Control d)None of these

8) Study of soil is known as
a) Pedology b) Paedology
c) Geology d) Morphology

9) What is the percentage of Nitrogen present in the air?
a) 79.2%% b) 69.2%
c) 89.2% d) 59.2%

10) The oxygen percentage in the soil air is
a) 0.03 b) 20.6
c) 79.0 d) 25.9

11) Central Soil Salinity Research Institute is located at
a) Jodhpur b) Karnal
c) Dehradun d) Hyderabad

12) Which of th following method is used to irrigate the fields by application of water as spray or rain?
a) Border Method b) Basin irrigation
c) Sprinkler irrigation d) Drip irrigation

13) Bet areas (Soil) are found in which areas of Punjab?
a) sub mountaneous areas
b) along the major rivers
c) south west of Punjab
d) North of Punjab

14) Which of the following areas of Punjab has the maximum rainfall?
a) Sub mountaneous areas
b) South West of Punjab
c) Central plains
d) None of these

15) Sowing of wheat is done in which period in Punjab
a) 4th week of October to 4th Week of Novmber
b) 1st week of Sept to 1st Week of October
c) 1st week of April to 1st Week of May
d) 4th week of July to 4th Week of August

16) HD 2967, PBW 621 are the improved varieties of
a) Maize b) Wheat
c) Paddy d) Barley

17) Durum wheat flour is used for
a) Bread Making b) Pizza Making
c) Pasta making d) Chapati making

18) PL 807, VJM 201, PL 426 are improved varities of
a) Gram b) Maize
c) Barley d) Paddy

19) Which of the following crop is used as a cereal and for extraction of oil?
a) Soybean b) Toria
c) Berseen d) Maize

20) Indian Veterinary Research Institute is situated as
a)Mathura b)Izzatnagar
c)Hisar d)Awikanagar

21) National Research centre on Camel is located at
a) Bikaner b) Bengaluru
c)Hydrabad d)Karnal

22) Any method used to turn fresh food into food product is known as
a) Food Processing b) Food Farming
c) Agro Industry d) None of these

23) Central Institute for Research on Buffaloes are situated at
a) Izzatnagar b) Hisar
c) Mathura d) Bhopal

24) International Livestock Research Institute is located is
a) Lima b) Nairobi
c)Manila d) Bogor

25) For how many days paddy field should remain flooded after transplanting?
a) 2 weeks b) 1 week
c) 1 month d) No flooding required

26) Which instrument is used for scheduling irrigation in paddy?
a) Hydrometer b) Anemometer
c) Tensionmeter d) Hygrometer

27) What is the effect of mulching?
a) Reduces nitrogen requirment of the plant
b) Results in reduction of evapo-transpiration
c) Reduces fertility of soils
d) It kills important micro organism in the soils

28) Which of the following crops can replace wheat as it requires lesser water?
a) Barley b) Maize
c) Sugarcane d) Mung

29) Which crops are used for fixation of atmospheric nitrogen into soil?
a) Paddy b) Pea
c) Wheat d) Mustard

30) Contour farming is practiced in
a) Hilly areas b) Plains
c) Deserts d) Bet Areas

31) Food Security Act was enacted in the year?
a) 2015 b) 2013
c) 2012 d) 2010

32) Cattle belong to the phylum
a) Chordata b) Molusca
c) Both a and b d) None of these

33) Buffalo meat is known as
a) Veal b) Pork
c) Buffen d) Beef

34) The highest number of buffaloes are found is
a) India b) Sri Lanka
c) Norway c) China

35) Origin of marino sheep is
a)Spain b)France
c)India d)China

36) Which is the largest producer of coffee in the world?
a) India b) Brazil
c) China d) Vietnam

37) Which one of the following is a Rabi Crop?
a) Gram b) Rice
c) Groundnut d) Cotton

38) Which of the following is not breed of buffalo?
a) Murrah b) Jafarabadi
c) Nagpuri d) Jersey

39) Which of the following is a breed of goat?
a) Kashmiri b) Gaddi
c) Jamnapari d) Chamba

40) Bhadawari breed of buffalo has its origin in
a) North East b)Gujarat
c) UP d)South India

41) Which animal is know as poormans cow?
a) Rabbit b) Sheep
c)Buffalo d) Goat

42) The breed of buffalo, which is considered best breed of world?
a)Mehrana b)Jafrabadi
c)Murrah d)None of these

43) Which breed of goat is called 'Milk queen' of goat world?
a)Saanen b)Alpine
c)Jamunapuri b)Togggenberg

44) Soil formation is
a) A slow process b) A fast process
c) A slow and continious process
d) An indigeneous process

45) Which one of the following describes a system of agriculture where a single crop is grown on a large area?
a) Shifting Agriculture b) Plantation agricuture
c) Horticulture d) Intensive Agriculture

46) A soil having ph 6.0 is called
a) Acidic Acid b)Alkaline Soil
c) Saline Soil d)Normal Soil

47) $CaCO_3$ (lime) is added to reclaim of
a)Alkaline Soil b) Acidic Soil
c)Saline Soil d) Laterite Soil

48) The vertical section of soil, which shows different layers, is called
a)Soil Horizon b) Soil Profile
c)Soil Pedone d)None of these

49) Soils with high ph are generally deficient in
a)Zn and Mn b)Cu and Mo
c)Zn and Fe d)Ca and Mg

50) The capacity of soil to be moulded when wet i.e.,to change shape in response to stress and to maintain that shape when the stress removed is termed
a)Consistence b) Cementation
c) Plasticity d) Stickness

ANSWER KEY

Q.	A.	Q.	A.	Q.	A.	Q.	A.	Q.	A.
1	B	2	C	3	A	4	B	5	D
6	A	7	B	8	A	9	A	10	B
11	B	12	C	13	B	14	A	15	A
16	B	17	C	18	C	19	A	20	B
21	A	22	A	23	B	24	B	25	A
26	C	27	B	28	A	29	B	30	A
31	B	32	A	33	D	34	A	35	A
36	B	37	A	38	D	39	C	40	C
41	D	42	C	43	A	44	C	45	B
46	A	47	B	48	A	49	D	50	C

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