Introduction to Agriculture

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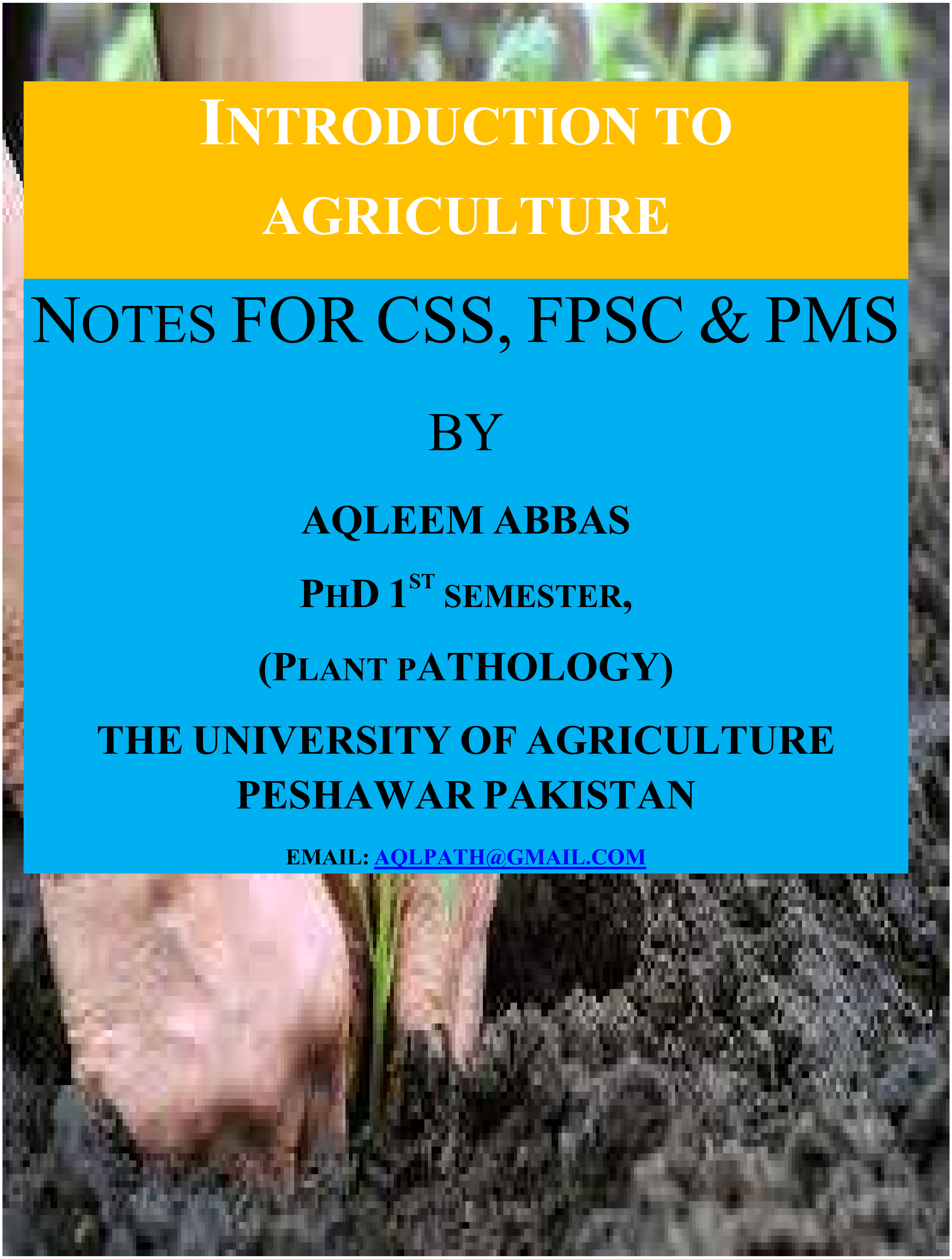

INTRODUCTION TO AGRICULTURE

NOTES FOR CSS, FPSC & PMS

BY

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INTRODUCTION TO AGRICULTURE

The word agriculture is derived from the Latin word ager…………its mean soil and cultural means cultivation. Simply we can say cultivation of soil

Technical definition

It is the science in art of farming including the work of cultivating the soil, producing the crops and raising livestock.

It has two main branches 1. Crops 2. Animals

CROPS

1. Forestry
2. Crops

Animals

1. Fisheries
2. Livestock

Components of agriculture

It has four components

1. Crops 54 %
2. Livestock 41 %
3. Fisheries 4.5 %
4. Forestry .5 %

IMPORTANCE OF AGRICULTURE

1. **Supply or provide us food and fiber**
2. **Contributes about 25 % in GDP**
3. **Agriculture provides raw materials to industries.**
4. **Agriculture provides 80 % in foreign exchange.**
5. **45 % labor force in Pakistan are engaged in agriculture**
6. **It is backbone of our country.**

AGRONOMY

It is derived from Greek word agro—field Nomo's –manage—so development and management of crop and soil sciences to produce abundant high quality food and fibers in a protected environment. Students who study agronomy are called agronomist.

Causes of low yield in Pakistan

Maize is 70 % less than America and Canada.

Our yield is low because low soil fertility. Our soil is 60 percent deficient in nutrients.

Low yielding varieties.

Poor agronomic practices

Farmers are illiterate

Application of water, harvesting of crops, attacks of insects, diseases, weeds

Non availability of seed.

Non availability of chemicals

Un availability of inputs

Low income

Water logging, salinity

Small land holdings

Lack of agro based industry.

Lack of storage, transport facilities and next one is weak govt policy.

Natural disaster, drought and

In case of KPK rains has not occurred in time

FACTORS RESPONSIBLE FOR INCREASING YIELD

1. **Use of high yielding variety**
2. **Proper tillage practices**
3. **Prepare seed bed properly**
4. **Balance fertilizers**
5. **Proper irrigation**
6. **Control of pest and diseases, weeds.**
7. **Proper time sowing**
8. **Time of harvesting.**
9. **Proper seed rate**
10. **Crop rotation-growing of crops one after the other in regular sequence in order to keep in view that fertility of soil may not disturb.**
11. **Multiple cropping system**

Our lands are so small because of small holdings and because of population we in Pakistan grow more crops in one year. America grow only one crop in a year called mono cropping

MODERN AGRICULTURE

Modern agriculture depends heavily on engineering **and technology and on the biological and physical sciences**. **Irrigation, drainage, conservation, and sanitary engineering**—each of which is important in successful farming—are some of the fields requiring the specialized knowledge of agricultural engineers. Agricultural chemistry deals with other **vital farming concerns, such as the application of fertilizer, insecticides (*see* Pest Control), and fungicides, soil makeup, analysis of agricultural products, and nutritional needs of farm animals.** Plant breeding and genetics **contribute immeasurably to farm productivity. Genetics has also made a science of livestock breeding. Hydroponics, a method of soilless gardening in which plants are grown in chemical nutrient solutions, may help meet the need for greater food production as the world's population increases.** The **packing, processing, and marketing of agricultural products** are closely related activities also influenced by science**. Methods of quick-freezing and dehydration** have increased the markets for farm products.

Mechanization, the outstanding characteristic of late 19th- and 20th-century agriculture, has eased much of the backbreaking toil(involving enormous physical effort) of the farmer. More significantly, mechanization has enormously increased farm **efficiency (desired result without using much effort) and productivity** (*rate of production*). Animals including horses, oxen, llamas, alpacas, and dogs, however, are still used to cultivate fields, harvest crops, and transport farm products to markets in many parts of the world. Airplanes and helicopters are employed in agriculture for **seeding**, **spraying operations for insect and disease control, transporting perishable products**, and **fighting forest fires**. Increasingly satellites are being used to **monitor crop yields**. Radio and television **disseminate vital weather reports and other information such as market reports that concern farmers**. Computers have become an essential tool for farm management.

WORLD AGRICULTURE

Over the 10,000 years since agriculture began to be developed, peoples everywhere have discovered the **food value of wild plants and animals, and domesticated and bred the**m. The most important crops are **cereals** such as wheat, rice, barley, corn, and rye; **sugarcane and sugar beets**; **meat animals s**uch as sheep, cattle, goats, and pigs or swine**; poultry such** as chickens, ducks, and turkeys; **animal products such** as milk, cheese, and eggs; and nuts and oils. **Fruits, vegetables, and olives are also major foods for people. Feed grains** for animals include soybeans, field corn, and sorghum. Agricultural income is also derived from **nonfood crops such as rubber, fiber plants, tobacco, and oil seeds used in synthetic chemical compounds, as well as animals raised for pelts(animal skin).** Conditions that determine what is raised in an area include **climate, water supply and waterworks, terrain**, and **ecology.** In **2003, 44 percent of the world's labor force was employed in agriculture**. The distribution ranged from **66 percent of the economically active population in sub-Saharan Africa (mali,Ethiopia,Zimbabwe etc)** to less than **3 percent in the United States and Canada**. In Asia and the Pacific the figure was **60 percent**; in Latin America and **the Caribbean, 19 percent**; and in **Europe, 9 percent.** Farm size varies widely from region to region. In the early **2000s the average for Canadian farms was about 273 hectares (about 675 acres) per farm**; **for farms in the United States, 180 hectares (440 acres).** By contrast, **the average size of a single land holding in India was 2 hectares (about 5 acres).** Size also **depends on the purpose of the farm**. **Commercial farming, or production for cash**, usually takes **place on large holdings**. The ***latifundia* of Latin America are large, privately owned estates worked by tenant labor. Single-crop plantations produce tea, rubber, and cocoa. Wheat farms are most efficient when they comprise thousands of hectares and can be worked by teams of people and machines. Australian sheep stations and other livestock farms must be large to provide grazing for thousands of animals. Individual subsistence(condition of managing to stay alive) farms or small-family mixed-farm operations are decreasing in number in developed countries but are still numerous in the developing countries of Africa and Asia. Nomadic herders range over large areas in sub-Saharan Africa, Afghanistan, and Lapland (region largely within the arctic circle, extending across the northern parts of Norway,Sweden, finland and the Kola peninsula of Russia.) ; and herding is a major part of agriculture in such areas as Mongolia.**

Much of the foreign exchange earned by a country may be derived from a single agricultural commodity; for example, **Sri Lanka depends on tea**, **Denmark specializes in dairy products**, **Australia in wool, and New Zealand and Argentina in meat products**. In **the United States, wheat, corn, and soybeans have become major foreign exchange commodities in recent decades**.

The importance of an **individual country as an exporter of agricultural products** depends on many variables. Among them is the **possibility that the country is too little developed industrially to produce manufactured goods in sufficient quantity or technical sophistication (advance technical development).** Such agricultural exporters include **Ghana, with cocoa**, and **Myanmar (formerly Burma), with rice**. However, a developed country may produce **surpluses that are not needed by its own population; this is the case with the United States, Canada, and some other countries.** Because nations depend on agriculture not only for **food** but for **national income and raw materials for industry as well**, **trade** in agriculture is a constant international concern. It is regulated by the **World Trade Organization.** The Food and Agriculture Organization of the United Nations (FAO) (to eliminate hunger on world scale main headquarter is Rome, Italy) directs much attention to agricultural trade and policies. According to the FAO, world agricultural production, stimulated by improving technology, grew steadily from the 1960s to the 1990s. Per capita food production saw sustained growth in Latin America, the Caribbean, Asia, and the Pacific areas (surrounding pacific ocean), and limited growth in the Near East (middle east) and North Africa. The only region not to experience **growth during the 1980s and 1990s was sub-Saharan Africa, which suffered from climatic conditions that made agriculture difficult**. Although agricultural growth began to taper off in the year 2000, it continued to outpace world population growth.

HISTORY OF AGRICULTURE

The history of agriculture may be divided into **five broad periods of unequal length**, differing widely in date according to region:

1. **Prehistoric,**
2. **Historic through the Roman period,**
3. **Feudal,**
4. **Scientific**
5. **Industrial.**

A countertrend to industrial agriculture, known as **sustainable (exploiting natural resources without destroying ecological balance of an area), agriculture or organic farming**, may represent yet another period in agricultural history.

PREHISTORIC

Early farmers were, archaeologists agree, **largely of Neolithic culture (latest period of stone age, between about 8000BC and 5000 BC,characterized by the development of settled agriculture and use of polished stone tools and weapon**) Sites occupied by such people are located in **southwestern Asia** in what are now Iran, Iraq, Israel, Jordan, Syria, and Turkey ; in **southeastern Asia**, in what is now Thailand; **in Africa, along the Nile River in Egypt**; and **in Europe, along the Danube River and in Macedonia, Thrace, and Thessaly (historic regions of southeastern Europe).** Early **centers of agriculture** have also been identified in the **Huang He (Yellow River) area of China**; the **Indus River valley of India and Pakistan**; and the **Tehuacán Valley of Mexico**, **northwest of the Isthmus of Tehuantepe**c. The dates of domesticated plants and animals vary with the regions, but most predate the **6th millennium BC, and the earliest may date from 10,000 BC.** Scientists have carried out **carbon-14 testing of animal and plant remains and have dated finds of domesticated sheep at 9000 BC in northern Iraq; cattle in the 6th millennium BC in northeastern Iran; goats at 8000 BC in central Iran**; **pigs at 8000 BC in Thailand** and **7000 BC in Thessaly**; **onagers, or asses, at 7000 BC in Iraq**; and **horses around 4000 BC in central Asia.** The **llama and alpaca were domesticated in the Andean regions of South America by the middle of the 3rd millennium BC.**

According to carbon dating, **wheat and barley were domesticated in the Middle East in the 8th millennium BC; millet and rice in China and Southeast Asia by 5500 BC**; and **squash in Mexico about 8000 BC.** Legumes found in Thessaly and Macedonia are dated as early as 6000 BC. **Flax was grown and apparently woven into textiles early in the Neolithic Period.**

The transition from hunting and food gathering to dependence on food production was gradual, and in a few isolated parts of the world this transition has not yet been accomplished. **Crops and domestic meat supplies were augmented by fish and wildfowl as well as by the meat of wild animals**. The farmer began, most probably, by **noting which of the wild plants were edible or otherwise useful and learned to save the seed and to replant it in cleared land**. **Lengthy cultivation of the most prolific and hardiest plants yielded stable strains. Herds of goats and sheep were assembled from captured young wild animals, and those with the most useful traits—such as small horns and high milk production—were bred**. The **wild aurochs was the ancestor of European cattle,** and **an Asian wild ox of the zebu, was the ancestor of the humped cattle of Asia. Cats, dogs, and chickens were also domesticated very early**.

Neolithic farmers lived in simple dwellings—**caves and small houses of sun baked mud brick or reed and wood.** These homes were grouped into **small villages or existed as single farmsteads surrounded by fields, sheltering animals and humans in adjacent or joined buildings**. In the Neolithic Period**, the growth of cities such as Jericho (founded about 9000 BC) was stimulated by the production of surplus crops.**

Pastoralism (individual country living) may have been a later development. Evidence indicates that **mixed farming**, combining cultivation of crops and stock rising, was the most common Neolithic pattern. Nomadic herders, however, roamed (wander aimlessly) the steppes (tree less plains covered by grasses} of Europe and Asia, where the horse and camel were domesticated.

The earliest tools of the farmer were made **of wood and stone**. They included the stone adz, an **ax like tool with blades** at right angles to the handle, used for woodworking; the **sickle or reaping knife with sharpened stone blades,** used to gather grain; the **digging stick**, used to plant seeds and, with later adaptations, as **a spade or hoe**; **and a rudimentary plow**, **a modified tree branch used to scratch the surface of the soil and prepare it for planting**. The plow was later adapted for pulling by oxen.

The **hilly areas of southwestern Asia and the forests of Europe had enough rain to sustain agriculture, but Egypt depended on the annual floods of the Nile River to replenish soil moisture and fertility**. The inhabitants of the Fertile Crescent **around the Tigris and Euphrates rivers in the Middle East also depended on annual floods to supply irrigation water**. Drainage was necessary to prevent the erosion of land from the hillsides through which the rivers flowed. The farmers who lived in the area near the **Huang He developed a system of irrigation and drainage to control the damage caused to their fields in the flood plain of the meandering river.**

Although Neolithic settlements were more permanent than **the camps of hunting peoples, villages had to be moved periodically in some areas when the fields lost their fertility from continuous cropping**. This was most necessary in northern Europe, where fields were produced by the slash-and-burn method of clearing. Settlements along the Nile River, however, were more permanent, because the river deposited fertile silt annually.

