



CROPS, CROPPING SYSTEM AND CROPESTABLISHMENT

In the previous lesson, we have discussed the basics of soil science. Every living organism on this planet needs food to stay alive and to continue all other essential life processes. Conventionally these foods are obtained from crop plants. Crop production practices are crucial for ensuring food security and efficient agricultural system. These practices encompass a range of activities involved in growing and managing crops. In this lesson, we will learn about some of these activities.



LEARNING OUTCOMES

After studying this chapter, the learner:

- classifies the crops growing in their surroundings following suitable criteria;
- develops integrated farming system plan for better farm productivity;
- recommends the crops for cultivation as per their specific soil and climatic requirement; and
- prepares the field scientifically for sowing and transplanting of crops.

6.1 WHAT ARE CROPPRODUCTION PRACTICES?

Let's discuss about the concept of crop production practices. Plants are the main source of food on which both humans and animals depend. These plants of known economic values when grown in community with specific purposes are called as crops. Since beginning of civilization, agriculture has been practised by people to meet the food requirement of family. It is considered as subsistence farming. On the other hand, commercialisation of agriculture started with the growing demand for food and advancement in agricultural science. It necessitated creation of crop production as a

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branch of agriculture to deal with the production and management of crops for food and fibre.

Crop production practices comprise a set of practices followed by farmers starting from selection of variety till harvest of crop. These practices are land preparation, sowing, transplanting, nutrient management, weed management, water management, pest management and harvesting. To ensure optimum crop productivity, cultivation practices need to be adopted as per the principles of crop production. Climate, soil and water available in the area have profound role in deciding production potential of a crop. To realise the yield potential of crops, the management practices can be manipulated to provide a favourable condition for growth of plants.

6.2 CLASSIFICATION OF CROPS

Crops have been classified based on various criteria for better understanding the crops vis-à-vis growing season, climate, soil and water, economic importance etc.

6.2.1 Based on Growing Seasons

Each crop has specific climatic requirement which must be met for growing the crop successfully. Air temperature, relative humidity and day length are important parameters which decide the crop performances.

- I. **Kharif Crops:** These crops are grown in monsoon season i.e. June-October/November which require warm, wet weather and short day length during their major growing period. In India, these crops are mostly cultivated utilizing rain water as source of irrigation. Example – rice, maize, jowar, bajra, greengram, blackgram, redgram, cotton etc.
- II. **Rabi Crops** are grown during winter months i.e. October/November to mid-April. Cold and dry weather with long day condition is required by these crops. Example – wheat, gram, mustard, lentil, field pea.
- III. **Zaid Crops:** Certain crops require warm and dry weather with long day condition which are prevalent during mid-April to mid-June are called *Zaid* crops or summer crops. For example, sunflower, greengram, summer rice, pumpkin, etc.

In some regions of the country, no such distinct seasons are there rather, particularly in areas where temperature fluctuations are not that wide. Under such areas, farmers have their own classification of seasons.

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6.2.2 Based on Use /Agronomic Classification

- A. Grain Crops:** These crops are the cultivated grasses grown for their edible starchy grains. Such large grained crops used as staple food are **cereals**, e.g. rice, wheat, maize, barley, whereas **millets** are the small grained cereals which are grown by farmers with minor importance as food crops. Millets are more nutritious than the staple food crops for which they are also called **nutri-cereals**. Under changing climatic situations, millets are considered as resilient crops and are suitable for rainfed and drier regions e.g. Finger millet, pearl millet, little millet, kodo millet etc.
- B. Pulse Crops:** Pulses are the legume crops whose seeds are used as food especially for making *dal* by splitting the seeds. Pulse crops being legumes have gained importance as they improve soil fertility. The grains are also rich in protein for which pulses are included as key food ingredient in Indian diet, e.g. green gram, blackgram, pigeon pea, chickpea, cowpea, etc.
- C. Oil Seeds Crops:** Those crops whose seeds are rich in fatty acids and are cultivated for production of vegetable oil. Those are suitable for human consumption, are edible oilseed crops, e.g. ground nut, mustard, sesame, soybean, sunflower, safflower. Other crops like linseed and castor are non-edible oilseeds which have industrial and medicinal values.
- D. Forage/ fodder Crops:** A group of crops whose vegetative parts, either fresh or preserved are used as animal feed. When fed to milch animals they increase milk yield and reduce the cost of feeding. Fodder crops are fed to animals in different forms such as hay, silage, green fodder, pasturage, e.g. Hybrid Napier grass, fodder maize, fodder sorghum, fodder bajra, guinea grass, berseem, cowpea, lucerne etc.
- E. Fibre Crops:** Crops which are grown for producing fibres as used in preparation of garments, bags, crafts and other useful items. Depending upon the plant parts from which fibre is obtained, there are different types of fibre crops, e.g. seed fibre (cotton), stem fibre (jute, mesta, sunhemp) and leaf fibre (agave, pineapple).
- F. Sugar Crops:** These crops are cultivated for production of sugar, e.g. sugarcane and sugar beet. Juice is extracted from sugarcane stems (called cane) used for jaggery or sugar production. By-products of sugar industry have economic uses e.g. molasses used for alcohol and yeast formation, bagasse for paper making and press mud used as soil amendment. In sugar beet, tubers are used for extraction of sugar.

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- G. Root Crops:** These are the crops where roots are the economic produce, e.g. sweet potato, sugar beet, carrot, turnip, etc.
- H. Spices and Condiments:** These crop plants or their products are used to add flavour, taste and/or color the prepared food items, e.g. ginger, garlic, chilli, cumin, onion, coriander, cardamom, pepper, turmeric etc.
- I. Vegetables Crops:** These are crops grown to harvest their fruits, roots or leaves afresh for human consumption. It forms an important component of vegetarian diet, e.g. brinjal, tomato, potato, okra, spinach, amaranthus, etc.
- J. Green Manure Crops:** These crops are grown only to increase fertility of soil, not for economic harvest. Green leaves or whole plant in vegetative stage is incorporated into the soil to add organic matter after decomposition, e.g. dhaincha, sunnhemp.