HISTORICAL AGRICULTURE THROUGH THE ROMAN PERIOD

With the close of the Neolithic period and **the introduction of metals**, **the age of innovation in agriculture was largely over.** The historical period—**known through written and pictured materials, including the Bible;** Middle **Eastern records and**

monuments; and Chinese, Greek, and Roman writings—was highlighted by agricultural improvements. A few high points must serve to outline the development of worldwide agriculture in this era, roughly defined as **2500 BC to AD 500**. For a similar period of development in Central and South America, somewhat later in date Some plants became newly prominent. **Grapes and wine were mentioned in Egyptian records about** 2900 BC, and **trade in olive oil and wine was widespread in the Mediterranean area by the 1st millennium BC. Rye and oats were cultivated in northern Europe about 1000 BC.**

Many vegetables and **fruits, including onions, melons, and cucumbers, were grown by the 3rd millennium BC in Ur (now Iraq). <u>Dates and figs were an important source of sugar in the Middle East, and apples, pomegranates, peaches, and mulberries were grown in the Mediterranean area.</u> Cotton was grown and spun in India about 2000 BC, and linen and silk were used extensively in 2nd-millennium BC China. F**elt was made from the wool of sheep in Central Asia and the Russian steppes. The horse, **<u>introduced to Egypt about 1600 BC, was already domesticated in Mesopotamia and Asia Minor. The ox-drawn four-wheeled cart for farm work and two-wheeled chariots drawn by horses were familiar in northern India in the 2nd millennium BC.</u>** Improvements in tools and implements were particularly important. **Tools of bronze and iron were longer lasting and more efficient, and cultivation was greatly improved by such aids as the ox-drawn plow fitted with an iron-tipped point, noted in the 10th century BC in Palestine**. In **Mesopotamia in the 3rd millennium BC a funnel-like device was attached to the plow to aid in seeding, and other early forms of seed drills were used in China**. Farmers in China further improved efficiency with the invention of a **cast-iron moldbar plow**. Threshing was also done with animal power in Palestine and Mesopotamia, although reaping, binding, and winnowing were still done by hand. Egypt retained hand seeding through this period on individual farm plots and large estates alike. Storage methods for oil and grain were improved. **Granaries—jars, dry cisterns, silos, and bins containing stored grain—provided food for city populations. Without adequate food supplies and trade in both food and nonfood items, the high civilizations of Mesopotamia, northern India, Egypt, Greece, and Rome would not have been possible. Irrigation systems in China, Egypt, and the Middle East were refined and expanded, putting more land into cultivation**. The **forced labor of peasants and the growth of bureaucracies to plan and supervise work on irrigation systems were probably basic in the development of the city-states of Sumer (now Iraq and Kuwait). <u>Windmills and water mills,</u>** developed toward the end of the Roman period, increased control over the many uncertainties of weather. The introduction of fertilizer, mostly animal manures, and the rotation of fallow and crop land increased crop production.N**<u>Mixed farming and stock raising</u>**, which were flourishing in the British Isles and on the continent of Europe as far north as Scandinavia at the beginning of the historical period, already displayed a pattern that persisted throughout the next 3,000 years. In many regions, fishing and hunting supplemented the food grown by farmers.About **AD 100 Roman historian Cornelius Tacitus** described the Germans as a **tribal society of free peasant warriors who cultivated their own lands or left them to fight. <u>About 500 years later, a characteristic European village had a cluster of houses in the middle, surrounded by rudely cultivated fields comprising individually owned farmlands; and meadows, woods, and wasteland were used by the entire community. Oxen and plow were passed from one field to another, and harvesting was a cooperative effort.</u>**

The Roman Empire appears to have started as a **<u>rural agricultural society of independent farmers. In the 1st millennium BC, after the city of Rome was established, however, agriculture started a development that reached a peak in the Christian era.</u>** Large estates (sector of society with some political power} that supplied grain to the cities of the empire were owned by absentee landowners and cultivated by slave labor under the supervision of **hired overseers.** As slaves, usually war captives, decreased in number, tenants replaced them. The late Roman villa of the Christian era approached the medieval (old fashion or middle age in Europe) manor (noble house and land) in organization; slaves and dependent tenants were forced to work on a fixed schedule, and tenants paid a predetermined share to the estate owner. By the 4th century AD, serfdom was well established, and the former tenant was attached to the land.

FEUDAL AGRICULTURE

The feudal period in Europe began soon after the fall of the Roman Empire, **reaching its height about AD 1100.** This period was also marked by development of the Byzantine Empire (late roman empire with its capital constanipole) and **the power of the Saracens (Muslim opposing Christian crusade) in the Middle East** and southern Europe. Agriculture in Spain, Italy, and southern France, in particular, was affected by events outside continental Europe.

As the Arab influence extended to Egypt and later Spain, irrigation was extended to previously sterile or **unproductive land**. In Egypt**, grain production** was sufficient to allow the country to sell wheat in international markets. In Spain, **vineyards were planted on sloping land, and irrigation water was brought from the mountains to the plains**. In some areas of the Middle East, oranges, lemons, peaches, and apricots were cultivated.

Rice, sugarcane, cotton, and vegetables such as spinach and artichokes, as well as the characteristic Spanish flavoring saffron, were produced. The silkworm was raised and its food, the mulberry tree, was grown.

By the **12th century agriculture in the Middle East had become static**, and **Mesopotamia declined to subsistence production levels when irrigation systems were destroyed by invading Mongols.** The Crusades, however, **increased European contact with Islamic lands and familiarized western Europe with citrus fruits and silk and cotton textiles**.

The structure of agriculture was not uniform. In Scandinavia (Norway Sweden and Denmark) and eastern Germany, the small farms and villages of previous years remained. In mountainous areas and in the marshlands of Slavic (Bulgaria, Russia and polish) Europe, the manorial system could not flourish.

A manor required roughly 350 to 800 hectares (about 900 to 2,000 acres) of arable land and the same amount of other prescribed lands, such as wetlands, wood lots, and pasture. Typically, the manor was a self-contained community. On it was the large home of the holder of the fief—a military or church vassal of rank, sometimes given the title lord—or of his steward. A parish church was frequently included, and the manor might make up the entire parish. One or more villages might be located on the manor, and village peasants were the actual farmers. Under the direction of an overseer, they produced the crops, raised the meat and draft animals, and paid taxes in services, either forced labor on the lord's lands and other properties or in forced military service.

A large manor had a mill for grinding grain, an oven for baking bread, fishponds, orchards, perhaps a winepress or oil press, and herb and vegetable gardens. Bees were kept to produce honey.

Woolen garments were produced from sheep raised on the manor. The wool was spun into yarn, woven into cloth, and then sewn into clothing. Linen textiles could also be produced from flax, which was grown for its oil and fiber.

The food served in a feudal castle or manor house varied according to the season and the lord's hunting prowess. Hunting for meat was, indeed, the major nonmilitary work of the lord and his military retainers. The castle residents could also eat domestic ducks, pheasants, pigeons, geese, hens, and partridges; fish, pork, beef, and mutton; and cabbages, turnips, carrots, onions, beans, and peas. Bread, cheese and butter, ale and wine, and apples and pears also appeared on the table. In southern Europe olives and olive oil might be used, often instead of butter.

Leather was produced from the manor's cattle. Horses and oxen were the beasts of burden; as heavier horses were bred and a new kind of harness was developed, they became more important. A blacksmith, wheelwright, and carpenter made and maintained crude agricultural tools.

The cultivation regime was rigidly prescribed. The arable land was divided into three fields: one sown in the autumn in wheat or rye; a second sown in the spring in barley, rye, oats, beans, or peas; and the third left fallow. The fields were laid out in strips distributed over the three fields, and without hedges or fences to separate one strip from another. Each male peasant head of household was allotted about 30 strips. Helped by his family and a yoke of oxen, he worked under the direction of the lord's officials. When he worked on his own fields, if he had any, he followed village custom that was probably as rigid as the rule of an overseer.

About the 8th century a four-year cycle of rotation of fallow appeared. The annual plowing routine on 400 hectares would be 100 hectares plowed in the autumn and 100 in the spring, and 200 hectares of fallow plowed in June. These three periods of plowing, over the year, could produce two crops on 200 hectares, depending on the weather. Typically, ten or more oxen were hitched to the tongue of the plow, often little more than a forked tree trunk. The oxen were no larger than modern heifers. At harvest time, all the peasants, including women and children, were expected to work in the fields. After the harvest, the community's animals were let loose on the fields to forage.

Some manors used a strip system. Each strip, with an area of roughly 0.4 hectare (about 1 acre), measured about 200 m (about 220 yd) in length and from 1.2 to 5 m (4 to 16.5 ft) in width. The lord's strips were similar to those of the peasants distributed throughout good and bad field areas. The parish priest might have lands separate from the community fields or strips that he worked himself or that were worked by the peasants.

In all systems, the lord's fields and needs came first, but about three days a week might be left for work on the family strips and garden plots. Wood and peat for fuel were gathered from the commonly held wood lots, and animals were pastured on village meadows. When surpluses of grain, hides, and wool were produced, they were sent to market.

In about 1300 a tendency developed to enclose the common lands and to raise sheep for their wool alone. The rise of the textile industry made sheep raising more profitable in England, Flanders (now in Belgium), Champagne (France), Tuscany and Lombardy (Italy), and the Augsburg region of Germany. At the same time, regions about the medieval towns began to specialize in garden produce and dairy products. Independent manorialism was also affected by the wars of 14th- and 15th-century Europe and by the widespread plague outbreaks of the 14th century. Villages were wiped out, and much arable land was abandoned. The remaining peasants were discontented and attempted to improve their conditions.

With the decline in the labor force, only the best land was kept in cultivation. In southern Italy, for instance, irrigation helped increase production on the more fertile soils. The emphasis on grain was replaced by diversification, and items requiring more care were produced, such as wine, oil, cheese, butter, and vegetables.

SCIENTIFIC AGRICULTURE

By the 16th century, population was increasing in Europe, and agricultural production was again expanding.

The nature of agriculture there and in other regions was to change considerably in succeeding centuries. Several reasons can be identified for this trend. Europe was cut off from Asia and the Middle East by an extension of Ottoman power. New economic theories were put into practice, directly affecting agriculture. Continued wars between England and France, within each of these countries, and in Germany consumed capital and human resources.

A new period of global exploration and colonization was undertaken to circumvent the Ottoman Empire's control of the spice trade, to provide homes for religious refugees, and to provide new resources for European nations convinced that only precious metals constituted wealth.

Colonial agriculture was intended not only to feed the colonists but also to produce cash crops and to supply food for the home country. This meant cultivation of such crops as sugar, cotton, tobacco, and tea, and production of animal products such as wool and hides.

From the 15th to the 19th century the slave trade provided laborers needed to fill the large workforce required by colonial plantations. Many early slaves replaced indigenous peoples who died from diseases carried by the colonists or were killed by hard agricultural labor to which they were unaccustomed. Slaves from Africa worked, for example, on sugar plantations in the Caribbean region and on indigo and cotton plantations in what would become the southern United States. Native Americans were virtually enslaved in Mexico. Indentured slaves from Europe, especially from the prisons of Great Britain, provided both skilled and unskilled labor to many colonies. Both slavery and serfdom were substantially wiped out in the 19th century. *See* Peonage; Plantation; Slavery.

When encountered by the Spanish conquistadors, the more advanced Native Americans in the New World—the Aztec , Inca, and Maya—already had intensive agricultural economies, but no draft or riding animals and no wheeled vehicles. Squash, beans, peas, and corn had long since been domesticated. Land was owned by clans and other kinship groups or by ruling tribes that had formed sophisticated governments, but not by individuals or individual families. Several civilizations had risen and fallen in Central and South America by the 16th century.

The scientific revolution resulting from the Renaissance and the Age of Enlightenment in Europe encouraged experimentation in agriculture as well as in other fields. Trial-and-error efforts in plant breeding produced improved crops, and a few new strains of cattle and sheep were developed. Notable was the Guernsey cattle breed, which is still a heavy milk producer. Land enclosure was increasingly practiced in the 18th century, enabling individual landowners to determine the disposition of cultivated land and pasture that previously had been subject to common use.

Crop rotation, involving alternation of legumes with grain, was more readily practiced outside the village strip system inherited from the manorial period. In England, where scientific farming was most efficient, enclosure brought about a fundamental reorganization of land ownership. From 1660 large landowners had begun to add to their properties, frequently at the expense of small independent farmers. By the mid-19th century the agricultural pattern was based on the relationship between the landowner, dependent on rents; the farmer, producer of crops; and the landless laborer, the hired hand of American farming lore. Drainage brought more land into cultivation, and, with the Industrial Revolution, farm machinery was introduced.

It is not possible to fix a clear decade or series of events as the start of the agricultural revolution through technology. Among the important advances were the purposeful selective breeding of livestock, begun in the early 1700s, and the spreading of limestone on farm soils in the late 1700s. Mechanical improvements in the traditional wooden plow began in the mid-1600s with small iron points fastened onto the wood with strips of leather. In 1797, Charles Newbold, a blacksmith in Burlington, New Jersey, reconceived of the cast-iron moldboard plow (first used in China nearly 2,000 years earlier). John Deere, another American blacksmith, further improved the plow in the 1830s and manufactured it in steel. Other notable inventions included the seed drill of English farmer Jethro Tull, developed in the early 1700s and progressively improved for more than a century; the reaper of American Cyrus McCormick in 1831; and numerous new horse-drawn threshers, cultivators, grain and grass cutters, rakes, and corn shellers. By the late 1800s, steam power was frequently used to replace animal power in drawing plows and in operating threshing machinery.

The demand for food for urban workers and raw materials for industrial plants produced a realignment of world trade. Science and technology developed for industrial purposes were adapted for agriculture, eventually resulting in the agribusinesses of the mid-20th century.

In the 17th and 18th centuries the first systematic attempts were made to study and control pests. Before this time, handpicking and spraying were the usual methods of pest control. In the 19th century, poisons of various types were developed for use in sprays, and biological controls such as predatory insects were also used. Resistant plant varieties were cultivated; this was particularly successful with the European grapevine, in which the grape-bearing stems were grafted onto resistant American rootstocks to defeat the *Phylloxera* aphid.

Improvements in transportation affected agriculture. Roads, canals, and rail lines enabled farmers to obtain needed supplies from remote suppliers and market their produce over a wider area. Food could be protected during transport more economically than before as the result of rail, ship, and refrigeration developments in the late 19th and early 20th centuries. Efficient use of these developments led to increasing specialization and eventual changes in the location of agricultural suppliers. In the last quarter of the 19th century, for example, Australian and North American suppliers displaced European suppliers of grain in the European market. When grain production proved unprofitable for European farmers, or an area became more urbanized, specialization in dairying, cheese making, and other products was emphasized.

The impetus toward increased food production following World War II (1939-1945) was a result of a new population explosion. A so-called *green revolution*, involving selective breeding of traditional crops for high yields, new hybrids, and intensive cultivation methods adapted to the climates and cultural conditions of densely populated countries such as India, temporarily stemmed the pressure for more food. A worldwide shortage of petroleum in the mid-1970s, however, reduced the supplies of nitrogen fertilizer essential for the success of the new varieties. Simultaneously, erratic weather and natural disasters such as drought and floods reduced crop levels throughout the world. Famine became common in many parts of Africa south of the Sahara. Economic conditions, particularly uncontrolled inflation, threatened the food supplier and the consumer alike. These problems became the determinants of agricultural change and development.

INDUSTRIAL AGRICULTURE

Many of the innovations introduced to agriculture by the scientific and Industrial revolutions paved the way for a qualitative change in the nature of agricultural production, particularly in advanced capitalist countries. This qualitative change became known as industrial agriculture. It is characterized by heavy use of synthetic fertilizers and pesticides; extensive irrigation; large-scale animal husbandry involving animal confinement and the use of hormones and antibiotics; reliance on heavy machinery; the growth of agribusiness and the commensurate decline of family farming; and the transport of food over vast distances. Industrial agricultural has been credited with lowering the cost of food production and hence food prices, while creating profitable businesses and many jobs in the agricultural chemistry and biotechnology industries. It has also allowed farmers and agribusinesses to export a large percentage of their crops to other countries. Farm exports have enabled farmers to expand their markets and have contributed to aiding a country's trade balance.

At the same time, industrial-scale agriculture has had adverse environmental consequences, such as intensive use of water, energy, and chemicals. Many aquifers and other water reservoirs are being drained faster than they can be renewed. The energy required to produce nitrogen-based synthetic fertilizers, to operate heavy farm equipment, to manufacture pesticides, and to transport food over long distances involves burning large amounts of fossil fuels, which in turn contribute to air pollution and global warming. The use of synthetic fertilizers has affected the ability of soil to retain moisture, thus increasing the use of irrigation systems. Fertilizer runoff has also stimulated algae growth in water systems. Finally, herbicides and insecticides in many cases have contaminated ground and surface waters. *See also* Environment.

During the 20th century, a reaction developed to industrial agriculture known as sustainable agriculture. While industrial agriculture aims to produce as much food as possible at the lowest cost, the main goal of sustainable agriculture is to produce economically viable, nutritious food without damaging natural resources such as farmland and the local watershed. Examples of sustainable agricultural practices include rotating crops from field to field to prevent the depletion of nutrients from the soil, using fertilizers produced naturally on the farm rather than synthetic products, and planting crops that will grow without needing extensive irrigation. Sustainable agricultural practices have seen great success in parts of the developing world where resources such as arable land and water are in short supply and must be carefully utilized and conserved. *See also* Organic Farming.

FIELD CROP PRODUCTION

Application of principles, of physical, biological and social science to growing domesticated plants to meet a diversity of human need in a profitable manner. It is a challenge to increase yield as population increases. It must be sustainable. (to use current resources in a way to safe guard future use of these resources)

Why we study field crop production

- To increase production.
- To bringing more area under cultivation.
- Dependence of agriculture

In 1951 it was 82%.

While in 1991 it was 70 %.

Share of agriculture in GDP

In 1951 it was 53.2%.

In 1998 it was 26 %.

In 2008-2009 it was 22.32 %.

- **Two ways to increase production sharing in GDP**
  1. Extensive cultivation

To produce crop using more resources particularly land.

2. Intensive cultivation

To produce crops by less resource particularly land.

Reason for low productivity Or Factors affecting crop productivity

1. **Climate** it is general weather conditions prevailing in an area over a long period.
2. **Soil** it is upper layer of earth in which plants grows.
3. **Socioeconomic**

Climate

Some crops can be grown in one climate while other can be grown in other climates. Some factors of climate can be manipulated e.g. irrigation makes desert bloom while some climatic component can not be manipulated.

Major component of climate

1.temperature

Most crop need optimum temperature.

2.water

Hydrophytes e.g. rice need a lot of water for optimum growth

Mesophytes some crops need moderate quantities of water

Xerophytes

Can get low quantities of water e.g. grain sorghum

Soil

Soil is medium for crop growth. It provide water, nutrients and also oxygen for root respiration.

Some crops can be grown in heaviest soil (more clay than silt e.g. potato

Some crops grow in lightest soil e.g. sugarcane

Socio-economic

Relating to or concerned with the interaction of social and climatic factors.

Inflexible surface irrigation system

Small land holding,

Inequitable land distribution and indigenous technology, poor quality of research and extension and other essential services.

Cultivation of crops

There is a big gap (yield gap) in potential yield of crop.

Yield gap = potential yield –average yield.

For mustard we get only 1/3 of potential yield.

Potential yield

It is maximum possible achievable yield of crop.

Average yield.

Currently achieving yield.

Requirement of improving Or developing crop productivity

- **Solving agriculture problems**
- **National level policy**
- **Specific strategies**
- **Farming system approach**
- **Improve marketing system**
- **Modern technology**

Solving agriculture problem

Problems

Major part of Pakistan's agriculture land is situated in arid and semi arid regions.

- **Salinity**

Means excess of salt

- **Sodicity**

Excess of sodium ions

- **Irrigation losses** are 59 percent in Pakistan. Seepage (leakage of water) is about 24 percent.
- Ill manner water sources (canals)
- Inadequate water distribution or drainage
- Lack of inputs or timely supply of inputs

  Solving of problems

  Solve these problems other due to water harvesting or storage, control of seepage, control of evaporation, water harvesting and storage, control of seepage, prevention of evaporation properly designing water canals (shape, design of canal)

National level policy

We have three priorities

Policy should be national food security.

Full employment to rural area.

Expanded foreign exchange (exports)

Specific strategy

Regulate support price (fix price by government) for inputs and out puts

Subsidies

Import and export duties

Fertilizers recommendation

Establishing soil labs in different zones.
Modernizing agriculture
Diversifying agriculture means to practice different crop on same land. Rural employment opportunity.
Farming system approach
Is to modify and generate technology to increase productivity for identified groups of farmers. It can be done to work for entire field through using farming system. To develop technology according to the local climate and farmer participation.
Improving marketing system
To improve marketing system government as well as private sector should participate. Government should regulate rules for marketing.
Modern technology
We should have modern technology.

AREA OR LAND MEASUREMENT OR FIELD MEASUREMENT AND SOME CONVERSION FACTORS

The variability in field or plot size has greater influence on the research conclusion. The conversion of one form of unit to other form need serious attention. Otherwise it will result in a big mistake in formulating and recommendation of agricultural technology.

One hectare	10000 meter square.
One hectare	2.47 acre
One acre	2 jareb
One jareb	4 kanal
One kanal	20 marla
One kanal	505.meter square
One marla	272.25 ft
One meter	3.28 feet

One meter	3.28 feet	One gram	.0353 ounce or .0022 pound or lb
One meter	39.37 inches	One kg	2.2 pounds
One inch	2.54 cm	One quintal	100 kg
One kilometer	1000 meter	One metric ton	1000 kg
One mile	1.69km	One ounce	28 g
One meter cub	1000 liters		
One liter	.2201 gallon		
One cubic feet	23.32 liter		

English units of weight (ounces, pounds, and tons)

CLASSIFICATION OF CROPS

Classification, in biology, identification, naming, and grouping of organisms into a formal system based on similarities such as internal and external anatomy, physiological functions, genetic makeup, or evolutionary history. Most plants are usually known by their common local name, which are different from country to country, locality to locality. For example pumpkin refer to species cucurbitaceous in America while in Britain pumpkin refer to any of several species of squash. In order to avoid confusion and to facilitate international communication, in scientific writing, a plant is given one name …………it's scientific, technical, or botanical name. According to international accepted rule, each plant has a two words or binomial name given in Latin. The first name refers to the Genus and second to Species. The initial of the person (authority) who names a plant species or variety is listed after the species name. for example in the name *Triticum aestivum L.*

L means Linnaeus who named the wheat plant. Generic name always begins with a capital letter while species name with lower case letter. These names are underlined If written by hand or type writer and italicized when printed.

1. **To identify related species for different purposes like feed, food and fiber.**
2. **To gave reference to avoid any confusion in identification.**
3. **Common names for some plants in different localities are different or some where it is extent so single (technical) anme is given for scientific purposes.**
4. **Classification was initiated by Theophrastus in 370 BC. Later on Carolous Linnaeous a Swedish botanist (1707-1778) has introduced a two name system for classification and divided plants on he basis of similarities and differences. According to him there are four groups of plants**
    1. **Thallophyta**
    2. **Bryotphyta**
    3. **Pteriodeiophyta**
    4. **Spermatophyte.**

Thallophyta

They may be single cell, rope cells or thallus

They are called lower plants.

They don't have roots, stems or leaves.

e.g. bacteria, algae and fungi

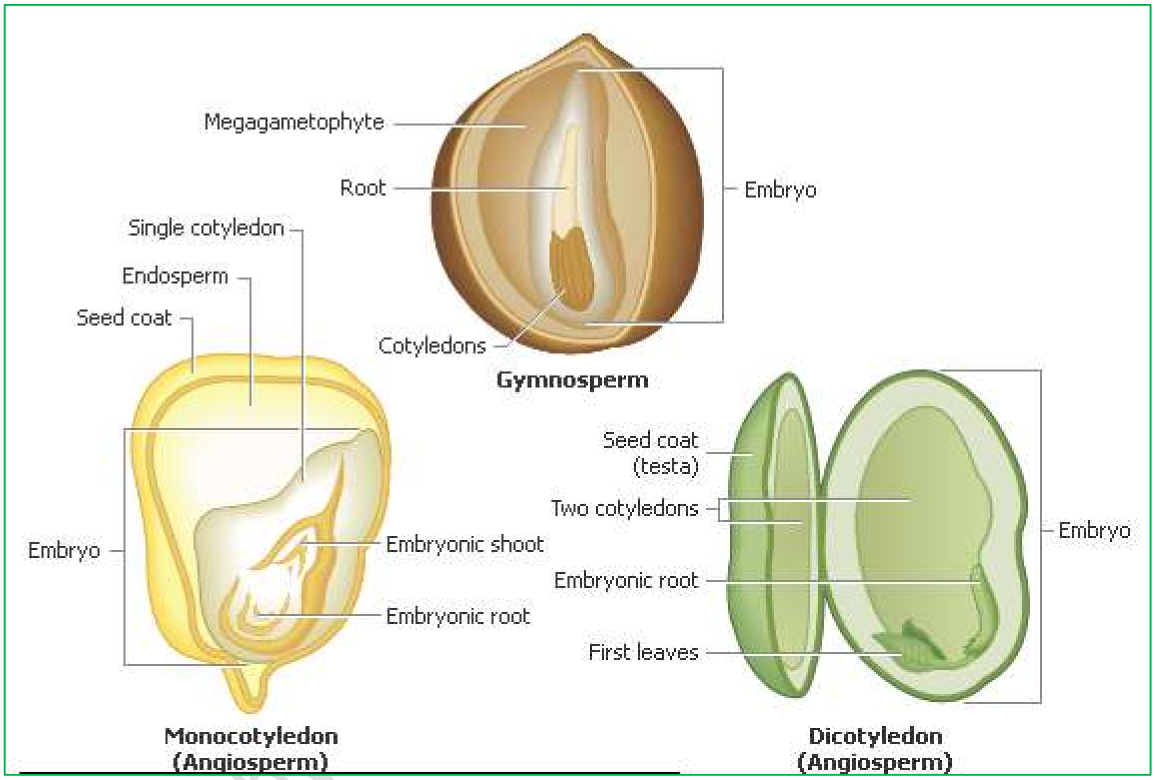
They have importance.

They fix nitrogen. They are harmful and cause diseases e.g. rust

Bryophyte

They are small green plants. They grow on wet places. Roots are not true called rhizoids. Stem and leaves are present. Have no agronomic importance e.g. mosses, liverworth, hornworth.

Pteriodiophyta.



They don't have flower and seeds but reproduce by spores. They don't have agronomic importance except as ornamentals. They have vascular bundles so called vascular plants.

E.g. ferns, horse tail

Spermatophyte

They are highly developed plants. They have leaves, stems, roots as well as having flowers. All have agronomic importance.

Gymnosperm

In which seeds are not covered e.g. pine

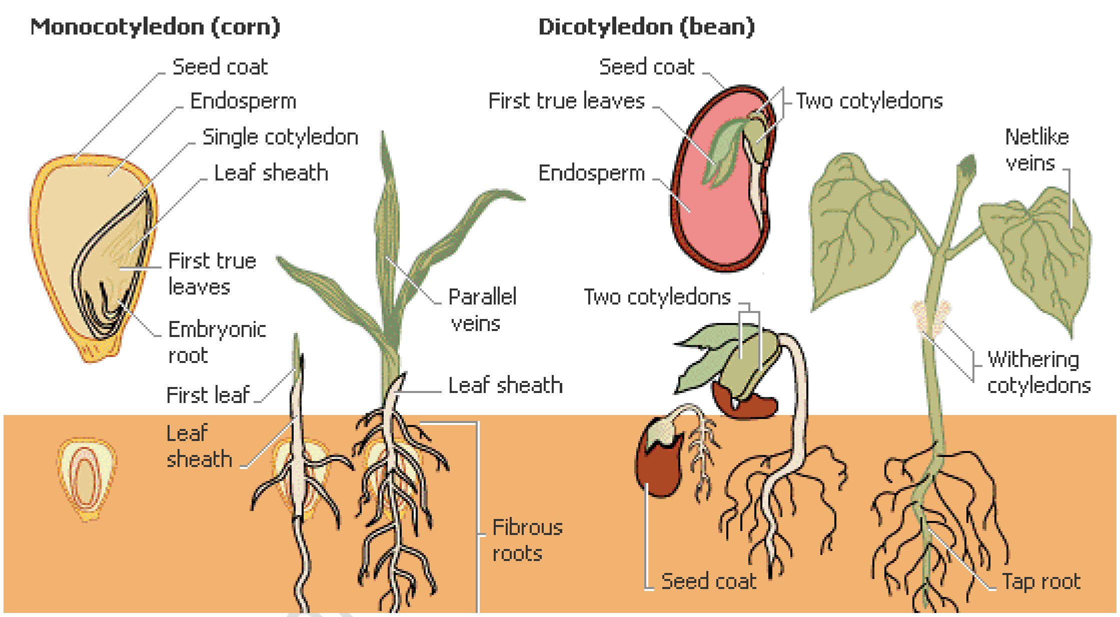
Angiosperm

In which seeds are covered in ovary

Angiosperms are divided into two group on basis of cotyledon.

Monocotyledon	Dicotyledonous
Single cotyledon	Two cotyledons
Narrow or needle like leaves	Broad or web like leaves
Hypogeal germination	Epigeal germination
Endosperm (2n)	Endosperm (3n)
e.g. maize, wheat	e.g. pea, grain, cowpea

UNITS OF CLASSIFICATION



Species

Group of plants that normally breed among themselves and have many characters common or a group of living organism consisting of similar individuals capable of exchanging genes or of interbreeding.

Variety

Is group of similar plants within a particular species that is distinguished by one or more than one character and given a name.

Cultivars of self pollinated plants as the pea or tomato usually constitute inbred lines or pure lines that breed naturally. Cultivar name is always capitalized but never underlined or italized. It may be identified as cultivar by single quotation mark e.g. Golden Delicious.

It is working unit for agronomist and breeders.

Genus

Group of similar species.

Family

Order

Class

Division

Kingdom

For example

Species aestivum
Genus Triticum
Family graminae
Order graminales
Subclass monocot
Class angiosperm
Division spermatophyte
Kingdom plantae

IMPORTANT TERMS

Variety

Variation within a species form a variety. It has DUS characteristic means distinct, uniform and stable characteristic. For example mexico pak, saleem, ghaznavi.

Botanical variety

It is a naturally occurring variety. Variation in it are because of nature. It is also called wild variety. Different from originally developed. It is unidentified or unnamed. When a group of plants occurring in nature in diffent form and botanical binomial is not enough to identify it called botanical variety.

Cultivar

Variety under field or cultivate variety e.g. mexico pak is a variety not cultivar because now a days it is not cultivated. Saleem is a variety as well as a cultivar. So all cultivars are varieties but all varieties are not cultivars.

Variety may be

- **Clone**

An organism or cell or a group of organisms or cells produced asexually from one ancestor to which they are genetically identical. E.g. by vegetatively i.e. cutting, budding, grafting, layering.

- **Line**
  It is also called if it is produced (by seed)

It is produced by pure breeding that is self pollinated. E.g. called pure line.

Open pollinated variety

They are reproduced by cross pollination in field. It is done automatically. E.g. maize

Hybrid variety

It is created artificially or manually by controlled crosses. Cross pollination should be done each time to develop hybrid. It is more vigorous form.

FERTILIZER COMPOSITION AND MEASUREMENT FOR AGRONOMIC CROPS

Fertilizer, natural or synthetic chemical substance or mixture used to enrich soil so as to promote plant growth. Plants do not require complex chemical compounds analogous to the vitamins and amino acids required for human nutrition, because plants are able to synthesize whatever compounds they need. They do require more than a dozen different chemical elements and these elements must be present in such forms as to allow an adequate availability for plant use. Within this restriction, nitrogen, for example, can be supplied with equal effectiveness in the form of urea, nitrates, ammonium compounds, or pure ammonia.

Virgin soil usually contains adequate amounts of all the elements required for proper plant nutrition. When a particular crop is grown on the same parcel of land year after year, however, the land may become exhausted of one or more specific nutrients. If such exhaustion occurs, nutrients in the form of fertilizers must be added to the soil. Plants can also be made to grow more lushly with suitable fertilizers.

Of the required nutrients, hydrogen, oxygen, and carbon are supplied in inexhaustible form by air and water. Sulfur, calcium, and iron are necessary nutrients that usually are present in soil in ample quantities. Lime (calcium) is often added to soil, but its function is primarily to reduce acidity and not, in the strict sense, to act as a fertilizer. Nitrogen is present in enormous quantities in the atmosphere, but plants are not able to use nitrogen in this form; bacteria provide nitrogen from the air to plants of the legume family through a process called nitrogen fixation. The three elements that most commonly must be supplied in fertilizers are nitrogen, phosphorus, and potassium. Certain other elements, such as boron, copper, and manganese, sometimes need to be included in small quantities.

Many fertilizers used since ancient times contain one or more of the three elements important to the soil. For example, manure and guano contain nitrogen. Bones contain small quantities of nitrogen and larger quantities of phosphorus. Wood ash contains appreciable quantities of potassium (depending considerably on the type of wood). Clover, alfalfa, and other legumes are grown as rotating crops and then plowed under, enriching the soil with nitrogen.

The term *complete fertilizer* often refers to any mixture containing all three important elements; such fertilizers are described by a set of three numbers. For example, 5-8-7 designates a fertilizer (usually in powder or granular form) containing 5 percent nitrogen, 8 percent phosphorus (calculated as phosphorus pentoxide), and 7 percent potassium (calculated as potassium oxide).

While fertilizers are essential to modern agriculture, their overuse can have harmful effects on plants and crops and on soil quality. In addition, the leaching of nutrients into bodies of water can lead to water pollution problems such as eutrophication, by causing excessive growth of vegetation.Fertilize calculation is done to provide optimum amount of nutrients to crops to enhance crop production and quality, to increase farmer income to sustain soil fertility, to avoid environment pollution.

Nitrogenous fertilizers	N	P	K
Urea	46%		
Ammonium sulphate . NH4SO4	21%		
Ammonium nitrate. NH4NO3	35%		
Phosphate fertilizers			
Single super phosphate		18%	
Triple supper phosphate		46%	
Potash fertilizer			
Sulphata potash K2SO4			50%
Murata potash KCL			60%
Compound fertilizers			
DAP	18 %	46%	
Nitrophosphate	23%	23%	

Amount of fertilizer =

<u>Amount of nutrient required(recommended by researcher)</u> × 100

%age of nutrient in grade (in table

AGRONOMIC CLASSIFICATION

Scientific names		Sugar cane	*Sacchrum officinarum*
flax	*Linum usittissimum*	cotton	*Gossipium hirsutum*
Jute	*Corchorus capsularis*		
sunhemp	*Cannabis sativas*		
sunflower	*Carthamus tinctorus*		
Rape and mustard	*Brassica campestris*		
soybean	*Glycine max*		
pepper	Capsicum annum		

Cereal crops or grain crops or cereal grains

The most important food-energy source for three-fourths of the world population is grains. Most grains are members of the grass family that are grown for **their large edible seeds**. Chief among these are wheat, rice, corn (maize), barley, oats, rye, sorghum, and millet. All are widely used as food for humans, both directly and in processed forms. Corn, barley, oats, and sorghum also serve as livestock and poultry feeds; stalks and straw from these crops are important sources of *fodder* (feed) and bedding for livestock. Grains are among the oldest crops, with their cultivation dating from about 10,000 years ago.

Wheat, barley, oats, and rye are grown throughout much of the Temperate Zone world, most commonly in areas with moderate to low annual rainfall (25 to 76 cm/10 to 30 in), where they are more productive than crops that require more water. Higher rainfall, irrigation, and fertilization, however, boost the yields of these cereal grains. Rice is primarily a tropical or subtropical cereal, although Chinese and Japanese breeders have developed short-season strains adapted to temperate areas. Most rice is grown in water or in paddies with ample water supplies. Upland, or dry land, rice is grown in limited areas.

Sorghum historically has been a tropical grain, grown for food in Africa and Asia. In the past half century its use has spread so widely that it has become an important livestock feed in dry land (arid) areas such as the southwestern United States. Corn originated in subtropical climates, but is now grown predominantly in temperate climates that have rainfall of more than 63 cm (more than 25 in) per year. Rapid expansion of irrigation systems has made possible the extension of corn acreage into drier areas in the central and western United States.

Grain crops are well adapted to mechanization. In the temperate zones most grain production is on large farms, where machines till, plant, and harvest (*see* Agricultural Machinery). This is less true in the Tropics and in locations where terrain is too rough for machinery. In these areas grains are grown in small plantings. Here much of the planting, harvesting, and threshing continues to be done by hand or with primitive equipment.

The development in the 1960s of improved grain-crop varieties with higher yields, stronger pest resistance, and greater response to fertilizers has improved productivity throughout much of the world. In many areas of the Tropics, the new developments triggered the so-called green revolution, a dramatic increase in grain production. More work was needed, however, to adapt superior varieties to local conditions and to solve human problems associated with the distribution of their benefits. The energy shortage that began in 1973 led to a shortage of oil-based chemical fertilizers and of fuel to run irrigation pumps, which also placed constraints on further gains from the green revolution. These are grasses grown for their edible seed. They are also called grain crops. Examples are sugar beet, wheat, maize, rice, sorghum, millet, and oat. Rye (scale cereal), and sugar cane.