Fig. 6.1: Sesbania green manuring

- K. Medicinal Crops:** Plant parts of these crops are used in preparation of medicines, e.g. opium poppy, senna, tobacco, Japanese mint, and peppermint, etc.
- L. Beverages:** Crops are used for preparation of mild, agreeable and simulating drinks, e.g. tea, coffee, cocoa etc. These are also called as plantation crops.

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Table 6.1: Popular field crops cultivated in India

Crop	Family	Scientific name	Major growing states
Rice	Poaceae	<i>Oryza sativa</i>	West Bengal, Uttar Pradesh, Punjab
Wheat	Poaceae	<i>Triticum aestivum</i>	Uttar Pradesh, Madhya Pradesh, Punjab
Maize	Poaceae	<i>Zea mays</i>	Andhra Pradesh, Karnataka, Rajasthan
Barley	Poaceae	<i>Hordeum vulgare</i>	Uttar Pradesh, Rajasthan, Madhya Pradesh
Oat	Poaceae	<i>Avena sativa</i>	Uttar Pradesh, Madhya Pradesh, Haryana
Sorghum/ Jowar	Poaceae	<i>Sorghum bicolor</i>	Karnataka, Maharashtra, Andhra Pradesh
Pearl Millet/ Bajra	Poaceae	<i>Pennisetum glaucum</i>	Rajasthan, Maharashtra, Gujrat
Finger Millet/ Ragi	Poaceae	<i>Eleusine coracana</i>	Karnataka, Tamil Nadu, Uttarakhand
Sugarcane	Poaceae	<i>Saccharum</i> Spp.	Uttar Pradesh, Maharashtra, Karnataka
Chick Pea	Leguminoaceae	<i>Cicer arietinum</i>	Maharashtra, Madhya Pradesh, Rajasthan
Pigeon Pea	Leguminoaceae	<i>Cajanus cajan</i>	Maharashtra, Karnataka, Andhra Pradesh
Lentil	Leguminoaceae	<i>Lens culinaris</i>	Madhya Pradesh, Uttar Pradesh, Bihar
Green gram	Leguminoaceae	<i>Vigna radiata</i>	Maharashtra, Andhra Pradesh, Madhya Pradesh

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Crop	Family	Scientific name	Major growing states
Black gram	Leguminoaceae	<i>Vigna mungo</i>	Madhya Pradesh, Uttar Pradesh, Andhra Pradesh
Ground nut	Leguminoaceae	<i>Arachis hypogaea</i>	Gujarat, Andhra Pradesh, Tamil Nadu
Soybean	Leguminoaceae	<i>Glycine max</i>	Madhya Pradesh, Rajasthan, Andhra Pradesh
Mustard	Cruciferae	<i>Brassica</i> Spp.	Rajasthan, Uttar Pradesh, Haryana
Cotton	Malvaceae	<i>Gossypium</i> Spp.	Maharashtra, Gujarat, Telengana
Tobacco	Solanaceae	<i>Nicotiana tabacum</i>	Andhra Pradesh, Telengana, Gujarat
Jute	Malvaceae	<i>Corchorus capsularis</i> and <i>C. olitorius</i>	West Bengal, Assam, Bihar



INTEXT QUESTIONS 6.1

- How many types of crops are classified based on growing season?
- Rice is a season crop.
- Give any two examples of pulse crop.
- Which of the following is a green manure crop
 - Rice
 - Sugarcane
 - Dhaincha
 - Tobacco
- Millets are also known as.....

6.3 CROPPING SYSTEM AND FARMING SYSTEM

Imagine a farmer who is adopting farming practices. Is he practising a single enterprise or a combination of multiple enterprises? The choice of enterprises, whether crops or any other allied enterprises, depends upon the resources available, prevailing climate, market and skill of the farmer. Growing of crop(s) on the same available piece of land in a year are expressed by different terminologies such as cropping pattern, cropping sequence, cropping system etc.

Mono cropping the same land may be occupied by one crop during one year, or with two crops (**double cropping**) in a year in sequence (**sequential cropping** or **crop rotation**), or with more than two crops in a year (**multiple cropping**). In many parts of eastern India, rice is grown during *kharif* season and the land remains fallow during dry season due to lack of irrigation and social constraints. It is a typical example of rice mono cropping system. With available irrigation rice-pulses/oilseed cropping pattern is practised by farmer which is a double cropping pattern. Rice-wheat-green gram cropping system is an example of multiple cropping in which a short duration green gram crop is fitted utilising available time between harvest of wheat and sowing of rice. Above discussion implies that, **cropping pattern** is the sequence of crops and fallow adopted in a year and their spatial arrangement on a given piece of land. Spatial intensification happens through **intercropping** wherein two or more crops are grown together on same area following definite planting geometry, e.g. maize + cowpea, wheat + chickpea, pigeon pea + ground nut, and cotton + blackgram, etc.

Cropping system and cropping pattern are used interchangeably to denote different crops grown with reference to their temporal and spatial allocation on a same piece of land in a year. However, **cropping system** considers the interaction of the existing cropping pattern with other enterprises, farm resources and used technology which determines their makeup.

6.3.1 Intercropping System for Cropping Intensification

Intercropping system is advisable in rainfed areas of dry, humid and semi-arid tropics where two or more crops can be grown simultaneously on the same piece of land. It ensures efficient utilization of inter-row space and higher productivity. Under adverse climatic conditions it insures against total crop failure. The crop of primary importance is taken as main crop and other crops in the system are included as intercrops. For example, in maize + cowpea system maize is the main crop and cowpea is the intercrop.