Forage crops

Forage-crop farming serves as the basis for much of the world's livestock industries. Forage crops are mowed, dried, and stored as hay; chopped and stored wet as silage; or fed directly to cattle as pasture or as freshly chopped forage. In tropical and subtropical regions, most livestock consume forages as pasture. In temperate zones, forages are commonly stored as hay or silage for winter use.

Common legume forages of the temperate zones include alfalfa; red, white, and alsike clovers; and birds foot trefoil. Popular grasses include timothy, orchard grass (cocksfoot), smooth brome grass, tall fescue, and bluegrass. Forage-crop farmers normally grow one or more legumes in association with a grass. Bacteria in the root nodules of the legumes convert atmospheric nitrogen (*see* Nitrogen Fixation) into forms available to these plants and enrich the soil for the grasses as well, thereby reducing the need for fertilizer and increasing the yields and the quality of the forage.

These crops are grazed by animals or harvest as green chops, hay, silage. E.g. leguminosa (clover) have three hundred types. Technically defined

Those crops which has dry matter greater than twenty fiver percent. For example barseem.

Fodder crops

When wheat, maize or other coarse grasses are harvested and cured for animal feed are know as fodder crops. Most of the forage crops belongs to grass family or leguminous group. E.g. grasses and clovers

Silage crops

Partially fermented and succulent

Soilage crops

they are green and succulent not cured(dried) directly feed to animals.

Fiber crops

These crops which are grown for their fiber for example textiles, rugs, ropes, kenaf,

Cotton ***Gossypium hirsute***, Jute ***Corchorus capsularis***, Flax ***Linum usitatissiumum,*** Kenaf Sun hemp

Sugar crops

Sugar is extracted from these crops e.g. sugar cane, sugar beet, and sweet sorghum.

Oil seed crops

These are crops which are grown for purpose of extracting oil from their edible seeds.

E.g. mustard, rape, ground nut, soybean, canola

Pulses or grain legumes

They are grown for their edible seeds. They belong to family leguminous. E.g. chickpea, pea, bean, and lentils

Root and tuber crops

These are vegetables crops grown for underground parts for example

rhizopus ……………..garlic

root radish and carrot

Tuber potato

Bulb onion

Narcotic or drug crops

Have narcotic value

Have medicinal value

Poppy, tobacco, tea, coffee

Vegetables or garden crops

Grown for edible leaves e.g. lettuce

Grown for edible shoot e.g. okra, asparagus

Grown for edible flower e.g. cauliflower

Grown for edible fruit e.g. tomato

Condiment crops

E.g. coriander, chili and mint.

Special purpose classification

Green manure crops

These crops are grown and ploughed under in green or manure stage to increase soil fertility e.g. dhancha (guar), barseen, and brassica.

Silage or haylage crops

Silage crops are cut, and preserved in succulent condition. It is achieved by partial fermentation in silos. E.g. oat, maize, soybean, sorghum, and grass arre called haylage crops. In Pakistan it is practiced only in military dairy farms.

Soilage crops or green feed or zero grazing.

It is harvested when still green and succulent and are directly fed to animals without curing e.g. barseem, shaftal, sorghum and maize.

Cover crops

They are grown to cover soil surface because to reduce soil erosion and nutrient losses by leaching e.g. rye, grasses, mash, moth,

Catch crops

Catch crops are grown when the major crops failed or could not raise successfully due to some reason. These crops are grown only for fodder not for yield. E.g. maize and sorghum for fodder purposes.

Companion crops

Companion crops increase soil fertility. Usually legumes are grown mixed with grass. These are those crops growing two or three together. E.g. leguminosia plus gramminae. Companion crops increase forage production and to improve quality.

Relay crops

When a major crops reach to reproductive or mature stage and is not harvested and a second crop relay crop is sown in the field to increase crop intensity. E.g. planting of sugar beet in sugar cane.

Rabi cereals		**Grain legumes**					
wheat	*Triticum aestivum L.*	Chicken pea	*Cicer arietinum*	Cow pea	*Vigna ungulita.*	linsee	*Linium usitatissiumum*
Barley	*Hordeum vulgare L.*	lentil	*Lens culinaris*	*Oil seed crops*		safflower	*Carthamus tinctoria*
Kharif cereals		Grass pea	*Lathyrus sativus*	Soy bean	*Gycine max*	Rap see (sarsoo)	*Brassica campesteris*
Rice	*Oryza sativa L*	pea	*Pisum sativum*	sunflower	*Helianthus annus*	jojoba	*Simmondisa*
Maize	*Zeemays*	Mung bean	*Vigna radiate*	Ground nut	*Arachis hypogeal*		
sorghum	*Sorghum bicolor*	Black gram	*Vigna mungo*	seesam	*Sesame indicum*		
millet	*Pennisetum typhoods*	Kidney bean	*Phaselolus vulgaris*	caster	*Ricinus comonusi*		

Fodder crops			
barseem	*Trifolium alex*	cowpea	*Vigna ungculita*
Alfalfa /lucerna	*Medicago sativa*		
oat	*Avena sativa*		
Persian clover or shaftal	*Trifolium vesupinatum*		
Sorghum	*Sorghum bicolor*		
Millet /bajra	*Pennisetum americanum*		
Cluster bean /guar	*Cyamopsis tetragonolobus*		

Legume crops (febacea /leguminosa)

They have pinnate leaves. They are those crops which have compound leaves or ovate leaves. They are divided into forages and pulses

Pulses

Pulses are annual leguminous crops yielding one to twelve grains. Play an important role in crop rotation due to their ability to fix nitrogen. India is world largest produce and larger importer of pulses. Pulses have twenty to twenty five percent protein by weight, which is double protein content than wheat and three times than rice so pulses are called poor man's nut.

Forages

Forage is plant material mainly plant leaves and stems eaten by grazing livestock. Historically term forage has meant nay plant eaten by animals directly as Pasteur, crop residue or immature cereal crops. These plants have trifoliate leaves for example clover

Clover

Trifolium is a genus of about three hundred species of plants in pea family. They are small annuals, biennials and short lived perennials herbaceous plants. Their leaves are trifoliate have red, pink while purple flowers. E.g. *shaftal (Trifolium resupinatum)*, *Barseem (trifolium alexandrium*, *Alfa alfa (medicago sativus0*

Rabi pulses		Kharif pulses	
Gram (chicken pea)	*Ciser aeritinum*	Mash(black gram)	*Vigna mungo*
lentil	*Lens culinaris*	Mung bean, golden gramm, green gram	*Vigna radiate*
peas	*Pisum sativum*	Cow pea	*Vigna unguculita*
		Pigeon pea(cajan pea)	*Cajanvas cajan*

Cropping pattern

The distribution of farm area to various crops per year in any agro ecological zone.

Monocropping

Growing one crops again and again in a particular area is called monocropping.

Multiple cropping

Growing two or more than two crops on the same piece of land per year is called multiple cropping.

Intercropping

Growing two or more than two crops simultaneously at the same time with proper row to row management or distance. E.g. sugarcane plus sugar beet

Mixed cropping

Growing two or more than two crops at the same time in which row to row distance is not maintained.

Oats plus mustard

Sequential cropping

Growing two or more than two crops in sequence on the same length per year. There are different types of sequential crops.

Double cropping

In gilgit we have maize and wheat per year is called double cropping.

Triple cropping

Quadruple cropping

Crop rotation

A crop rotation is growing crops in a regular sequence one after the other on the same land keeping in mind that soil fertility may not be adversely affected

E.g. sugarcane than legume crops.

Ratooning

After the harvest of sugar cane under ground portion of crop is left in the soil to sprout another crop of sugar cane. Sugar cane is vegetatively grown in Pakistan. Research show that sugar percent is greater than fresh one.

CROP NUTRITION

A process by which plants take in and utilize food substances is called crop nutrition.

Ingestion

Taking in of food nutrients (inorganic substances from the soil by roots.

Digestion

When these inorganic substance are being converted into organic form.

Assimilation

When these organic material is used by plants to obtain energy. Energy is used for growth and development. Growth is increase in size while development in which leaves, stem and nodes arises. Sixteen nutrients are essential. The crops are unable to complete its life cycle in the absence of essential nutrients if the nutrients are deficient or absent plant cannot grow properly. The function of one essential nutrient is not replaced by another nutrient. Nutrients are involved in plant metabolism nutrients must be involved in plant metabolism.

Macro nutrients

Primary nutrients

C, H, O

Plant gets carbon from air while H and O from water.

N, P, K

These are primary nutrients are required by plant in more quantity. Therefore we called this nutrients primary.

Secondary nutrients

Ca, Mg, S

Are secondary nutrients these are present in soil to some extent. Therefore these nutrients are called secondary nutrients.

Nitrogen

Nitrogen is most important in all over the world

Cell division and cell enlargement

Important for vegetative growth.

Present in enzymes and proteins.

It is important for the protoplasm formation.

Nitrogen Is important for plumbness of seeds

Chlorophyll formation

Greenery of plants depends on nitrogen.

Deficiency symptoms of nitrogen

Leaves of plant become yellow due to deficiency of nitrogen. This process is called chlorosis.

Cell development and cell enlargement stops than plant has stunted growth.

Deficiency of nitrogen causes decrease in no of tillers and inflorescence and also decrease in protein. Similarly quality of sed.

Excess of nitrogen

When nitrogen increases than the optimum will delay crop maturity.

Excess of nitrogen will increase plant height. It will cause lodging.

Excess of nitrogen in fiber crops decrease the fiber quality.

Excess of nitrogen in fodder crops is toxic to animals. Excess of nitrates cause cancer.

Excess of nitrogen is not economical to the farmers.

Excess of nitrogen increases impurities in sugar.

Phosphorous

Phosphorous is second most important nutrients after nitrogen. It is component of energy rich compounds. Phosphorous is also component of RNA and DNA. Phosphorous application to crops can increase the size of seeds. It also helps in the formation of seeds and crops. Phosphorus applications associated with early maturity.

Research shows that phosphorous resistant toward disease. It is also important for root development of crops.

Deficiency of phosphorus

1. Less not of roots and plants will be stunted.
2. Will delay maturity.
3. Root proliferation.
4. Increase lodging.
5. Old leaves will be yellow if nitrogen is absent. While in absence of phosphorous leaves will be dark green or purple.
6. Seed size will be reducing so yield will be reducing.

Potassium

Potassium is very important for enzymes activation. It helps the plant in uptake of water. It increases resistance to drought. It increases qualities of seed, food and other product of crops. Potassium is useful for tobacco. Potassium increase oil quality in brassica. It increase shelf life of food products and play a major role in resistant to diseases.

Deficiency

Enzymes become inactive.

Tip or margins of leaves will be red, white or yellow.

Note:

Plant absorb nitrogen only as inorganic nitrate No3 and in a few cases as ammonium NH4 or amimo NH2 IONS. Phosphorous is absorbed by plant as orthophosphate ions H2PO4- ION.

FERTILIZERS

Any organic or inorganic material that is added to the soil to supply one or more than one nutrients essential for the growth of plant.

Balance fertilizers

Balanced fertilizers are that fertilizer which is applied to the need or requirement of crop.

Fertilizer recommendation

1. Plant analysis
2. Soil analysis
3. Deficiency symptoms

4. Field experiments

Types of fertilizer

Straight or simple fertilizers

A fertilizer which contain only one essential nutrient. It is called straight fertilizer.

E.g. urea, SSP, and TSP

Compound fertilizer

A fertilizer which contain more than one essential nutrients is called compound fertilizer or complex or called mixed fertilizer.

E.g. DAP, NP

Complete fertilizer

a fertilizer which contains all the three major nutrients is called complete fertilizer.

NPK = 15; 15; 15

But according to some scientist a fertilizer that contains all essential nutrients.

Methods of fertilizer application

Fertilizers are available in solid and liquid form so their method of application is different from each other

Solid fertilizer

Standing crops

Basal dose

Basal dose

The fertilizer which is applied to crops in sowing time is called basal dose.

Broadcasting

Band application

Broadcasting

On the surface of soil uniformly by hand or by a machine

Band application

Application of fertilizer along the rows by drill or hand hoe machine.

Standing crops

Only the nitrogen or urea is used for standing crops.

For standing crops fertilizers are being used by following tow methods'

Top dressing

Fertilizers are used by hands or air crafts .

Side dressing

Along the rows by using hands or machines.

Liquid fertilizer

Liquid fertilizer is also applied in liquid form in advance countries. Fertilizer are applied in liquid form.

Direct application

Injection of fertilizer to the field or soil by special planters.

Fertigation

Application of fertilizers along with irrigated water .

Foliar application

Spray of fertilizers on the leaves of crops

Root dipping

The treatment of liquid fertilizers with the roots of crops e.g. in rice treatment witn zinc sulphate solution.

Seed priming

Treatment of crop seeds with nutrient solution for sometime before planting.

Fertilizer requirement kg per hectare			
	nitrogen	Phosphorous	Potassium
Wheat irrigated	135	60	60
Wheat barani	80	40	40
Rice basmati fine	100	60	60
Rice coarse	140	60	60
Maize	120	60	60
Cotton	120	60	60
Tobacco	35	70	70
Sugar cane	170	70	160
Sugar beet	90	100	60
Pulses	25	60	0

Classification on the basis of life cycle or crop duration.

On the basis of their duration or life cycle crops are divided into three groups;

Annual crops

These crops which complete their vegetative as well as reproductive stage in one growing season (year) and produce flower and seed.

For example wheat, maize, and barley.

Biennial crops

Those crops which complete vegetative growth in first year and reserve food in roots or other plant parts during second year the reserved food is utilized to produce flowers and fruits. E.g. sugar beet, radish, carrot, and turnip. However these crops are usually harvested during first year to obtain commercial products.

Perennial crops

These crops grow for more than two years. They may produce seed each year but their life span is for more than two years. These crops have the regenerative power to resprout from the stubble after cutting. E.g. sugar cane and alfalfa.

Classification on the basis of season

In Pakistan we have four distinct seasons like summer, winter, spring and autumn. However plants are not classified according to seasons. Crops classification is based on planting date, water charges and govt revenues. Crops are divided into two major seasons

Kharif crops

These crops which are planted in the summer months from march to july and harvested in autumn or winter are called kharif crops e.g. maize, rice, sorghum, milet.

Rabi crops

These crops are planted in winter from October to December and harvested in summer from March to may. Examples are wheat, barley, gram and lentil. However crops which deviate from these two categories are termed as zaid kharif crops and zaid rabi crops.

Zaid kharif crops

These crops which are planted in august –September and harvested in dec-january e.g. toria (brassica spp).

Zaid rabi crops

These are crops which are planted in February and harvested in May-June is called Zaid rabi crops e.g. tobacco

Purity analysis and adjusting the seed rate for a specific crops

Objective of practical

To investigate the percent composition of seed sample and to identify the main component of seed sample that is pure seed, other seed, inert material and also to calculate the adjusted seed rate for a particular crop variety.

Pure seed

Those seeds which dominate the seed sample a lot. It includes 1. Immature 2. Undersize 3. Shrivel 4. Germinated. Pure seed belong to a particular variety.

Other seeds

We will take all those seeds other than pure seed or all those seeds which donot belong to pure seeds.

Inert materials

All those materials or matter which is neither pure seed nor other seeds.

For example

A wheat sample five hundred gram having four hundred and thirty three gram pure seed, twenty five gram other seed, and forty two gram inert material. Than calculate percent purity.

Percent purity = pure seed weight/sample wheat ×100

433/500×100 =87%

In 100 kg wheat sample 87 percent pure seed or purity.

We do purity test to adjust seed rate because the market seed are not hundred percent pure or hundred percent germinable.

Emergence

When plumule comes out of soil surface is called emergence.

Germination

The protrusion of radical and plumule of seed.

Adjusted seed rate:

Market seed are not 100% pure or 100% germinable. Thus seed rate higher than recommended seed rate is used for uniform crop growth and stand. It is calculated as

Adjusted seed rate = normal (recommended) seed rate/useful seed rate

Useful seed rate= %purity ×%germination /100

Percent germination

Percent germinated seed out of total seed.

%Germination = germinated seed/total no of seed ×100

Classification based on climate

Based on different climatic factors (light, temp etc) plants are classified as;

Temperate zone crops

These crops are winter hardy and tolerate very low temperature. Around the world these plants grow in a belt between 30 and 50 north and south latitude. They even existed a tropic of high altitude e.g. chitral, kalam, gilgit . Some of these crops require chilly temperature e.g. wheat, oat, barley, rye, and rice.

Tropical zone crops

These crops grow between 20 norths and 20 south latitude where frost does not occur during the growing season. Normal growth is affected by temp below 10 degree centigrade and plants are killed at freezing temperature e.g. sugar cane, mango, banana, papaya, pineapple, cotton, mango, maize, rice, millet, sorghum, sugar can

Subtropical crops

These crops tolerate some sub freezing temperatures but cannot grow well in temperate or tropical zones. Subtropical belt includes both humid and semi arid zones. Subtropical fruit plants are killed by temp below -7 degree centigrade e.g. citrus, date, fig, and pomegranate.

Photoperiod

Plants grown vegetatively produce leaves and branches, then change from vegetative to reproductive stage by producing flowers and fruits. This change is brought about by changes in day length i.e. number of hours of light. Crops are classified according to their responsive to day length which is known as photoperiodism.

Short day plants

Short day plants are those plants which change from vegetative to reproductive stage when day become short for example rice require less than fourteen hours.

Long day plants

They change from vegetative to reproductive stage when the days become longer e.g. wheat, barley, greater than fourteen hours.

Day neutral plants

Plant whose initiation of flowering is not affected by the length of days e.g. tomato, cucumber and okra.

Classification of crops on basis of growth habit

Based on vegetative and reproductive mode plants are classified into

Determinate plants

Those who initiate their reproductive stage after completion of vegetative stage . They can be harvested only once. E.g. wheat, rice and maize.

Indeterminate plants

These are those crops which continue simultaneously both vegetative and reproductive stage at the same time on the same plants. These plants have both mature and immature fruits, flowers and buds on the same plant at a time.

For example

Soybean, mung bean, pea, tomato, cucurbits

Agro meteorology

Meteorology

The word meteorology is derived from lating word metro-atmosphere and logos means science. The science of atmosphere is called meteorology.

Agro meteorology

It is a science that deals with the atmospheric condition which is significant for agriculture.

Atmosphere

A thin layer of colorless, odorless and tasteless gases hold to the surface of earth.

Percent of gases

Nitrogen =78%

Oxygen =21 %

Argon =.93 %

Carbon dioxide = .03 %

Neon = .0018 %

Helium = .005 % etc.

Weather

Condition of atmosphere at a given place in a given time. Weather is related to smaller area e.g. village, city, district. It is also related to smaller for short time (day or part of the day), hot day, and cold day, dry day.

Climate

Climate is the summation of weather condition over a given region or given zone related to years. From fifty years we know Australia has cooler temperature than Pakistan.

Environment

Environment is the aggregate (total) of all external condition that influence life and development of an organism.

AGROECOLOGY OR CROP ECOLOGY

The relationship between crops and environment is called agro ecology.

Agro ecological zone

Are large areas in which agriculture and socio-economic conditions are similar for agriculture. They are ten in number.

Indus delta

This includes south Hyderabad to Arabian sea. This area is called Indus delta e.g. rice, sugarcane, pulses and barseem

South irrigated plains

The area from Jacobabad to dado is called south irrigated plains. E.g. cotton, beet, mustard, and sugarcane.

Sandy desert

This area includes

Thar to cholistan and thar to mianwali. This zone is divided into east sandy deserat and west sandy desert. E.g. guar, millet, sorghum and wheat.

Northern irrigated plains

Include those areas of Punjab which are irrigated by river Sutlej and Jhelum.

In kpk from Peshawar to mardan that area is called northern irrigated plain. E.g. sugarcane, sugar beet, maize, tobacco, wheat, plum, pear

Barani land

Includes karak, atock, Rawalpindi, banu,

Wet mountains

This area includes upper hazara and swat.

Northern dry mountains. This area include gilgit, chitral and dir.

Western dry mountains

Bannu, zhob, quetta, pasheen, parachinar, wazirstan.

Dry western plateau

Chagi, coastal area of makran.

Suliman pediments

From DI khan to DJ khan.

Agro ecological zones of kpk				
Kpk zones	temp	altitude	rainfall	areas
Moist mountainous and sub mountanes	2-----35	1200-2300meter	>600 mm per year	Malakand, hazara and upper kurum
Higher plains	4--38	600-1200 meter	600—750 mm per year	Swabi, lower kurum agency and malakand agency
Plains of higher rainfall	7-----41	450---600 meter	500—600 mm	Mardan division, Peshawar division, district charsada
Plains and sub mountainous areas of lower rainfall	7---41	300—800 meter	375---500 mm per year	Nowshera tehsil, part of peshawer division.
Arid plains	2-----43	150---300 meter	< 250 mm	Nizampura of nowshera, karak, laki marwat, DI khan, south wazirstan

Land cultivation of Pakistan

Urban/rural distribution
Share urban 35 percent (2005 estimate)
Share rural 65 percent (2005 estimate)

. Literacy rate Total 47.4 percent (2005 estimate) Female 32.4 percent (2005 estimate) Male 61.4 percent (2005 estimate) Education expenditure as a share of gross national product (GNP) 1.8 percent (2000-2001)

GDP by economic sector Agriculture, forestry, fishing 19.4 percent (2006) Industry 27.2 percent (2006) Services 53.4 percent (2006Workforce share of economic sector Agriculture, forestry, fishing 42 percent (2002) Industry 21 percent (2002) Services 37 percent (2002) Unemployment rate 7.7 percent (2004

Area of Pakistan	79.61 million hectare
forest	4.04 million hectare
Cultivated area	22.1 million hectare
export	65 %
Baluchistan total area	35 million hectare
Punjab total area	21 million hectare
kpk	10 million hectare
sindh	14 million hectare

Cultivated area of Pakistan

22 million hectare

Rainfed = 5 million hectare

Irrigated area =17 million hectare.

Rainfed area of Pakistan

Punjab 14

Sind 30

Kpk 50

Baluchistan 25

Crops of Pakistan	% production in rain fed area
Wheat	10
Maize	27
Millet and sorghum	56
Pulses	85
Ground nut	90
Rap and mustard	25
Domestic livestock	70

Pakistan is divided into four zones

Arid zone	Rainfall less than 200 or 300 mm per year e.g. baluchistan, sindh, DI khan, nowshera, gilgit,
Semi arid zone	Rainfall 300-600 mm per year. Northern areas of Punjab, Peshawar , mardan, charsada, deer, bajour, banu
Sub humid zone	600-1000 mm per year. Sialkot, Gujranwala, parachinar, abotabad, swat
Humid zone	Rainfall greater than 1000 mm. muree hill, upper hazara, upper swat, and dir,

Eleven different ecological zone of Pakistan	
Zone 1	DI KHAN TO SIBI
Zone 2	E.G. GUJRAT
Zone 3	E.G. RAWALPINDI
Zone 4	E.G. TALA GANG
Zone 5	E.G. MUREE TO SWAT
Zone 6	CHITRAL AND GILGIT
Zone 7	QUETTA TO LORALI
Zone 8	MAKRAN TO JALAWAN
Zone 9	THAR PAR KAR
Zone 10	CHOLISTAN
Zone 11	THAL

Kpk has 2 million hectare cultivated area. From this 1.05 million hectare area is rainfed and .95 million hectare area is irrigated. Pujab has 16 million hectare is cultivated. Sindh only 4 million hectare and Baluchistan is less than 1 million hectare.

Environmental factors are divided into five groups;

1. Climatic factors
2. Water factors i.e. hydrophytes, xerophytes and mesophytes
3. Topographic factors or slope or elevation
4. Edapic factors i.e. soil factors, soil structure, soil texture.
5. Biotic factors ; biotic factors are also important for growth and life of plants

Classification of crops on the basis of pollination

Pollination

The transfer of pollen grains from anther to stigma of a flower. Based on pollination we have divide crops into two types

Self pollinated crops or autogamy

These crops in which pollens are transferred into the stigma of same flower, different flower on same plant and different flower on different plants of same cultivar. Self fertilized plants have close flower but 1 to 3 percent cross pollination can be occurred.

For example wheat, barley, rice and soybean

Cross pollinated crops (allogamy)

Transfer of pollen grains to stigma of different cultivars. It is carried out by insect, wind and water. They have open type flower. Cross pollination occur to an extent of 96 percent e.g. maize, safflower, sunflower, and brassica. Cross pollination by wind is called anemophily while by insect it is called entomophily.

Some reasons for allogamy

1. Self incompatibility
2. Dichogamy a. protandry (pearl millet) anther ripe before carpel. B. protogamy.
3. Cytogenetic reasons. A. translocation, aneuploidy, autopolyploidy.
4. Hetrostyle
   The situation in which the stamen and style of unequal length for example
   Pinflower have long pistil and short anthers.
   Thrumb flower have long stamens and short pistil.
   Floral mechanism
   Cleistogamy
   Their flower donot open and are internally pollinated and fertilized. It is autogamy.
   Chasmogamy
   When pollination occurs after opening of flower. It may be autogamy or allogamy.

Based on propagation

More plants are produced from single desirable plants to preserve its characteristic. A successful method is one that transferred all the desirable characters.

Sexually propagated.

These crops are propagated by seeds. Most common for example wheat, maize etc.

Asexually propagated plants

Propagated by using special parts or using certain techniques like cutting, grafting, budding and layering e.g. sugarcane, potato

Modes of photosynthesis or plant efficiency

This classification is based on the effective utilization of resources and mode of carbon dioxide fixation

1. C3 plants or inefficient plants
2. C4 plants or efficient plants
3. Crassulation acid metabolism plants

C3 plants or inefficient plants

During photosynthesis, some plants fix carbon dioxide and form a three carbon molecule called 3-phosphoglyceric acid. This pathway was first worked out by calvin and his co-workers(basham and calvin 1957). Plant with this pathway of carbon-assimilation is called C3 pathway plants. Such plants cannot utilize carbon dioxide, light, temperature and water efficiently. Therefore they are called inefficient plants

e.g. wheat, oat, rice, soybean, rye , banana, cotton

C4 plants or efficient plants (hatch and slack)

Another pathway of carbon dioxide fixation was found in some plants by Hatch and Slack (1966). In these plants the first product of photosynthesis is a four –carbon molecule. Plants which fix carbon dioxide in this way have no photorespiration and make efficient use of carbon dioxide, light, temp and water. Therefore these plants are called efficient plants. E.g. sugarcane, maize, sorghum.

Crassulation acid metabolism

Cam plant fix carbon dioxide into 4-carbon acids as do the c4 plants but fixation of carbon dioxide occurs at night when the stomata are open. Typical cam plants grow in deserts and have succulent fleshy leaves and stems with low transpiration and water requirement e.g. pineapple, prickly pear and cactus.

Classification of the basis of nutrients uptake

Crops vary in their nutrient requirements some crops add to soil fertility while others deplete the nutrient reservoir.

Restorative crops

These are crops which return nutrients and organic matter to the soil. For example barseem, alfalfa and soybean.

Exhaustive crops

Crops which feed heavily on the soil and deplete soil nutrients e.g. sorghum, tobacco and sunflower.

IDENTIFICATION OF METEROLOGICAL INSTRUMENT AND THEIR USE

Thermometer

It records the temperature of air and soil.

Thermograph

It also records temperature on the graph paper. It is automatic

Hygrometer

It measures or record humidity of the air.

Hygrograph

Measure or record humidity on the graph paper. It is also automatic.

Anemometer

It records wind speed.

Sky wane or wind wane.

It records duration of wind.

Evaporation pan.

It measures or record evaporation or loss of water from soil surface.

Sunshine record

It records duration of sunshine,

Mechanical phonograph it records intensity of light.

Rain gauge

It records or calculate amount of rain fall.

Irrigation methods.

Irrigation, artificial watering of land to sustain plant growth. Irrigation is practiced in all parts of the world where rainfall does not provide enough ground moisture. In areas of irregular rainfall, irrigation is used during dry spells to ensure harvests and to increase crop yields. Irrigation has greatly expanded the amount of arable land and the production of food throughout the world. In 1800 about 8.1 million hectares (about 20 million acres) were under irrigation, a figure that rose to 41 million hectares (99 million acres) in 1900, to 105 million hectares (260 million acres) in 1950, and to more than 273 million hectares (675 million acres) today. Irrigated land represents about 18 percent of all land under cultivation but often produces over twice the yield of non irrigated fields. Irrigation, however, can waterlog soil, or increase a soil's *salinity* (salt level) to the point where crops are damaged or destroyed. This problem is now jeopardizing about one-third of the world's irrigated land.

1. Surface irrigation
2. Sub surface irrigation
3. Sprinkle irrigation
4. Drip irrigation or trickle irrigation

Surface irrigation

In surface irrigation water is applied on the surface of soil.

Kinds of surface irrigation

1. Basin irrigation
2. Furrow irrigation
3. Border irrigation

Basin irrigation

In basin irrigation water is applied to the entire field for example supply of water to whole field.

e.g. barseem, shaftal, wheat.

Furrow irrigation

In furrow irrigation water Is applied to the plant rows in the small water channels. E.g. cabbage, maize and tomato

Border irrigation

In border irrigation water is applied to the crops or field in small strips e.g. shafta. Agroforestary trees.

Sub-surface irrigation

In sub surface irrigation water is applied from below ground surface to the roots of plants.

E.g. karez system.

Sprinkle irrigation.

Water is applied in the form of spray or foliar application.

Drip or trickle irrigation

When water is applied to the plants roots in small plastic pipes only.

TILLAGE

Mechanical manipulation of soil aimed at improving the physical condition of the soil. Tilth is physical condition of soil resulting from the tillage.

Objectives/Advantages of tillage

It improves soil structure vs. texture.

Soil structure

The aggregate of soil particles is called soil structure. Results show that round structure is good for agriculture.

Soil texture

Relative proportion of clay, silt and sand is called soil texture.

Removing of weeds or stubbles.

For the decomposition and incorporation of organic matter (plant residues)

Increase multiplication of nitrogenous bacteria.

Destroy the eggs of insect and pest.
Tillage is also important for incorporation of organic and inorganic matter.
Tillage is also important for control of soil erosion.
Water infiltration in the soil increases as a result water runoff decreases and it will decrease soil erosion.
Improve the temp of soil.
Increase water conservative.

Disadvantage of tillage

1. Extra lost, extra energy, labor and time is required.
2. Sometime it also destroys the soil particles or soil structure.
3. Intertillage damage crops
4. Higher decomposition of organic matter.
5. Tillage operation will increase the no of weeds.
6. No of microorganism will also increases.

Tillage operation

Tillage operation changes from area to area it is because of soil type, cropping pattern, soil moisture content and climatic factors.

Types of tillage:

1. On seasonal tillage
2. Off seasonal tillage
3. Special purpose tillage

On seasonal tillage consist of Preparatory tillage **and** Intertillage

Preparatory tillage has two types

Primary tillage

Secondary tillage

On seasonal tillage

Tillage operation performed for sowing of seasonal crops

Preparatory tillage

The tillage we prepare soil for growing of crops.

Primary tillage

After the harvest of crops usually deep tillage is practiced.

e.g. desi and mesion plough, mould board plough, disc plough, subsoiler and rotavater.

Secondary tillage
By which soil bed is prepared.
Sohaga conventional
Disc harrow
Cultivater or tiller
Roller
Levelers

Intertillage
Is that tillage operation when the seed is present in soil till maturity . it is performed after planting of plants e.g. earthing, thining and weeding.

Off seasonal tillage includes Post harvest tillage summer tillage**,** Winter tillage **and** Fallow tillage

Off seasonal tillage

Tillage operation required for soil conditioning but not for the immediate sowing of crops.

Post harvest tillage

After harvest crops we don't want to sow seed but we want to prepare our land only weeds and stubbles are removed. It is also important for conservation of rain water.

Sumer tillage

Is practiced in tropical zones.

Winter tillage

Is practiced in temperate zone.

Fallow tillage

Leaving the arable land un cropped for one season or for more than one season due to some reasons.

Special purpose tillage

Tillage operations performed for specific purpose is called special purpose tillage.

Subsoiling

It is also called deep tillage. Sub soiling is done once three to five years to break the hard pan below the plough layer. It is also called chiseling

Leveling

Tillage operation is used to convert un even land to smooth, see bed.

Blind tillage

Cultivating the soil with shallow tillage implements before the emergence of crop. It is practiced when germination is delayed due to some reasons.

Clean tillage

Tillage operation in which no plant is left undisturbed is called clean tillage. In clean tillage weeds are removed from crops.

Deep tillage is used to incorporated to destroy crops as well as weeds.

Mulch tillage

Tillage operation in such a way that plant residues(stubbles) or other mulch material (plastic, stones) are left on soil surface is called mulch tillage.

This tillage is implemented where temperature is high, availability of water is low.

Contour tillage

Tillage operation along the contour in order to reduce run off (speed of water).

Wet tillage

It is also called puddling. Tillage operation in standing water in order to produce an impervious layre. This layer reduces percolation and leaching fertilizers.

Minimum tillage or zero tillage

Concept of minimum tillage was started in united state in 1974 because of high costs of oil prices. Minimum tillage is aimed at reducing tillage to minimum which is necessary for good seed bed, rapid germination, satisfactory plant stand and favorable conditions. It is against primary and secondary tillage. Tillage operation can be reduced by two ways.

By omitting operations which don't give much benefit and are very costly.

Combining tillage operations by combine drill.

Disadvantages

1. Lesser seed germination.
2. Germination percent decreases.
3. Poor root development.
4. Poor nodule formation.
5. Reduce the rate of decomposition of organic matter.
6. In minimum or zero tillage weeds are controlled by herbicides but continuous use of herbicides cause pollution. Zero tillage refers to growing of crops with least soil disturbances in which unwanted crops are controlled by herbicides.
7. The seed is planted directly into the soil with special planting equipments (diplers).
8. Zero tillage is used in high erosion areas.

Dry land agriculture

Growing of crops under rainfed condition is known as dry land agriculture. Most fifty percent kpk is rainfed. Depending on the amount of rainfall dry land agriculture is divided into three categories. Dry farming, Dry land farming and Rainfed farming

Dry farming

Cultivation of crop in those areas where rainfall is less than 750 mm annually.

Dry land farming

Cultivation of crop in those areas where rainfall is greater than 750 mm .

Rainfed farming

Where rainfall is greater than 1100 mm.

Types of climate

Tropical

Climate is hot or temperature is high throughout the year.

Temperate

Summer is spring like while winter is freezing less than zero.

Subtropical

Summer very hot

Spring spring like

Winter is mild.

On the basis of rainfall

Humid

Rainfall is greater than 1000 mm per year.

Sub humid

That area where rainfall is between 600-1000mm.

Arid

Where rainfall is less than 250 mm.

E.g. thar in cholistan, thal in miawali.

Semi arid

Subtropical like temperature

250 mm to 600 mm rainfall per year.

Four types of barani cultivation practices.

1. Rainfed cultivation
2. Flood water cultivation or silabah farming
3. Rod kohi
4. Run off farming or khush kaha

Rainfed cultivation
Where plants totally depend upon rainfall. This type of cultivation is practiced in gujrat, Rawalpindi, miawali, swat, etc
Flood water cultivation
In this type of cultivation monsoon rainfall is stored in by deep tillage and then the residual water is used for cultivation of wheat in winter.
Rod kohi
In this type of cultivation rainfall on hills are collected and then diverted toward the field. This is practiced in DI khan, larkana, Dado, and some areas of Baluchistan.
Run off farming
This type of farming is practiced in Baluchistan where rainfall is less than 200 mm per year. The rainwater is collected in the area which is called catchment area. It is also called kush kawa. This practices are called water harvesting.

Problems of crop production in dry land of Pakistan.