Certain criteria are followed while selecting the intercrops which are:



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- i. Intercrop should mature earlier than the main crop, e.g. pigeon pea+ground nut.
- ii. Peak growing periods of both the crops should not coincide.
- iii. Intercultural requirements of both crops should be similar.
- iv. Crops should not be competitive rather complementary to each other both below and above ground.



Fig. 6.2: Intercropping of Coconut with Marigold

6.3.2 Relay Cropping for Intensification

Sowing of a second crop in a standing main crop just before its harvest so that there is overlapping of a part of life stages of each crop is called relay cropping or ***paira/utera cropping***. Relay cropping is the best way to utilise the left over residual soil moisture after a rainfed *kharif* crop. It is commonly followed in shallow low land and lowland rice ecology, e.g. rice-blackgram, rice-chickpea, rice-lathyrus, rice-linseed, rice-berseem and rice-lentil, etc. Vast rice fallow areas can be brought under cropping through promotion of relay cropping with right selection of crops and suitable varieties.



INTEXT QUESTIONS 6.2

1. When same land is occupied by more than two crop in a year, it is known as
 - a. Double cropping
 - b. Multiple cropping
 - c. Mono cropping
 - d. Sequential cropping

2. What is intercropping?
3. State two examples of *rabi* season based cropping systems.
4. Relay cropping is also known as *paira* cropping. (True/False)

6.3.3 Farming System

No single farm enterprise is likely to support the small and marginal farmers for generation of adequate income and gainful employment year round. Traditionally farmers take a combination of few enterprises, e.g. rice, dairy, poultry to meet the family needs. The scope for enhancement of income from crop production activities are limited, however, fishery, horticulture and animal husbandry sectors have tremendous potential. Government of India strategized to double the farmers' income within a short period of 6 years in which farming system approach had been emphasized. Looking at the predominance of small and marginal farmers with limited resources, Integrated Farming System (IFS) approach can enhance farm income in a viable and sustainable manner.

Integrated farming system (IFS) is a sustainable agricultural system that integrates livestock, crop production, fish, poultry, tree crops, plantation crops and other systems that benefit each other. It looks at the whole farm as a system and how different components work together to enhance ecosystem functions of the land at local and possibly landscape levels. It is based on the concept that 'there is no waste' and 'waste is only a misplaced resource' which means waste from one component becomes an input for another part of the system. The entire philosophy of farming system revolves around better utilization of time, money, resources and family labour. The farm family gets scope for gainful employment round the year.

Goals of Integrated Farming System

- Enhancing productivity per unit area
- Proper waste management through recycling
- Income generation round the year
- Employment generation and engagement of family labour
- Soil health management



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6.3.3.1 Components of Farming System

Integrated farming can have many variants comprising of components chosen according to available resources on the farm, soil and climate condition, scope of recycling of byproducts and profitability of the system. Major components of IFS are,

- A. **Agriculture:** Cereals, pulses, oilseeds, millets, fiber crops, sugar crops, fodder crops
- B. **Horticulture:** Vegetable crops, fruit crops, ornamental crops
- C. **Fishery:** Fish production, fingerling and yearling production, ornamental fish, prawn
- D. **Livestock:** Dairy, goatery, poultry, piggery, duckery etc.
- E. **Allied sectors:** Bee keeping, sericulture, mushroom production, vermin composting, azolla production, value additions etc.

Let us examine few complementary components and observe how resources are recycled among them in farming systems.

- **Fish-duck Integration:** Duck farming integrates well with fish farming wherein with a little additional investment ducks can enhance farmers' income. Ducks add manure in fish pond and act as aerator as required for growth of fishes. Pond surface water is utilized for free ranging of ducks who feed on aquatic weeds in pond.
- **Rice-mushroom- vermicompost:** Paddy straw which is otherwise underutilized can find its best value when used for mushroom production. After harvest of mushroom the spent substrates can be recycled for taking up vermicompost production. Vermicompost is well-known good quality compost for improving plant growth and soil health.
- **Fish-vegetable/fruits:** In high rainfall and lowland ecosystems fish production is a remunerative enterprise. Pond based farming system models in those areas incorporate vegetable and fruit crop as a complementary component which are grown on pond dykes.

**INTEXT QUESTIONS 6.3**

1. What is the full form of IFS?
2. To double farmer's income, Government of India emphasized..... approach.
3. What are the components of farming system?

**ACTIVITY 6.1**

Assume that you are a farmer in an area facing various challenges such as declining soil fertility, water scarcity, and fluctuating market prices for crops. Propose an Integrated Farming System plan for your farm. Also highlight how this system can contribute to improve farm productivity and improve your income.

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6.4 SOIL AND CLIMATIC REQUIREMENT

Can any crop be successfully grown anywhere? It is not possible because the local climate is the basis for crop growth and development. Crops are selected for the areas to which they are adapted. Climate of a place characterized by temperature, relative humidity, rainfall and day length has profound role in deciding potential productivity of any crop.

Type and nature of soil too decide the type of crops suitable for cultivation in an area. A particular soil is suitable for growing few crops, in other words, all crops are not suitable to grow in all types of soils. Physical characteristics of soil such as soil texture, structure, porosity and water holding capacity, chemical properties like soil reaction (acidity, salinity, alkalinity), soil organic matter, nutrient availability status, cation exchange capacity and biological properties viz. beneficial activities of soil microorganisms are important considerations for selection of crops. Crop management practices should aim at modifying the properties of soil to provide favourable condition for crop growth and realization of their potential yield.