1. Climatic factors
   High temperature
2. Soil factors
   Low organic matter, erosion, salinity or alkalinity.
3. Socioeconomic factors
   Economic condition of farmer.
   Lack of transport facilities.
   Lack of market , storage, unemployment, and political unstablity.
4. Technological factors.
   lack of modern technology in dry land.
   Improvement in agri-dry land
   Short term improvement
   Long term improvement
   Short term improvement
   1. Introduction of new technology.
   2. Availability of credits to farmers.
   3. Loans availability.
   4. Training of farmers (field dry)
   5. Supply of seeds and fertilizers.
   6. Availability of tillage implements.
      Long term improvement
      Planning in research to upgrade the existing developing infrastructure.
      Digging wells and ponds.
      Making small dams for collecting runoff water.
      Provision of education
      Health facilities
      Communication and transport facilities

Development of agro-forestry.

Green Revolution, term widely used since the 1960s to describe the effort to increase and diversify crop yields in agriculturally less advanced regions of the world

CROP

1. AGRICULTURE BOTANY **plants grown for use:** a group of plants grown by people for food or other use, especially on a large scale in farming or horticulture
2. AGRICULTURE **amount harvested:** the amount harvested from a plant or area of land, during one particular period of time
   - *a good crop of tomatoes*
3. AGRICULTURE **animals reared for produce:** a group of animals reared in farming, or something produced from them
   - *a poor crop of lambs*

A community of plant grown for economic value under filed conditions. distribution of commercial crops is governed by plant environment interaction and its adaptation is related to climatic factors, soil, topography, pest and diseases of a particular region which fulfill the plant requirement for normal growth and development. An agronomist has a key role in such situation. He can modify the production technology of crops to adapt or can acclimatize the crops to new environment.

Adaptation

The feature of plant or crops which has survival value under existing climatic conditions or habitat. And such features allow the crops to fully utilize the nutrients water, light etc for optimum growth.

Acclimation

Changing plant behavior by exposure several times to a new environment. We can say temporary changing the phenotypic characteristic of a plant to adjust the new environment.

Production technology

It refers to raising of crops on a piece of land and cover all operations needed for raising a successful crops. It includes land preparation, soil, fertilizer application, irrigation, weed/insect/pest management, harvesting and finally storage.

Choice of crops

Modern agriculture is an industry and therefore it is important to asses the choice of crops or feasibility of crops for a region. It needs basic knowledge of adaptability, basic production technology and socio economic value of crops.

General guidelines for successful crop production

1. **Selection of cultivar**
2. **Field preparation**
3. **Manure application**
4. **Seed bed preparation**
5. **Inoculation**
6. **Commercial fertilizer**.

Selection of cultivar

Select the recommended variety or cultivar for your area.
Barani is irrigated
Late vs. early
For feed or for storage
In general variety must be disease resistant and high yielding and adaptable to environment.

Field preparation

Field should be prepared at field capacity condition. The previous year stubble must be incorporated and mix with soil.

Field capacity.

Moisture condition of soil after downward drainage of gravitational water.
After harvesting stubbles should be removed properly. In barani areas ploughing should be done at proper time to conserve moisture. After ploughing the field is left as such to dry out the weeds.

Manure application

Incorporate fertilizer thirty to sixty days before sowing and should be well mixed there fore losses of nutrients will be less.

Seed bed preparation

For final seed bed preparation the fields are irrigated for fortnightly and again plough at field capacity condition. No of plowing depends upon crop nature whether it is cereal or sugar cane crop. Cereal needs shallow plowing while sugar crops need deep plowing.

Inoculation

Use of or addition of rhizobia to soil or seed. Rhizobia are nitrogen fixing bacteria. When legumes are sowing for first time rhizobia is not present in soil and should be applied from external source for example *Rhizobium japanicum* is applied to soybean crops.

Commercial fertilizer

Fertilizers are applied pre-sowing i.e. potassium and phosphorus as a single dose where as nitrogen is applied in split application half at sowing and other half at first or second irrigation. Fertilizers must be well mixed into soil. In barani areas all type of fertilizer is applied before sowing or after rainfall. Legume required less nitrogen fertilizer than other crops.
Nitrates is leaching while ammonia is volatile.

Rotation

In rotation of crops our main interest is fertility of soil while in sequential crop production is our interest. The sequential growing of crops at a piece of land to improve productivity as well as soil fertility is called crop rotation. It should be well planned. Legumes must be included e.g.

Wheat mungbean wheat

Maize gram tobacco

Seed

It is a prime importance. It must belong t refuted company. It has high purity and germination.

Sowing method

Planting it a recommended seed depth, seed rate and row to row and plant to plant distance. Seed must be covered after sowing with soil. Appropriate methods should be used.

Line sowing

Sugarcane, maize, tobacco

Broad cast

Clover, sorghum, maize.

Irrigation

Kharif crops need more irrigation than rabi crops. Irrigation must be done at evening time avoid water storage in plots.

Multi harvest crops

Some crops are multi harvest means gives us more than one single cut. After each cut plants or fields must be irrigated and fertilized to increase its succlency e.g.

Barseem, shaftal and all types of clover.

Thinning

The uprooting of extra plants from dense population is called thing. It is done to optimize plant population . it should be practiced within a month of emergence . try to uproot weak and damaged plant only. It is done to decrease input cost and to facilitate hoeing, and harvesting etc.

Thinning is based on crop nature that is morphology, crop duration and purpose of cultivation.

Long duration …..thining more

Short duration……..for fodder not thinning.

Weeding

Control weeds as early as possible using herbicides or manually. It should be completed upto reproductive stage. Use light implements and not too deep and frequent at field capcacity level.

Insect , pest and diseases

Check periodically for insects, pest and diseases control through pesticides. Disease resistant cultivar is preferred.

Harvesting and storage

Harvest the crop at harvest maturity to increase quality, quantity and to avoid shattering.

Yellowing of leaves or drying of leaves and loss of green color is indication for crop harvest stage.

Storage.

Crop store the seed at proper moisture content

For oil crop seed store at moisture 4 to 8 %.

Other cereal seed 10 to 16 % moisture.

Store in dry and clean place. Fumigate the store house before storing crop seeds.

Physiological maturity.

It is no further accumulation of dry matter through photosynthesis. At that time moisture content is 30 to 40 percent.

Harvest maturity

When moisture reach to 8 to 20 percent and have maximum dry matter.

PRODUCTION TECHNOLOGY FOR CEREAL CROPS

The edible grains are called cereal grain, grain crops. It includes in a family poacea or graminae for example wheat, maize, rice, rye, millet, barley , sorghum and triticale.

Economic importance

1. It is used as a staple food for human through out the world.
2. It occupies about fifty percent of plow land in world.
3. In Pakistan it occupies about 54 % . it dominated world agriculture because it directly or indirectly provide as major portion of human diet. It is the cheap source of calories uses as feed and forages for live stock.

PRODUCTION TECHNOLOGY OF WHEAT

General characteristics of wheat

Local name gandum

Common name wheat

Scientific name ***Triticum aestivum***

Growing season rabi

Mode of pollination

Self

Photoperiod requirement

Long day plants

Special name king of cereal

adaptation	Seed bed preparation	Sowing time	Seed rate	Method of sowing	weeding	yield	diseases	control	varieties
Wide range of climate and soil. Soil loam or clay loam	4 to 5 times plow and is followed by 1-2 planking. Farm yard manure 10-15 tons/hec NPK 135,80,00 for irrigated. 80,40,00 for rainfed. All phosphorous is applied at sowing while nitrogen is split half. Half at first irrigation while half at second irrigation. Potash is applied 60-80 kg per hectare.	Irrigate area 15nov-15 dec. Rainfed area 15 oct to 16 nov.	Irrigate 100 to120 kg per hectare For rainfed 60 to 80 kg per hecater	Broadcast Line par or drill and khora method. khora method is old one. Drill is better because decrease labor cost. Avoid seed wastage	1 to 2 weeding is enough. after 1st irrigation for effective weed control. First irrigation is done after 2 to 3 weeks of emergence. Than growth root initiation. Than at tillering stage. Than at boot stage (spike development stage), than at earing or anthesis stage. Than milk stage than harvesting at 15 april to 15 may at plain areas while in hilly areas it is done at june or july	For rainfed 1000 to 1500 kg per hectare. From irrigate area 2000 to 3000 kg per hectare. National is 2780kg per hectare.	Rust Smut Loose smut, flag smut and partial smut.	Vitavax, banlet	Saleem 2000, haider 2000, inqilabi, Khyber, bakhtawar, margala, fatha sarhad, pirsabaq Rainfed varieties Bamon, suleman, bard 1, bard 2.

PRODUCTION TECHNOLOGY OF MAIZE

Local name
maki
Botanical name zeemays
Growing seasons
Kharif and spring
Mode of pollination
Cross pollination
Photoperiod
Short day plants
Economic importance
Use as a food, feed, oil crops

Adaptation

It is adapted to diversified climate and soil from near sea level to altitude of about 1300 feet. It also grows in subtropical area or climate. It is grown from sandy to clay soil. The best soil is medium soil texture.

Cultural practices

Seed bed preparation

Four to five times plowing, followed by two to three plankings.

Farm yard manure at the rate of 15 to 20 tons per hectare. So maintain the soil. 40 to 50 days before sowing.

Nitrogen is applied at split.

NP 120, 50 kg per hectare is added.

Potassium and zinc play very important role and is added when soil test show deficiency.

Time of sowing

Spring from February to March

Kharif from May to June

Seed rate

Recommended seed rate is 30 kg per hectare for grain while recommended seed rate is 60 to 70 kg per hectare for fodder.

30 kg per hectare seed gives us 6000 to 70000 plants per hectare. Similarly plant to plant distance is 20 cm and row to row distance is 70 to 75 cm for grain maize and maintained via thinning.

Method of sowing

Maize is dual purpose crop either it is grown for grain or fodder. If it is used for grain we can use two methods

Plain bed or line

Ridges

If we use for fodder, we use only plain bed method (broadcast)

Weeding

Three to four times weeding is essential for higher products. Weeds can be controlled or either chemically or mechanically (seeding)

Hand hoeing

Weeds must be controlled before tassel formation. Weeds are higher in summer crops than winter crops due to favorable conditions. Thus must be controlled for improved productivity.

Irrigation

Maize is very responsive to water stress. Six to seven irrigation at ten to fifteen days interval. Most critical stages of water supply.

Tassel formation

Silking

Cob-development

Forty percent yield reduction occurs if water stress is imposed at tassel formation stage.

Harvesting

Crops are harvested when

1. Leaves turn out dry.
2. Silk becomes brown or dark
3. Stalk of plant turn yellow
   Moisture content at harvesting stage is twenty percent. Kept in plot, when moisture reduce to 12 to15 percent, than cobs are removed and threshed after de husking of cob.
   Cobs……….ear plus leaves.
   Ear…………grain portion without leaves.
   Storage

Store in gunny bags on cemented floor in cool and dry places.

Yield

1500 to2200 kg per hectare.
Potential 7000 kg per hectare.

Cultivars

Kissan 92, azam, shaheen, Khyber, neelum, akbar.
Diseases

Seed rot and seedling blight.

Root and stalk blight

Leaf spots

Ear and kernel rot

Smut

Insects or pests

Borers, armyworms and shoot flies.

PRODUCTION TECHNOLOGY OF RICE

Scientific name Oryza sativa
Local name chawal
Mode of pollination self pollinated crops
Photoperiod short day plant
Growing season kharif
Also called summer kharif crop.

Class monocot

Pady grain plus hull

Rice milled rice after dehulling

Root seminal plus adventitious

Seminal

That root directly develops from seed.

Adventitious

Develop from first internodes above seeds.

Adaptation

It is adapted to humid tropical climate which has plenty of rainfall, sunshine and high temperature. It is adapted to heavy clay or clay loam soil . for its production PH range should be 4.5 to 8.5 . However grow well in acidic soil due to major micro-nutrient availability.

We can store water in clay soil but we cannot store water in sand.

Sowing methods of rice.

Transplantation of nursery

Direct seeding

It is done in countries which has adequate water supply system. For transplantation we develop nursery establishment. It must be completed before 20th may. It takes 25 to 40 days for its establishment. There are three methods of nursery establishment.

Wet bed method

Dry bed method

Rabbi method

Wet bed method

Wet bed method is practiced in traditional growing area of rice. Fine texture soil in which clay content is greater than sand. Plots are puddle and pre-emerged seed are broad casted. Seed rate is 20 to 40 kg per hectare. High seed rate results in weak seedling whereas low rate encourage weed to sprout.

Dry bed method is practiced where the soil is loamy or silt loam and puddling is not possible. Plots are prepared in dry conditions or field capacity level. Seed rate is 1.5 times higher than wet bed method. Weeds control is not satisfactory.

Rabbi method is practiced in dera ghazi khan area where the soil is hard and seedling uprooting is difficult. Nursery plots are prepared with spade and crop residue is spread and burnt a day before sowing to loosen the soil. Seed rate is twice as compared to wet method. Weeds can be controlled satisfactory.

Small size seed (basmati)

Coarse seed (mehran)

Seed rate is low for fine or small size seed (basmati than coarse seed)

Production technology

Land preparation

In dry condition, upland rice production. The land is plowed 2 to 7 times and than smooth it via planking. In wet condition (low land) the soil is puddle, this puddling make an impervious layer which reduce water movement.

Fertilizer and manure application

10 to 15 tons FYM is added a month before puddling. NPK 120,60,60 is used for fine varieties.

NPK 140,60,60 is used for coarse varieties.

Zinc is an important microelement is used at the rate of 12.5 kg per hectare i.e. znso4.

Cultural practices

Land preparation

Manure and fertilizers

Transplantation

Early transplantation causes sterility of plant due to increase in temperature at anthesis stage. Late transplantation of seedling result in insects, pest and diseases attack as well as cause lower no of production tiller due to shortening of vegetative period. Time range is from twenty June to fifteen July. Good condition seedling 25-40 days old are transplanted. Two seedling per hill whereas 50 days older seedling are transplanted two to four seedling per hill. Optimum plant production is 1000,00 plants per hectare.

Irrigation

In pady land, water is allowed to stand particularly for initial twenty five to thirty five days. In transplantation the water level is kept at 3 to 4 cm, to avoid submerging of seedling. After a week, the water level is rose upto 7 to 8 cm. exchange of water is done once a month. Fresh water should be applied.

Weeding

First month of transplantation is very critical for weed infestation and reduce yield upto fifty percent. Uprooting the weeds at least twice is done.

Proper land management

Irrigation management

Herbicides

Can be used for weeds control.

Harvesting

When panicle turn out yellow and lower grains are in hard drought condition. So fifteen days before harvesting water is drained at. At harvesting moisture content of pady should be greater than twenty percent. After harvesting paddy is kept for 4 to 5 days in plots for sun drying and than store in cool and dry place.

Insect pest or diseases

Grass hopper

Leaf hopper

Plant hopper

Leaf hopper

Diseases

Foot rot

Paddy blast

Stem and leaves blight.

Chemicals

Diazine 1.15 litre per hectare for insect

Topsin M is used for diseases

Yield

2 to 2.5 tons per hectare. Coarse varieties have higher yield than fine varieties.

Cultivar

Basmati 370

Basmati 385

Ks-282

Ir .6 mehran.

PRODUCTION TECHNOLOGY FOR BARLEY, SORGHUM AND MILLET

Parameters	barley	sorghum	Millet
Local name	jow	jawar	Bajra
Scientific name	*Hordeum vulgare*	*Sorghum bicolor*	*Penisatum typhodes*
Pollination	self	self	Cross
Photoperiod	long	short	Short
Root system	Fibrous	fibrous	Fibrous
Special characters	Drought tolence Efficicient water utilization,	Drought resistance due to way leaves	Drought resistance
adaptation	Cool,temperate, sutropical	tropical	Hot and dry climate
soil	Loam to silt loam	All types of soil	All types of soil
Cultural practises			
No of ploughing	5-6	4-5	3-4
No of planking	1-2	2-3	1-2
Fertilizers NPK	50.25.0	100.50.0	80.40.40
Time of sowing	Mid oct to mid nov	3rd week of june-july	June-july
Method of sowing	Broadcast or drill	Broadcast or drill	Broadcast or drill
Row to row distance	20-30	60-00	50cm
Seed rate	50-60	6-8	6-8
weeding	No need	1-2	1-2
Insect/pest/diseases	Powdry mildew,smut and rust Army worm , aphids	Shootflies, borers.Leaf spot, blight	Smut and blight
irrigation	2-4	2-3	2-3
harvesting	March-april	Nov-dec	Sept-oct
Storage	15% moisture	12-13 % moisture	<10 % moisture
yield	0.7-12 tons per hectare	0.2 to 0.4 tons per hecatare	0.2 to 0.3 tons per hectare
cultivars	Awarum Bujawar Frontier 87 Neelum	Hagari Shaheen Kamandari Aachi jas	Der kohat kohat

PRODUCTION TECHNOLOGY FOR LEGUMES CROPS

Whose grains are edible purposes.