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Table 6.2 Soil and climatic requirement of important field crops

Crop	Soil requirement	Climatic requirement
Rice	Rice is grown in all types of soil. Soils with high water holding capacity such as heavy soils (clay, clay loam and loamy) are suitable. Neutral soil pH is needed; however, it is grown normally with soil pH between 5 to 8.	Cultivated in varying climatic conditions. Warm and humid climate with temperature from 21 ⁰ C to 37 ⁰ C is desirable during crop growth stages. Rice is a short day plant which restricts its cultivation in <i>kharif</i> season but with development of photo insensitive varieties it is grown in <i>rabi</i> and summer seasons too.
Wheat	Well drained loam and clayey loam soils are best for wheat. <i>Durum</i> wheat requires heavy soils whereas <i>Aestivum</i> type can be grown in all types of soils.	Wheat has narrower adaptability than rice with respect to temperature and moisture variations. Cool and moist weather during vegetative growth period and warm-dry weather during grain formation are ideal conditions. Optimum temperature for wheat growth is 20-25 ⁰ C.
Maize	Deep, well drained and medium textured sandy loam to clayey loam soil with a high water holding capacity is suitable for maize. Optimum soil pH varies from 5.5 to 7.5. The crop cannot tolerate water logging condition.	Maize is a warm weather plant but can be grown under diverse conditions due to its wide adaptability. It is grown from sea level up to 3000 m above mean sea level. Optimum temperatures for germination and growth stages are 21 ⁰ C and 32 ⁰ C, respectively.
Sorghum	Grown over a variety of soils but the clayey loam soil is found to be the most ideal.	It can be successfully grown under temperature ranging between 15 ⁰ C to 40 ⁰ C. It is a drought tolerant crop and can perform well under dry land condition.

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Crop	Soil requirement	Climatic requirement
Pearl millet	Light textured soils with good drainage are the best soil for the crop. However, it is grown in a variety of soils, such as sandy loams (U.P, Punjab, Rajasthan), heavy clay, black soils (A.P, Tamil Nadu)	A warm weather crop which has wider adaptability to grow under different day length and temperature conditions.
Finger millet	Grown in plains and hill slopes	It is chiefly a <i>kharif</i> crop; however, it can be cultivated in some part of country round the year due to its photo and thermo-insensitivity.
Greengram	Grown in variety of soils, ranging from sandy loam to heavy loam. However, deep, well drained loam soils are ideal for crop growth.	Being tropical crop it cannot tolerate low temperature. It can be grown in <i>kharif</i> , spring and summer seasons. It can tolerate drought during <i>kharif</i> but cultivated with irrigation in spring and summer seasons.
Blackgram	Blackgram requires heavy soils, well drained with high water holding capacity. Deep loam soils free from salinity are ideal.	It is grown in <i>kharif</i> , <i>rabi</i> and summer seasons. It is drought tolerant for which it is preferred under rice fallow.
Redgram	Sandy loam to clayey loam soils is ideal, however, crop is grown in a wide variety of soils. Soil should be deep, well drained and neutral in soil reaction.	Needs warm, tropical and sub-tropical climate, fairly moist, bright sunny weather for fruit setting, susceptible to frost at flowering. Requires temperature ranging from 20°C to 40°C.
Gram / chickpea	It is grown in all types of soils, viz. light loam to heavy clay without salinity and sodicity. Also in soils with an efficient	A winter season crop in India, grows well in humid, arid and semi-arid conditions, cannot tolerate severe cold and frost.

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Crop	Soil requirement	Climatic requirement
	drainage and free from soluble salts.	Frost at flowering damages the crop and destroys the seeds inside pod. Optimum temperature for its growth ranges from 15 ⁰ C to 25 ⁰ C.
Groundnut	As pod development happens underground, it requires a light textured soil. The crop grows best on sandy loam and loamy soils. Heavy clayey soils are unsuitable for groundnut cultivation.	It is a tropical crop requiring warm growing season with bright sunshine. High rainfall, drought and cold weathers are detrimental for crop growth. Optimum temperature for growth is 21-26 ⁰ C.
Soybean	Best soil is sandy loam with good organic matter content with a normal soil pH of 7. It is grown on wide variety of soils including black cotton soil of M.P.	The crop needs warm and moist climate, grows well in a temperature range of 15-30 ⁰ C. It can be grown in <i>kharif</i> , spring and summer seasons. Cold temperature during fruit setting lowers the oil content in seeds.
Rapeseed and mustard	Rapeseed and mustard thrive best in medium to heavy loam soils with pH of 7, however, taramira prefers light textured soils. Waterlogging is harmful for these crops.	These crops need cool and dry weather with bright sunshine. Grown during winter in India requiring about 18-25 ⁰ C temperature, low humidity and with no rain particularly at flowering stage.
Sugarcane	Heavy soil and light textured soils with high water retention capacity, high organic matter content are suitable for this crop.	The crop performs its best in tropical region receiving rainfall of 750 to 1200 mm. It can also be grown in sub-tropical regions. Optimum temperature for bud sprouting is 21-25 ⁰ C and for tillering it is 30-35 ⁰ C.

**INTEXT QUESTIONS 6.4**

1. Which crop is ideal for cultivation in soil with high water holding capacity?
2. Wheat requires..... weather during vegetative growth and weather during grain formation stage.
3. Optimum temperature of germination of maize crop is.....
4. Which type of soil is ideal for pod development of ground nut?
5. is harmful for rapeseed and mustard.

*Notes***6.5 CROPESTABLISHMENT**

Land is the unit where farmers grow crops. The land must be prepared well to provide a good seed bed. In a cropped land the soil becomes hard at harvest of the crop. To take up sowing of subsequent crops, the soil must be loosened for which farmers plough the field.

A sequence of operations is followed while growing field crops that usually starting from land preparation to harvest of the crop. Two stages, land preparation followed by planting are known as crop establishment.



Loosening the soil, cleaning field and levelling are required conditions for a well prepared seed bed. Seed bed facilitates seed germination, root penetration, aeration to rhizosphere zone, ease of intercultural operations and proper distribution of water and applied nutrients in field leading to a good crop. It is ensured by tillage operations.

6.5.1 Tillage

Tillage refers to manual or mechanical manipulation of soil to provide an ideal medium for crop establishment and growth. The word tillage has originated from Anglo-Saxon words *tilian* and *teolian*, meaning ‘to plough, to cultivate soil to sow seeds and raise crops’.

More emphasis on tillage was given by **Jethro Tull** in England, who is considered as the Father of Tillage. He suggested that, ploughing is necessary to break soil in to fine

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soil particles as required for plant growth. In his book 'Horse Hoeing Husbandry', he introduced horse drawn tools and drills for undertaking sowing of seeds.

Purposes of Tillage

Tillage is carried out with several purposes, the major ones are

- (i) **Seed Bed Preparation:** Seed must make good contact with soil in order to absorb soil moisture for good germination. Extent of tillage required for seed bed depends up on the size of seeds. Small seeded crops need fine tillage and bold seeded ones require, coarse tillage. Raised beds, ridge and furrow, broad beds and other land shaping required for planting different crops are made through tillage only.

Tillage: Tillage refers to the physical condition of soil in relation to its friability, ease of tillage and suitability for planting while growing a crop. Soils with good tillage are described as being crumb-like, easy to slice and spongy nature brought by tillage.
- (ii) **Weed Control:** Unwanted plants are to be removed before sowing of crop and during growth stages through different types of tillage operation.
- (iii) **Improvement of Physical Condition of Soil:** Movement of farm vehicles, implements, humans and animals make the soil compact. Puddling operation carried out in rice crop creates impervious soil layer called hard pan which need to be broken by tillage. Root growth will be hampered by presence of hard pan in unploughed field.
- (iv) **Land Levelling:** A well levelled land can produce good crops as it ensures uniform crop stand, efficient use of water and nutrient, management of weeds etc. Tillage is required to level the land.
- (v) **Soil and Water Conservation:** High velocity run-off water causes soil erosion which can be slowed down by creating rough surface through tillage. When compact soil is ploughed it allows higher infiltration, storage of rain water and conserving it *in-situ* for future use.

6.5.2 Tillage Systems

Tillage systems describe the nature and sequence of tillage operations used in preparing a seed bed for planting. According to the degree of soil stirring, tillage is classified into two groups, conventional tillage and conservation tillage.

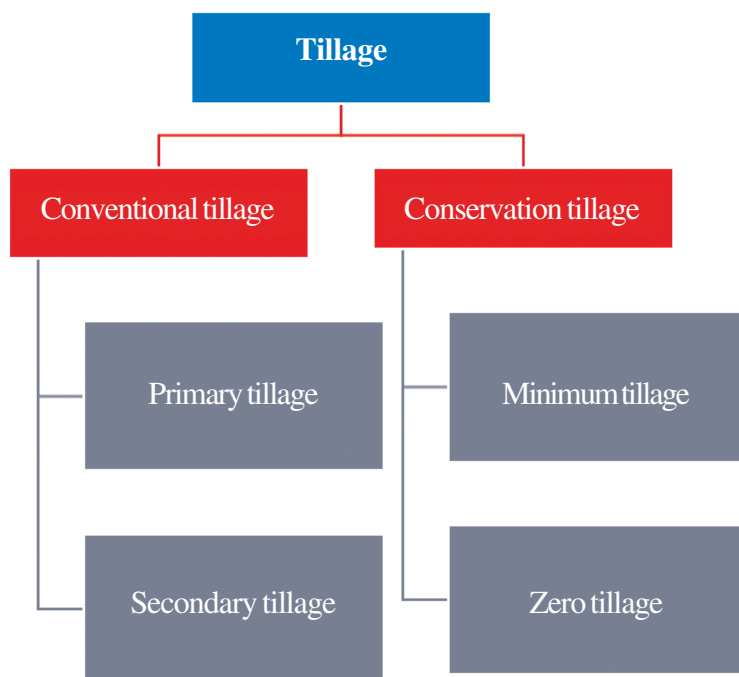


Fig. 6.3: Classification of tillage

Conventional Tillage

Conventionally farmers plough the entire field to the maximum extent using various kinds of implements. Conventional tillage is achieved by a sequence of operations starting from ploughing down the untilled compact soil until preparation of desired tilth. At each step, different tillage implements are used. Two types of conventional tillage operations as carried out are, primary tillage and secondary tillage.

1. Primary Tillage

It is the first tillage operation performed before cultivation of crops. Operations performed under this tillage system include breaking of compact top soil, inversion of soil and burying of weeds during the process. The term ploughing as commonly used refers to this primary tillage where soil is tilled to a depth of 15-30 cm.

Time of tillage is governed by soil moisture content and time of sowing of the crop. If the soil is too dry it requires more power to break the soil and large sized clods are formed. If land is ploughed under wet conditions, the soil sticks to plough, soil structure is damaged and clods on drying become very hard.

Crops with fibrous root systems (rice, wheat, maize) require shallow-deep tillage up to 15 cm depth and deep tillage up to 30cm is given to crops with tap root system (arhar, chickpea, brinjal). The deep tillage is recommended even in shallow rooted crops once in 3-4 years.

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Primary tillage implements are mouldboard plough, disc plough, chisel plough, country/ indigenous (desi) plough, and power rotary tiller, etc.

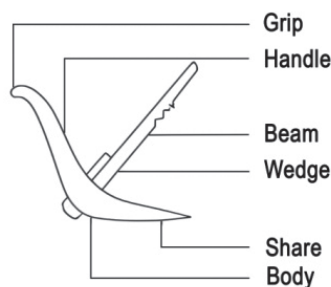


Fig. 6.4: Different types of plough a) country plough
b) mouldboard plough c) disc plough d) chisel plough

2. Secondary Tillage

Tillage operations which are carried out after primary tillage to produce finer tilth for seeding is secondary tillage. It is performed with various objectives such as reducing clod size, weed control, incorporation of fertilizers, puddling and leveling soil surface. Secondary tillage is done to a shallower depth, i.e. 5-15 cm. Normally 2-3 secondary tillage operations are done after primary tillage and before planting; but this depends on the size of clods, weed density, the need to incorporate fertilizer and the need for puddling.