Pulses

The dehuled grain legume

Importance of legume

1. Cheap and excellent source of protein grain legumes
2. Poor man meat in developing countries.
3. It has higher protein than cereals.
4. It can increase soil fertility through nitrogen fixation.
5. Cereal crops are grain crops and they are rich source of carbohydrates.
6. Good source of animal and poultry feed.

parameter	Gram or channa	Lentil or masoor	Mungbean or green gram	Pigeon pear or arhar
Local name	channa	masoor	Green gram	Arhar
Scientific name	*Cicer aeritinum*	*Lens culinaris*	*Vigna radiata*	*Cajanus cajan*
Pollination	self	self	self	Cross
Photoperiod	Long	long	self	Cross
Root system	Tap root system	Tap root system	Tap root system	Tap root system
Season	rabi	rabi	Kharif or spring	Kharif or spring
Special characters	Nitrogen fixation	Nitrogen fixation resistant to cool	Not resistant to heat and drought	Nitrogen fixation
adaptation	Semi arid	semiarid	Tropical or subtropical	Subtropical or tropical
Soil and climate	Sand-sandy soil/clay Ph=4-8	Sandy to sandy clay	Loam to clay loam	Sandy loam
Cultural practises				
Land preparation				
No of plowing	1-3	2-3	3-4	1-3
No of planking	1-2	1-2	2-3	
fertilizers	15.50.50	25.60.60	20.60.60	25.50.00

				No nodule
Time of sowing	Sept to novemeber	Oct to november	June to july	
Sowing method	broadcast	broadcast	broadcast	Broad cast
Seed rate	50-60	25-30	25-30	30-40
weeding	1-2	1-2	2-3	2
irrigation	1-2	No irrigation	2-3	6-7
Insect or pest	Cater piller, aphids boreress	Aphid, weevils	aphid	Pod borer
disease	Blight, root rot	Downy mildew, rust, blight	Leaf spot or rot	Sterility mosaic virus
harvesting	March-april	March-april	Sept-oct	Oct-nov
storage	10 %	<10 %	<10 %	<10%
yield	700-800 kg per hectar	600-700 kg per hectare	800-900 kg per hectare	700-800kg per hectare
cultivar	Punjab 91, noor 91, karak 7	Masor 85,mansehra 89, precoz	NM-92,NM 98, NM 19-91	ICPL-ISI

PRODUCTION TECHNOLOGY FOR SUGAR CROPS

Sugar cane and sugar beet

By product (leaves, top) are used for the preparation of paper and also use as feed for animals. By product (molasses) are used as alcohol and remaining part of molasses called bagasses. Most of sugarcane cultivars are male sterile and therefore they donot change into reproductive stage. But there are two areas jaban (dargai) and karachi where sugarcane reach to its reproductive stage. Sugar beet reprodcuting stage is called bolting stage which occur in second year which is undesirable because sugar content decreases.

parameters	Sugar cane	Sugar beet
Local name	ghanna	Chukander
Scientific name	*Sacchrum officinarum*	*Beta vulgaris*
Mode of pollination	cross	Cross
Season	Spring or autumn	Rabi or winter
Roots	fibrous	Tap root
Adaptation	Tropical only irrigated and semi arid	Temperate or soil
Climate	Heavy soil clay to clay loam	Loam, clay to silt
Cultural practices		
Land preparation		
No of plowing	6-8	4-5
No of planking	1-2	1-2
NPK	175.80.60 125.80.40 FOR RATOONING	140.100.00
SOWING TIME	FEB-MARCH IN FURROWS	SEPT-OCT RIDGES
SEED RATE	6-7 TONS PER HECTARE	5-6KG PER HECTARE
ROOT TO ROOT	70CM	50CM
IRRIGATION	12-15	6-8
CRITICAL STRESS	MAY -JUNE	AFTER START OF PHOTOSYNTHESIS
HARVESTING	JAN –MARCH(AUTUMN) APRIL-JUNE(SPRING)	MAY-JUNE
INSECT OR PEST	BORERS, TERMITES, APHIDS, PYRILLA	CUTWORM,APHID
DISEASES	RED ROT	ROOT ROT PLUS DAMPING OFF
YIELD	40-50 TONS PER HECTARE	30-40 TONS PER HECTARE
CULTIVAR	APHID 96, MARDAN 92,93, CP 77/400	KAWA MILA, KAWA PURA, KAWE TERA

PRODUCTION TECHNOLOGY OF POTATO

POTATO

Potato, **edible starchy tuber**. It is produced by certain plants of a genus of the nightshade family, especially the common white potato. The name is also applied to the plants.

Location

The white-potato tuber is a food staple in most countries of the temperate regions of the world.

PLANT PARTS

The plant is grown as an annual herb. The stem attains a length of up to almost 1 m (almost 3 ft), erect or prostrate, with pointed leaves and white to purple flowers. The fruit is a many-seeded berry about the size of a cherry. Like the stems and the foliage, the fruit contains significant amounts of solanin, a poisonous alkaloid characteristic of the genus. The plant, native to the Peruvian Andes, was brought to Europe in the 16th century by Spanish explorers. The cultivation of the potato spread rapidly, especially in the temperate regions, and early in the 18th century the plant was introduced into North America. The earliest authentic record of its cultivation there was dated 1719, at Londonderry, New Hampshire. In ordinary cultivation, propagation is accomplished by planting the tuber or a section of the tuber **containing an eye, which is an undeveloped bud**. New varieties are developed from seed produced after controlled pollination. Improved varieties may be propagated rapidly by using cuttings from the sprouts. Rich, sandy loams are most suitable for producing the light, mealy types; heavy, moist soils produce the firm type preferred. Freshly dug potatoes contain 78 percent water, 18 percent starch, 2.2 percent protein, 1 percent ash, and 0.1 percent fat. About 75 percent of the dry weight is carbohydrate. The potato is an important source of starch for the manufacture of adhesives and alcohol.

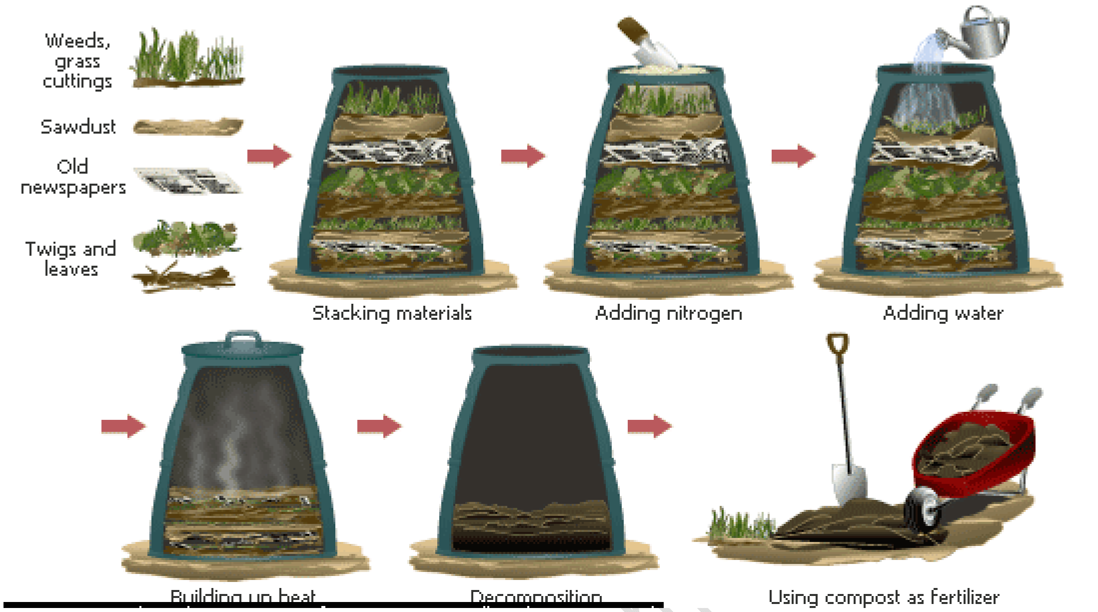
IMPORTANT DISEASES

The most important disease of the potato is late blight, caused by a fungus that rots leaves, stems, and tubers. The early blight, caused by a different fungus, is not so destructive but causes lesions that permit entry of the various forms of bacterial rot. Several forms of mosaic disease and leaf curl are caused by infection with viruses.

PESTS

The Colorado potato beetle is the most destructive of the insect pests; others include the potato leafhopper, the potato flea beetle, and species of aphids and psyllids. *See also* Sweet Potato.

Scientific classification: Potatoes are produced by plants of the genus *Solanum,* of the family Solanaceae. The common white potato is classified as *Solanum*



tuberosum .

compost

Compost, ***partially decomposed organic material used in gardening to improve soil and enhance plant growth. Compost improves the movement of water, dissolved nutrients, and oxygen through the soil, making it easier for plant roots to absorb these vital substances***.

A versatile material, compost benefits virtually any soil type.

Clay soil, for example, has tiny, tightly packed particles that hamper the flow of water, nutrients, and oxygen. Compost reconfigures the clay into larger, more loosely packed particles. The larger spaces between the particles improve the flow of water, oxygen, and nutrients to roots. In addition, the roots are able to penetrate deeper into the soil and contact more nutrients. Compost also improves sandy soil, where the large spaces between loosely packed particles enable water and its dissolved nutrients to drain too quickly for optimum root absorption. Compost soaks up and holds these substances so that the roots have more time to absorb them. Compost also adds small amounts of zinc, copper, boron, and other vital nutrients to soils.

MAKING COMPOST

Compost is made by harnessing the natural decomposition process carried out by certain species of microorganisms. These microorganisms, primarily bacteria and fungi, live in intimate association with their food supply—on the surface of dead plants, in soil, or on or in animal waste. By breaking down these materials with their digestive enzymes, the tiny creatures release and absorb the nutrients within. For home gardeners, making compost is simply a matter of collecting food for microorganisms in one place and letting them go to work.

A broad range of organic matter, including manure from plant-eating animals, grass clippings, and dead leaves or garden plants, provides a veritable feast for microorganisms. For optimal decomposition, the combined starting materials should have an appropriate carbon to nitrogen ratio, preferably 30 parts carbon to 1 part nitrogen. Leaves, straw, and paper, called brown materials, have a high carbon to nitrogen ratio, about 300 to 1, while grass clippings, kitchen scraps, and manure, called green materials, have a low carbon to nitrogen ratio, about 15 to 1. For the best mix, green materials should be added in abundance; brown materials should be used more sparingly. Materials that should not be used to make compost include manure from meat-eating animals, because it may contain disease-causing organisms that can harm humans who eat plants grown in the compost. Meat should be avoided since it may attract rodents. Fatty foods such as cheese also should not be added to the compost pile, as they are hard for most microorganisms to digest.

The starting materials are heaped into a pile—in a home garden, the pile is typically about a meter high and a meter wide (about three feet high and three feet wide); on farms, composting is done on a larger scale. The pile may sit loose on the ground or it may be enclosed using a variety of materials, including wire fencing, wood boards, cinder blocks, or widely stacked bricks.

MANAGING COMPOST

A variety of techniques may be used to increase the rate of compost decomposition. One technique is to cut the starting materials into 10- to 15-cm (4- to 6-in) pieces to increase the surface area on which the microorganisms act. Increased surface area accelerates decomposition, much like a large ice chunk melts faster if broken up into small pieces. The microorganisms in the compost pile also thrive when oxygen and moisture are present. Fluffing the compost pile every week or so with a pitchfork or other tool introduces oxygen into the pile, and sprinkling water on the pile when it dries out provides the necessary moisture.

In a well-managed compost pile, the microorganisms eat and reproduce rapidly, and heat is released as a byproduct of their intense biochemical activity. The heat in the pile kills most plant diseases and weed seeds that may have been present on the starting materials. The increased heat may also kill the microorganisms doing the decomposing as well, especially those at the center of the pile where temperatures may climb to 90° C (200° F). Mixing the materials well about once a week prevents lethal temperature increases by distributing the heat evenly throughout the pile.

The time it takes microorganisms to decompose the starting materials in compost varies. Factors include the size of the pile, the techniques used to manage the pile, and the nature of the starting materials—green materials decompose readily, while brown materials take longer to break down. In an actively managed compost pile, microorganisms use up their food supply and become less active after about six weeks. Then the pile slowly cools, signaling the near-final stages of decomposition. If the materials in a compost pile are relatively large, if the pile is not kept moist, and if oxygen is not introduced, microorganism activity is slow and the pile does not heat up. Depending upon the climate, it may take months or years for decomposition to occur.

No matter how long decomposition takes, when in its final stage, the compost pile is about half its original size and resembles dark soil. The material in the pile is now called humus—although the terms *humus* and *compost* sometimes are used interchangeably. Humus is the highly beneficial material that is added to the garden soil. Once in or on the soil, it continues to decompose at a very slow rate, releasing ammonia, carbon dioxide, and salts of calcium, phosphorus, and other elements that are beneficial for plant growth.

Humus can be added to the soil at any time of year. It can be worked into the soil, where its benefits take effect most rapidly, or it can be left on the soil surface. Humus can be used year after year, and there is never danger of adding too much, since this remarkable substance only enhances soil and encourages plants to thrive.

Cities compost on a large scale to reduce yard waste so that it does not take up space in landfills. Industries compost hazardous materials because the activities of the microorganisms help break down toxic substances into less-harmful or harmless materials. Many municipalities provide information on composting as part of their programs to reduce the amount of solid waste entering their landfills. County or regional offices of the state Cooperative Extension Service also have information on composting.

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Organic Farming

Introduction

Organic Farming, system of agriculture that excludes the use of synthetic pesticides, growth hormones, antibiotics, genetically modified seeds and animal breeds, and irradiation. Organic farmers instead rely on ecosystem management, including the use of pesticides and fertilizers derived from plants, animal wastes, and minerals. They incorporate biological methods, such as the use of one organism to suppress another, to help control pests. The methods used in organic farming seek to increase soil fertility, balance insect populations, and reduce air, soil, and water pollution.

In the United States, organic farming is a rapidly growing sector of agriculture. In 2006 organic food sales reached $16.7 billion, up from $7 billion in 2001. Exports of organic food products are also growing, particularly to Japan and Europe.

Organic farming techniques

Organic farming combines a variety of methods to maintain the health of soil, prevent soil erosion, and control pests with minimal or no use of synthetic pesticides. Conventional farmers also use some of these methods, but to a lesser degree.

Soil preservation in organic farming

Fertilizers are used to provide the minerals lacking in some soils, and to replace the minerals removed from the soil by crops as they grow. Many conventional farmers rely on concentrated chemical fertilizers that are rapidly absorbed by plants. These fertilizers produce quick growth but may kill important soil organisms, such as earthworms and beneficial bacteria. Organic farmers use manure, compost (a mixture of decaying organic matter that is rich in beneficial soil microorganisms), and other natural materials to nourish soil organisms, which in turn make minerals available to plants.

Organic farmers are more likely than conventional farmers to rotate crops, a technique that replenishes soil nutrients without the use of synthetic fertilizers. In crop rotation, a field is used for one to several years to grow one type of crop, such as corn or wheat, followed by a season in which a legume such as alfalfa or soybean is planted. Legume roots harbor beneficial bacteria that incorporate nitrogen from the air into the soil (*see* Nitrogen Fixation), enriching the soil and reducing the need for nitrogen-containing fertilizers. Crop rotation also conserves nutrients. For example, the roots of the first crop may be near the surface and the second crop's roots may be deeper, so that nutrients are drawn from different depths in the soil.

Soil held in place by plant roots is less likely to blow or wash away, or erode, than bare soil. Organic farmers minimize soil erosion with cover crops—short-lived plants, often grasses or legumes—that protect the soil between the harvesting of one crop and the planting of the next. Many organic farmers also conserve soil by practicing no-till or low-till farming, avoiding the use of plows to turn the soil, or using implements that only slice or slightly turn the soil. They may also leave the unharvested portion of a crop in the field to cover the soil, preventing soil erosion from wind or rain.

Pest management in organic farming

Conventional farms rely on an array of synthetic pesticides to kill weeds, disease-causing fungi, and harmful insects. These pesticides are manufactured by chemically processing petroleum, natural gas, ammonia, and a number of other raw materials. They include active and inactive ingredients, both of which can be highly toxic and long lasting. Organic farmers typically use pesticides primarily derived from chemically unaltered plant, animal, or mineral substances in which the active toxic ingredient breaks down rapidly to become nontoxic after being applied to the crop. Pyrethrum (a substance extracted from the chrysanthemum), a variety of soaps, and oil from the neem tree are among the insecticides used by organic farmers. Bordeaux mix, a combination of calcium carbonate and copper, is used by organic farmers to control disease-causing fungi.

In addition to using natural pesticides, organic farmers control pests by planting different crops in wide, alternating bands, a technique called intercropping. This approach interrupts the movement of disease-causing organisms through a field, since many insects and fungi feed on just one type of crop. Organic farmers also reduce insect damage by spraying crops with bacteria that kill larvae (immature insects) and planting crops that attract ladybugs, lacewings, and other beneficial insects that prey on unwanted insects.

Organic farmers use many methods for weed control. Mulching involves covering the soil around crops with straw or other materials that smother weeds. Cover crops can be planted in the fall and turned under in a few months; they help control weeds by competing with them—an oat crop, for example, grows faster than weeds and deprives them of the nutrients they need to produce seeds. Other types of cover crops, such as cereal rye, release substances from their roots that inhibit weed seed germination. Organic farmers sometimes use a variety of tractor-drawn equipment to uproot weeds that emerge with crops.

Organic farming is sometimes referred to as sustainable agriculture, although the two concepts have subtle but significant differences. Sustainable agriculture seeks to improve the entire food and agricultural system by balancing production and consumption. For example, a farmer practicing sustainable agriculture may use the manure from the animals to fertilize the fields of grain that are grown to feed the animals. Eliminating the purchase of fertilizer reduces the cost of growing grain, and growing grain for animal feed rather than buying it reduces the cost of raising livestock.

Sustainable agriculture also addresses the environmental, economic, and social issues related to agricultural systems. It attempts to ensure that arable land is protected so that current and future generations will be able to farm it successfully; many involved in sustainable agriculture also seek to preserve the vitality of family-owned farms and rural communities. A sustainable farm may not be organic, and an organic farm may not be sustainable, although they may use similar techniques.

Benefits

For consumers, the most obvious benefit of organic farming is health-related. Studies show that organically grown food contains higher levels of essential minerals than conventionally grown food. In addition, organic food is free from genetically modified organisms (GMOs), hormones, and antibiotics, and has little or no pesticide residue.

Longer-term benefits of organic farming include the preservation and enhancement of soil, increasing the likelihood that it will continue to produce quality food for future generations. Organic farming encourages healthy populations of beneficial insects that keep destructive insects under control. It also helps preserve aquatic life and clean water by minimizing the flow of toxic pesticides into streams, rivers, and lakes.

Critics of organic farming argue that the method is less profitable, requiring more labor and management skill than a conventional farm. Savings on pesticides, fertilizers, and fuels, however, usually offset the cost of the extra labor. And the environmental benefits of organic farming represent long-term savings, not just for the organic farmer, but also for future generations.