Based on purpose, different tillage implements are used like cultivator, harrows, rotavator, levelers, puddler, and cage wheel etc.



Fig. 6.5: Rotavator



Fig. 6.6: Land leveller

Both animal and machine powers are employed to operate secondary tillage implements, however machine power is more commonly used in recent years.

6.5.3 Few crops specific special secondary tillage operations are carried out as briefed hereunder.

Tillage practices carried out in the field after planting of a crop are known as intercultural operations. Hoeing, earthing up and weeding are such operations performed in standing crops. These operations are done purposively for loosening the soil to provide well aerated environment to roots, controlling weeds present in crop and making ridges and furrows to facilitate irrigation. Besides, few more operations such as levelling and puddling are practised as special practices in crop production.

- a) **Levelling:** A field must be well levelled before planting a crop which is achieved by using a plank, leveller, ladder, scrapper, or laser land leveller, etc. The benefits of land levelling include, better nutrient use efficiency, better control of weeds, uniform distribution of water, uniform crop growth and higher yield.

Accuracy of levelling can be improved with use of laser land leveller. In India, this laser guided systems are being adopted by farmers in sizable area with 50% more levelling accuracy as compared to other methods.

- b) **Hoeing:** It is the practice of breaking the hard soil in standing crop field with the help of tools like hand hoe, wheel hoe, spade, cultivator, trench hoe, and garden rake, etc. Weeds are uprooted during hoeing and are either removed or incorporated there.

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- c) **Earthing up:** It is the practice of heaping up soil around the base of crop plants so as to make the plants stable against wind. In this process ridges are formed in crop rows and furrows in inter-row spaces. Earthing-up also facilitates irrigation in furrows and control of weeds.



Fig. 6.7: Earthing up in potato

- d) **Weeding:** It is another intercultural operation carried out manually or mechanically to make the crop weed free. In dry soils dryland power weeders can be effectively used for weeding and wetland power weeders used under wet conditions particularly for rice. Manual uprooting of weeds leads to ineffective weed control as aerial parts of weed plants are detached from roots which remain inside soil and regrow after a few days.
- e) **Puddling:** Puddling refers to the practice of ploughing of soil in standing water repeatedly till soft and muddy texture is obtained. It is an essential cultural practice in transplanted rice where seedlings are planted in soft puddled soil.



Fig. 6.8: Puddling of soil before rice transplanting in field



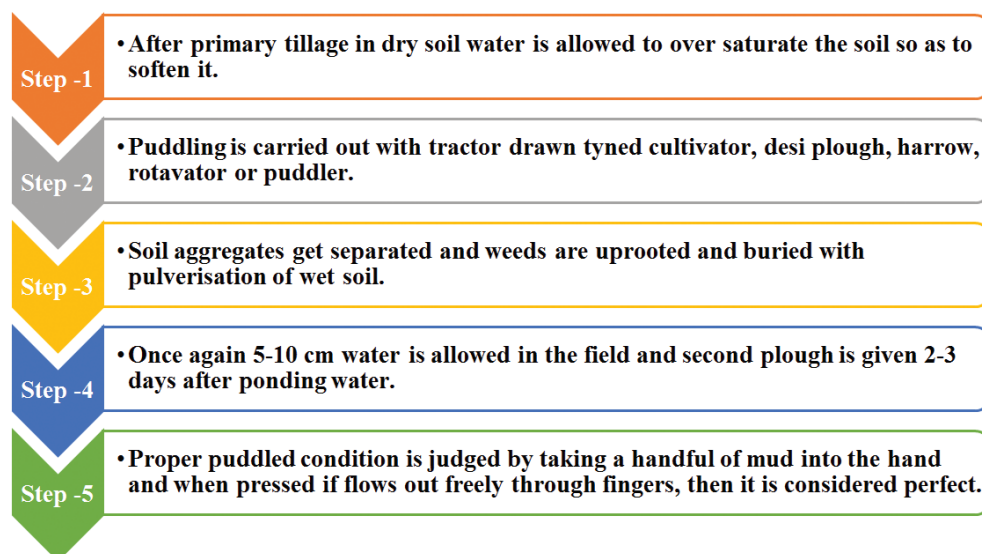
Rice is grown with standing water throughout its growth stages for which water needs to remain ponded in the field with little percolation. It is only possible with the creation of a layer that is impermeable to percolation of water to maximum extent. Puddling operation forms that impervious layer below the surface to reduce deep percolation losses of water.

It is a general feeling of farmers that, transplanted rice characterised by puddling operation produces better rice yield than that under unpuddled direct seeded method. Few advantages of puddling are

- ❖ creation of impervious soil layer which ensure standing water in rice field
- ❖ good control of weeds as incorporated and decomposed in puddling
- ❖ facilitates easy transplanting of seedling due to soft mudded condition

However, puddling deteriorates soil structure separating sand, silt and clay from their natural structural orientation. Soil becomes very hard after harvest of rice due to accumulation of clay particles on upper layer of soil upon puddling. It results in poor physical soil condition leading to low soil productivity.

Process of Puddling:



Generally depending upon the texture of soil, 2-3 puddling operations are carried out.

Conservation Tillage

It is well accepted that, natural structure of soil is damaged upon conventional tillage which deteriorates soil physical properties. Removal of crop residues and presence of loose soil very often cause losses of productive top soil through erosion. Generally

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minimum of 3-4 tillage operations are carried out in field which cause huge energy consumption and environmental pollution due to burning of fuel. All these reasons led to the development of concept of conservation tillage system comprising of minimum tillage, zero tillage, and stubble mulch tillage, etc. Conservation of soil, water, energy and soil biodiversity are the objectives of this system.