History

Prior to the invention of synthetic fertilizers and pesticides, all farming was "organic" by definition. In the modern age, one of the first proponents of organic farming was the British agriculturalist Sir Albert Howard, who, in his 1940 book *An Agricultural Testament,* advocated farming without synthetic fertilizers and pesticides. British agriculturist Lady Eve Balfour was also involved in the 20th-century organic farming movement. Her 30-year research farm, the Haughley Experiment, was the site of numerous experiments comparing organic and conventional farming. Balfour's book, *The Living Soil* (1943), corroborated Howard's studies and documented the importance of healthy soil for farming. The work of Howard and Balfour inspired American researcher and publisher J. I. Rodale to found *Organic Farming and Gardening* magazine in 1942 (now called *Organic Gardening*), which educates the public about organic techniques. Rodale also established the nonprofit Soil and Health Foundation research center (now called the Rodale Institute).

Rachel Carson, a marine biologist with the United States Fish and Wildlife Service, added momentum to the organic farming movement with her book *Silent Spring* (1962), which chronicles the harmful effects of pesticides on wildlife. Also in the United States, Helen and Scott Nearing pioneered in organic farming. Their book *Living the Good Life* (1954*)* and their numerous other publications promoted organic farming and helped inspire the back-to-the-land movement of the 1960s and 1970s.

Hydroponics

Introduction

Hydroponics, term applied to cultivation of plants in nutrient solutions without use of soil. Soilless growing of cultivated plants began in the 1930s as an outgrowth of the culture techniques used by plant physiologists in plant nutrition experiments. More recent successful methods of soilless growth differ in particulars but have two common features: (1) nutrients are supplied in liquid solutions; and (2) plants are supported by porous material, such as peat, sand, gravel, or glass wool, that acts as a "wick" in relaying the nutrient solution from its source to the roots.

Nutrients

Through photosynthesis, green plants manufacture their own organic food, using carbon dioxide and oxygen as raw materials. The nutrients usually supplied to plants by soil are almost entirely mineral salts. Plant physiologists have discovered that plants require carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, sulfur, calcium, iron, manganese, boron, zinc, copper, and probably molybdenum. Carbon, hydrogen, and oxygen are obtained in large quantities from water and air, but the remaining elements are ordinarily supplied as salts by the soil. The relative amount of each of these elements required for normal growth is different in each plant, but all plants require relatively large proportions of nitrogen, phosphorus, potassium, magnesium, sulfur, and calcium. Iron, manganese, boron, zinc, copper, and molybdenum are supplied in minute quantities, and are called micronutrients or trace elements. The specific salts used to supply these elements may be varied at the discretion of the grower; a typical solution of primary minerals is composed of distilled water containing potassium nitrate, KNO_3, calcium nitrate, $Ca(NO_3)_2$, potassium acid phosphate, KH_2PO_4, and magnesium sulfate, $MgSO_4$. In solution, the salts dissociate into ions; potassium nitrate, for example, is available to plants as the ions K^+ and NO_3^-. A solution of micronutrient salts is added to the solution of primary elements to complete the nutrient solution. A small amount of fungicide is usually added to prevent the growth of mold.

Hydroponic culture method

Several culture techniques are used. The most practical commercial method is subirrigation, in which plants are grown in trays filled with gravel, cinders, or other coarse materials, and periodically flooded with nutrient solution. The solution is allowed to drain off after each flooding and may be reused as long as sufficient minerals remain in it. The water-culture method is used widely for botanical experimentation. A common type of water culture consists of glazed porcelain jars filled with solution; the plants are placed in beds of glass wool or similar material that are supported at the surface of the solution. Roots of the plants penetrate the beds and remain in the solution. The least exact method, commonly called the slop method, is the easiest to operate. Coarse, clean sand is used in place of soil, and nutrient solution is poured on the sand in approximately equal amounts at regular intervals. A refinement of this practice is the drip method, in which a steady, slow feed of nutrient is maintained. Excess nutrient solution is allowed to drain off in both slop and drip methods.

Hydroponic culture methods are being used successfully to produce plants out of season in greenhouses and to produce plants in areas where either the soil or the climate is not suitable for the crop grown. During World War II, for example, several U.S. Army units successfully produced vegetables hydroponically at various over-seas bases. In the 1960s hydroponic farming developed on a commercial scale in the arid regions of the United States, particularly in Arizona, where research was also undertaken at state universities. In other arid regions, such as the Persian Gulf and the Arab oil-producing states, hydroponic farming of tomatoes and cucumbers is under way; these countries are also researching an additional group of crops that may be grown by this method, as they have limited arable land.

Water Cycle

Introduction

Water Cycle or Hydrologic Cycle, series of movements of water above, on, and below the surface of the earth. The water cycle consists of four distinct stages: storage, evaporation, precipitation, and runoff. Water may be stored temporarily in the ground; in oceans, lakes, and rivers; and in ice caps and glaciers. It evaporates from the earth's surface, condenses in clouds, falls back to the earth as precipitation (rain or snow), and eventually either runs into the seas or reevaporates into the atmosphere. Almost all the water on the earth has passed through the water cycle countless times. Very little water has been created or lost over the past billion years.

Storage

Enormous volumes of water are involved in the water cycle. There are about 1.4 billion cu km (about 340 million cu mi) of water on the earth, enough to cover the United States with water 147 km (92 mi) deep. Slightly more than 97 percent of this amount is ocean water and is therefore salty. However, because the water that evaporates from the ocean is almost free of salt, the rain and snow that fall on the earth are relatively fresh. Fresh water is stored in glaciers, lakes, and rivers. It is also stored as groundwater in the soil and rocks. There are about 36 million cu km (about 8.6 million cu mi) of fresh water on the earth.

The atmosphere holds about 12,000 cu km (about 2,900 cu mi) of water at any time, while all the world's rivers and freshwater lakes hold about 120,000 cu km (about 29,000 cu mi). The world's two main reservoirs of fresh water are the great polar ice caps, which contain about 28 million cu km (about 6.7 million cu mi), and the ground, which contains about 8 million cu km (about 2 million cu mi).

Almost all of the world's fresh ice is found in the ice caps of Antarctica and Greenland. These ice caps cover more than 17 million sq km (more than 6.6 million sq mi) of land to an average depth of more than 1.5 km (more than 0.93 mi). Most other glaciers, formed in mountain valleys at high latitudes, are tiny compared to the ice caps. If all of the ice in the ice caps and other glaciers melted, it would raise the sea level by about 80 m (about 260 ft).

The amount of water stored as ice on the land varies with climate. At the peak of the last ice age, about 22,000 years ago, an additional 20 million sq km (8 million sq mi) of land—including almost all of Canada, the northern fringe of the United States, northern Europe, and large tracts in Siberia—were covered with ice about 1.5 km (about 0.93 mi) thick. Because this water came from the oceans, sea level was about 120 m (about 390 ft) lower than it is today. Most water in the ice caps remains frozen for centuries and is not readily accessible.

Most groundwater is more accessible and supplies much of people's water needs in many regions of the earth. Permafrost, ground that is always frozen, forms an impermeable barrier to the flow of groundwater. Permafrost occurs in places such as northern Canada and Siberia where the annual average temperature is below 0° C (below 32° F).

Almost all groundwater fills the tiny pores and cracks in the soil and rocks. Very little is stored in subterranean caverns. Near the earth's surface, most soils and sedimentary rocks are so porous that water can occupy from 20 to 40 percent of their volume. As depth increases, the pores and open spaces in the rocks are squeezed shut. As a result, almost all groundwater is found in the top 8 to 16 km (5 to 10 mi) of the earth. Water below this depth is chemically bound in the rocks and minerals and is not readily available, but it can be released as a result of geologic processes such as volcanic eruptions (*see* volcano).

Evaporation

Evaporation is the process by which liquid water changes to water vapor and enters the atmosphere as a gas. Evaporation of ice is called sublimation. Evaporation from the leaf pores, or stomata, of plants is called transpiration. Every day about 1,200 cu km (about 290 cu mi) of water evaporates from the ocean, land, plants, and ice caps, while an equal amount of precipitation falls back on the earth. If evaporation did not replenish the water lost by precipitation, the atmosphere would dry out in ten days.

The evaporation rate increases with temperature, sunlight intensity, wind speed, plant cover, and ground moisture, and it decreases as the humidity of the air increases. The evaporation rate on the earth varies from almost zero on the polar ice caps to as much as 4 m (as much as 13 ft) per year over the Gulf Stream. The average is about 1 m (about 3.3 ft) per year. At this rate, evaporation would lower sea level about 1 m per year if the water were not replenished by precipitation and runoff.

Precipitation

Precipitation occurs when water vapor in the atmosphere condenses into clouds and falls to the earth. Precipitation can take a variety of forms, including rain, snow, ice pellets, and hail. About 300 cu km (about 70 cu mi) of precipitation falls on the land each day. Almost two-thirds of this precipitation reevaporates into the atmosphere, while the rest flows down rivers to the oceans. Individual storms can produce enormous amounts of precipitation. For example, an average winter low-pressure system drops about 100 cu km (about 24 cu mi) of water on the earth during its lifetime of several days, and a severe thunderstorm can drop 0.1 cu km (0.02 cu mi) of water in a few hours over a small area.

Runoff

Water that flows down streams and rivers is called surface runoff. Every day about 100 cu km (about 24 cu mi) of water flows into the seas from the world's rivers. The Amazon River, the world's largest river, provides about 15 percent of this water. Runoff is not constant. It decreases during periods of drought or dry seasons and increases during rainy seasons, storms, and periods of rapid melting of snow and ice.

Water reaches rivers in the form of either overland flow or groundwater flow and then flows downstream. Overland flow occurs during and shortly after intense rainstorms or periods of rapid melting of snow and ice. It can raise river levels rapidly and produce floods. In severe floods, river levels can rise more than 10 m (more than 33 ft) and inundate large areas. Groundwater flow runs through rocks and soil. Precipitation and meltwater percolate into the ground and reach a level, known as the water table, at which all of the spaces in the rocks are filled with water. Groundwater flows from areas where the water table is higher to areas where it is lower. The speed of flow averages less than 1 m (less than 3.3 ft) a day. When groundwater reaches streams, it supplies a base flow that changes little from day to day and can persist for many days or weeks without rain or meltwater. During periods of sustained drought, however, the water table can fall so low that streams and wells dry out.

Effects on human activity

Human beings have been altering the water cycle for thousands of years. Irrigation channels are constructed to bring water to dry land. Wells are dug to obtain water from the ground. Excessive pumping from wells has drastically lowered the water table, depleting some ancient water supplies irreversibly and causing the intrusion of salt water into groundwater in densely populated low-lying coastal regions. Levees are built to control the course of rivers, and dams are built to render rivers navigable, store water, and provide electrical power. Evaporation of water behind dams is a serious source of water loss. Increasing urbanization has led to more severe flooding because rainwater reaches streams more rapidly and in greater quantity from areas where the ground has been paved.

As human population continues to grow, effective use and management of the planet's water resources have become essential. Careful management of waterworks has alleviated many problems, but limits to the water supply place limits on the sustainable population of an area and can play an important part in the politics of some regions, as in the Middle East.

Nitrogen Cycle,

natural cyclic process in the course of which atmospheric nitrogen enters the soil and becomes part of living organisms, before returning to the atmosphere. Nitrogen, an essential part of the amino acids, is a basic element of life. It also makes up 78 percent of the Earth's atmosphere, but gaseous nitrogen must be converted to a chemically usable form before it can be used by living organisms. This is accomplished through the nitrogen cycle, in which gaseous nitrogen is converted to ammonia or nitrates. The high energies provided by lightning and cosmic radiation serve to combine atmospheric nitrogen and oxygen into nitrates, which are carried to the Earth's surface in precipitation. Biological fixation (*see* Nitrogen Fixation), which accounts for the bulk of the nitrogen-conversion process, is accomplished by free-living, nitrogen-fixing bacteria; symbiotic bacteria living on the roots of plants (mostly legumes and alders); cyanobacteria (formerly known as blue-green algae); archaebacteria (also known as archaea) in deep-sea hydrothermal vents and other geothermal environments; certain lichens; and epiphytes in tropical forests.

Nitrogen "fixed" as **ammonia and nitrates is taken up directly by plants** and incorporated in their tissues as plant proteins. The nitrogen then passes through the food chain from plants to herbivores to carnivores. When plants and animals die, the nitrogenous compounds are broken down by decomposing into ammonia, a process called ammonification. Some of this ammonia is taken up by plants; the rest is dissolved in water or held in the soil, where microorganisms convert it into nitrates and nitrites in a process called nitrification. Nitrates may be stored in decomposing humus or leached from the soil and carried to streams and lakes. They may also be converted to free nitrogen through denitrification and returned to the atmosphere.

In natural systems, nitrogen lost by denitrification, leaching, erosion, and similar processes is replaced by fixation and other nitrogen sources. Human intrusion in the nitrogen cycle, however, can result in less nitrogen being cycled, or in an overload of the system. For example, the cultivation of croplands, harvesting of crops, and cutting of forests all have caused a steady decline of nitrogen in the soil. (Some of the losses on agricultural lands are replaced only by applying energy-expensive nitrogenous fertilizers manufactured by artificial fixation.) On the other hand, the leaching of nitrogen from overfertilized croplands, cutover forestland, and animal wastes and sewage has added too much nitrogen to aquatic ecosystems, resulting in reduced water quality and the stimulation of excessive algal growth. In addition, nitrogen dioxide poured into the atmosphere from automobile exhausts and power plants breaks down to form ozone and reacts with other atmospheric pollutants to form photochemical smog.

TYPES OF FLOWERS

Complete flower

Those in which floral part are present e.g. tobacco, brassica, cotton

Incomplete flower

Those in which at least one floral part is missing e.g. wheat,rice

Permanent flower

In which both male and female parts are present e.g. wheat, rice, flower

Imperfect flower

Such a flower which has either male part or female part e.g. maize, date palm.

Hermaphrodite or perfect flower

Presence of male and female part on same flower is called perfect flower.

VARIATIONS

Variations in a population is the basis for selection. Such variations can be hereditary or eniornmental. Without hereditary variations any adverse change in the environment may finish a pecies in its natural habitat. Hereditary variations are important for breeding of plants they results in permanent hereditable changes in the genotype. Such variation can occur in plants due to many factors.

That donot involved changes in number of chromosomes but results from changes in number and sequences of gene of chromosomes.

Mutations

Sudden new variations or changes that is inherited. It is variously used to include individual gene changes and chromosome changes.

Polyploidy

Any organism with more than two sets of basic or monoploid (haploid) no of chromosomes. It is exact multiple of monoploid.

For example triploid three sets of chromosomes

Tetraploid, and penta ploid. 23,46,69 etc.

Aneuploid or heteroploid

It is not an exact multiple of monoploid.
Hyper…….23 multiple is 46 but here 47 forms.
Hypo………23 multiple is 46 but here 45 forms.

Recombination

The observed new combination of characters different from those shown or exhibite by parents.
Explanation
These process occurs in nature but a plant breeder strive to increase frequency and attempts to induce the desired changes. The new genotype serves as the basis for selection and further breeding. The knowledge and control of these basic processes has revolutionized plant breeding and man has been able to successfully create new and useful varieties. Origin of wheat is good example. These crops originated in nature is a result of complex hybridizations and polyploidy over a no of years. But man has been able to resynthesize this plants in only a few years by controlled crosses and induce doubling of chromosome complement of hybrids. Many species of brassica and solanum has been resynthesize. Generally autopolyploid are more vigorous than corresponding diploid and tend to have large leaves, fruits, flowers, seeds etc.
The knowledge that radiation can induce mutations are available and many chemicals also known which can induce mutations. Triple gene dwarf wheat variety is good example of induce mutation.

MODES OF REPRODUCTION IN PLANT CROPS

Reproduction is a mean of increasing population as well as maintaining continuity of species. Before initiating a breeding program a plant breeder should have a good knowledge of plant reproductive system.
Reproduction in plants can occur by three main ways.

a. Sexual reproduction
b. Asexual reproduction e.g. apomixes
c. Vegetative reproduction or cloning propagation.

INTERNATIONAL ORGANIZATIONS

1. CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURE RESEARCH (CGIAR)
2. INTERNATIONAL RICE RESERCH INSTITUTE (1961) PHILIPINE
3. INTERNATIONAL CENTRE FOR WHEAT AND MAIZE IMPROVEMENT (IMMYT)MEXICO
4. INTERNATIONAL CENTRE FOR TROPICAL AGRICULTURE (CIAT) COLUMBIA
5. INTERNATIONAL INSTITUTE FOR TROPICAL AGRICULTURE (IITA) NIGERIA.
6. INTERNATIONAL POTATO CENTRE (CIP) PERU
7. INTERNATION LABORATORY FOR RESEARCH ON ANIMALS(ILARD) ETHIOPIA
8. WEST AFRICAN RICE DEVELOPMENT ASSOCIATION (WARDA) LIBERIA
9. INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE (IFPRI) USA
10. INTERANTIONAL SERVICE FOR NATIONAL AGRICULTURE RESEARCH (ISNAR) NETHERLAND
11. INTERNATIONAL BREEDING PLANT GENETIC RESOURCE (IBPGR) ITALY
12. INTERNATIONAL CROP RESEARCH SEMIARID TROPICS (ICRSAT) INDIA Hyderabad.
13. INTERNATIONAL CROP AND RESEARCH DRY AREAS (ICARDA) SYRIA Aleppo province

    National agricultural organizations

    1. ARID ZONE RESARCH INSTITUTE (AZRI) BALOUCHSITAN Quetta
    2. BARANI AGRICULTURE DEVELOPMENT PROJECT (BADP)
    3. AGENCY FOR BARANI DEVELEPEMENT (ABAD) PUNJAB
    4. SEMI ARID ZONE DEVELOPMENT AUTHORITY (SAZA)
    5. WATER AND ARID LAND DEVELOPMENT AUTHORITY (WALDA) ISLAMABAD
    6. CHOLISTAN DEVELOPMENT AUTHORITY (CDA)
    7. NATIONAL AGRICULTURE RESEARCH CENTER (NARC)
    8. PAKSITAN AGRICUTURE RESEARCH COUNCIL (PARC)
    9. NATIONAL POTATO CENTER (NPC) ABOTABBAD

THE END