I. Minimum Tillage

Some times the number of tillage operations can be reduced without affecting soil environment for ensuring good germination of crops. Minimum tillage is also called reduced tillage. It comprises soil disturbances but to a lesser extent than that carried out under conventional tillage. Crop residues are allowed in the field for conserving soil and water.

II. Zero Tillage

Tillage operations are reduced extremely and limited only to the spot where the seed to be sown. Without tillage, weeds may become problematic which are controlled using non-selective herbicides prior to seeding. This tillage system conserves soil and water, saves fuel or energy and eventually becomes profitable.

**INTEXT QUESTIONS 6.5**

1. Mechanical manipulation of soil to provide a medium for crop growth is known as
2. Who is considered as Father of Tillage?
3. Which of the following are the primary tillage implements?

a. Mould Board Plough	b. Country Plough
c. Disc Plough	d. All of these
4. What is the main objective of doing secondary tillage?
5. Puddling is an useful practice in

a. Wheat	b. Green gram
c. Mustard	d. Rice

6. Which type of tillage is advocated to reduce the harmful effects of conventional tillage?

6.6 SEEDS AND VARIETIES

6.6.1 Seed

Seed is the primary or basic input in crop production. Use of good quality seed leads to higher production. Quality seeds should be clean (free from stones, soil particles, weed seed), pure (true to the type seeds, without presence of seeds of other distinguishable varieties), healthy (free from pest and disease), dry (moisture content, 10-12%) with good germination percentage.

6.6.2 Type of Seeds

Based on sources of seed production and producer, the seeds are classified into five groups. All good quality seeds meeting the minimum seed standards are labeled with proper information tags.

1. **Nucleus seed** is the original seed produced by the developer.
2. **Breeder seeds** are produced under the supervision of the breeder.
3. **Foundation seeds** are the progeny of breeder seeds that maintains highest standard of genetic identity and purity and produced under direct supervision of technical persons. It has white colour tag.
4. **Certified seeds** are the progeny of foundation or breeder seeds that produced by research institutes, departments or farmers following specific standards in large quantities for distribution to the farmers. The certified seed has a blue color tag. The genetic purity decreases gradually from nucleus seed to certified seeds. The certified seed must be obtained from certified growers, sellers, states departments, state agricultural universities and research institutes.

6.6.3 Variety

A variety is a uniform population of a particular plant species with some special characteristics. Cultivated varieties in short are called as cultivars. Different varieties of a same crop differ in production potentials and in other characteristics too. Selection of suitable variety of the chosen crop is the most important factor deciding crop productivity and profitability.



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6.7 SOWING AND TRANSPLANTING

Crops are established in field through sowing or transplanting. Most of the field crops are directly sown in fields where as in few crops like rice, tomato, brinjal, transplanting is a common method of establishment. However, for raising a healthy seedling, the seeds need to be treated properly before sowing.

6.7.1 Sowing

Sowing is the practice of placing seeds in soil for germination and establishment of a good crop stand. Crop stand in field depends upon a number of planting variables such as seed rate, time of sowing, depth of sowing and method of sowing.

- **Seed rate:** Seed rate is defined as the quantity of seed required per unit land area for optimal crop stand and economically optimal yield. Seed rate for a particular crop determines the final plant population in the field. Higher seed rate increases the competition between crop plants while low seed rate reduces the plant population and hence the crop yield. An optimal seed rate should be used for higher crop production. It changes with test weight, plant spacing, purity and germination percentage of the seed. It is expressed in kg/ha or g/ha depending upon the quantity of seeds.
- **Time of sowing:** Time of sowing influences the productivity of crop to a great extent. Prevalence of suitable temperature and soil condition favourable for seed germination and subsequent crop growth decide the optimum time of sowing. Therefore, season wise optimal time of sowing for different regions of the country has been identified. Timely sowing enhances crop productivity, whereas delayed sowing normally reduces it. Under rainfed conditions, availability of soil moisture is an important consideration. The optimal time of sowing for most of the *kharif* crops is June and July while for *rabi* or winter crops October and November and for summer crops it is March- April.
- **Depth of sowing:** The optimal depth of sowing depends upon seed size, reserve food material in seed, coleoptile length and moisture availability. Generally optimal depth of sowing for most of the field crops is 3 - 4 cm. The crops with larger seed sizes and reserves like maize, groundnut and castor can be sown at a greater depth of 6 cm. However, smaller sized seeds of pearl millet, sesame and mustard can be sown at 2-3 cm and for even very small seeds like tobacco the optimal depth of sowing is 1 cm.

- **Method of sowing:** Seeds are sown directly in main field or in nursery bed for raising seedlings. Direct seeding in main field can be done in three methods i.e. broadcasting, dibbling and drilling. Direct seeding can be practiced both in dry and wet conditions but dry seeding is sometime more acceptable in mechanized seeding.
 - ❖ **Broadcasting:** In this method seeds are spread over the soil by hand or mechanically by using seed broadcasters. Seeds are then covered with soil by a light plough or planking. It is the cheapest method of sowing. However, spacing and uniformity maintenance is difficult leading to poor plant population and limited scope for mechanical intercultural operation.
 - ❖ **Dibbling:** In this method, a seed or few seeds are placed in each holes by a dibble or hand at a particular spacing and thereafter covered with soil. It is more time consuming and laborious but provides uniform germination with lower seed rate compared to broadcasting.
 - ❖ **Drilling:** In this method crops are sown in lines using seed drills at a requisite spacing. It helps in sowing at uniform depth leading to even crop stand. It also reduces seed rate and provides scope for fertilizer placement along with sowing and intercultural operation.

*Notes*

6.7.2 Transplanting

Transplanting is the removal of an actively growing seedling from one place and planting again in main field for further growth and crop production. In this method the young seedlings are raised with proper care by sowing seeds in a small area called **nursery**. Transplanting is a common practice in rice, tobacco and some vegetable crops. It is also recommended for other crops like finger millet, pearl millet, mustard etc. which are conventionally grown by direct seeding.

Majority of rice fields in India are transplanted and that too manually. Alternative to manual transplanting, mechanized transplanting using a paddy transplanter is recommended because of higher efficiency and labor-saving compared to manual transplanting. It requires only 1 person day to transplant 1 ha of land as compared to manual method that utilizes 20-25 person days. Seedling nurseries usually use 5"10% of the total transplanting area. About 40 kg of seeds is sown in nursery to transplant 1 ha of main field for manual transplanting. 20-25 days old seedlings are uprooted and transplanted. In mechanical transplanting a special type nursery called mat nursery is prepared which uses 18-25 kg seeds to transplant 1ha field.

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Fig. 6.9: Transplanting of rice in puddled field



Fig. 6.10: Rice nursery by wet method



Fig. 6.11: Paddy transplanter for mechanical transplanting



INTEXT QUESTIONS 6.6

1. What are the parts of a good viable seed?
2. How many types of seeds are there based on production source?
3. Foundation seed has tag colour of
 - a. Blue
 - b. Green
 - c. White
 - d. Orange
4. State whether true or false.
 - a. Hybrids yield less than other type of varieties.
 - b. Registered seeds are the progeny of the foundation seeds.
 - c. Seed is an immature ovule.
5. Method of sowing where seeds are spread over the soil by hand
 - a. Broadcasting
 - b. Drilling
 - c. Transplanting
 - d. Dibbling



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Notes**ACTIVITY 6.2**

Visit a local agriculture shop selling seeds of different crops/Beej Bhandar. Check the packets/bags of seed. Identify the type of seed being sold in the market. Alternatively, you can also interact with the local farmer to know about the nature of seeds used by them.

**ACTIVITY 6.3**

Collect some seeds of any crop. Divide them into two parts. Place one part of these seeds in your garden through line sowing method and other part through broadcasting method. Take proper care for their germination and growth. Record your observations regarding plant growth pattern in both the type of sowing.

**ACTIVITY 6.4**

Visit to your nearby farm and ask the farmers about the crop that they are growing. Group them according to their growing season and usage and prepare a chart. (Consult the section ‘Classification of the crops’ for this purpose)

**WHAT YOU HAVE LEARNT**

- Field crops are classified according to various criteria. On the basis of the growing season, crops are classified into kharif (monsoon), rabi (winter) and zaid (summer) crops. Further, such crops are classified into grain, pulse, oilseed, forage, fibre, sugar, spices, medicinal and green manure crops based on usage.
- A same piece of land may be occupied by one crop (mono cropping), two crops (double cropping) or more than two crops (multiple cropping) in a year. At a particular time in a year, a land may be occupied by more than one crop following a definite plant geometry that is called intercropping.
- Physical, chemical and biological properties of soil can vary from region to region. One of the main drivers for this variation is local climate. Such a unique combination of climate and soil are specific to the crops. Therefore, it is not advisable to cultivate any crop without considering their specific soil and climatic requirements.
- Mechanical manipulation of soil to provide an ideal medium for crop establishment and growth is called tillage. It improves physical condition of soil, controls weeds, and provides good contact between seed and soil.

**TERMINAL QUESTIONS**

1. Enlist and briefly describe about various types of agronomic crops along with suitable examples.
2. What are the criteria to be followed during selection of suitable intercrops?
3. Discuss the benefits of Integrated Farming System (IFS) model in improving farmers income.
4. Describe soil and climatic requirement of rice, wheat, chick pea and sugarcane.
5. Why tillage is carried out before raising any crop?
6. Differentiate between conventional and conservation tillage.
7. What do you mean by intercultural operations?

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ANSWERS TO INTEXT QUESTIONS

6.1

1. 3 types (Kharif, rabi and zaid crops)
2. Kharif season
3. Green gram/ black gram/ pigeon pea/ chickpea/ cowpea
4. Dhaincha (Option c)
5. Nutria cereals

6.2

1. Multiple cropping (Option b)
2. It is a system of cropping where two or more crops are grown together on same area following definite planting geometry.
3. Wheat based/ chick pea-based/ rabi sorghum-based cropping systems
4. True

6.3

1. Integrated Farming system
2. Farming system approach
3. Agriculture, horticulture, fishery, livestock and allied sectors

6.4

1. Rice/sugarcane
2. Cool-moist and warm-dry weather
3. 21°C
4. Light textured soil
5. Waterlogging



6.5

1. Tillage
2. Jethro Tull
3. All of these (Option d)
4. To provide fine tilth for seeding
5. Rice (Option d)
6. Conservational tillage

GLOSSARY

Hoeing: Hoeing is the practice of breaking the hard soil in standing crop field with the help of tools like hand hoe, wheel hoe, spade, cultivator, trench hoe, and garden rake, etc.

Integrated farming system (IFS): It is a sustainable agricultural system that integrates livestock, crop production, fish, poultry, tree crops, plantation crops and other systems that benefit each other.

Intercultural operations: Practices carried which are out in the field after planting of a crop are known as intercultural operations.

Puddling: It refers to the practice of ploughing the soil in standing water repeatedly till soft and muddy texture is obtained.

Tillage: Tillage refers to manual or mechanical manipulation of soil to provide an ideal medium for crop establishment and growth.

SUGGESTED READINGS

1. Reddy, T. Y. and Reddy, G. H. S. (2016). *Principles of Agronomy*, Kalyani Publishers, Ludhiana.
2. Reddy, S. R. (2018). *Principles of Agronomy*, Kalyani Publishers, Ludhiana.
3. *Principles of Agronomy & Agricultural Meteorology*, B.Sc. (Agriculture), e-KrishiShiksha, Agricultural Education Division, Indian Council of Agricultural Research, New Delhi (<https://ecourses.icar.gov.in/>).

WHAT YOU HAVE LEARNT

