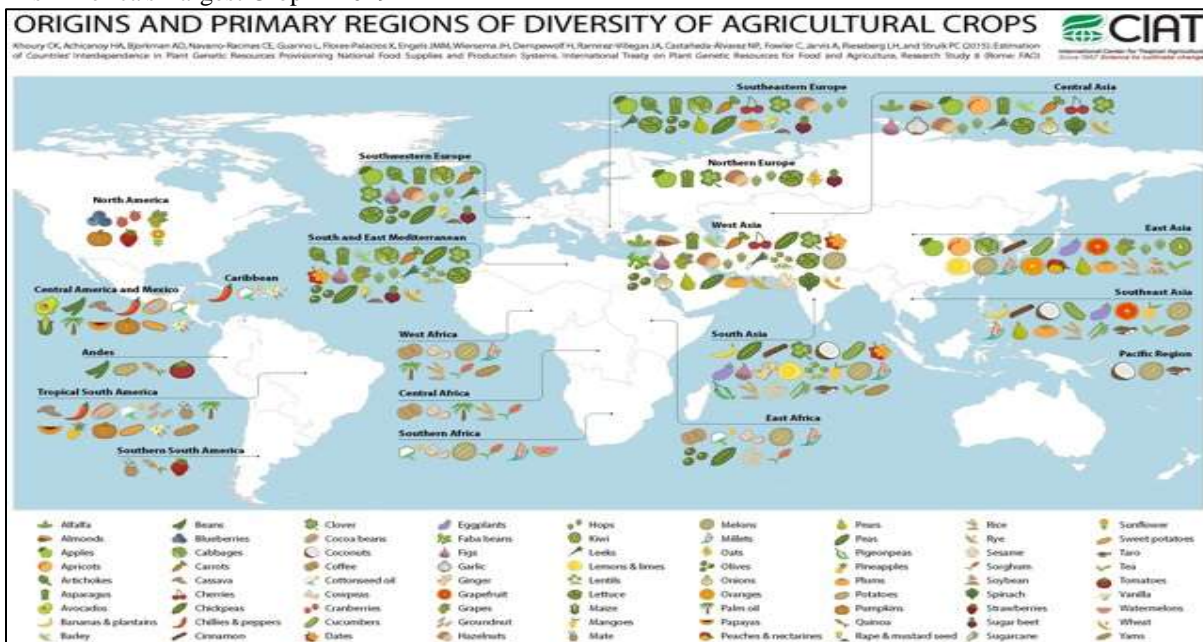




## I. INTRODUCTION

Agriculture is derived from Latin words Ager and Cultura. Ager means land or field and Cultura means cultivation. Therefore the term agriculture means cultivation of land. i.e., the science and art of producing crops and livestock for economic purposes. Agriculture is defined as follows:

- 1) It is also referred as the science of producing crops and livestock from the natural resources of the earth.
- 2) In the process of cultivation of crops the various tasks performed by farmers for crop production is called agriculture.
- 3) It is also defined as 'purposeful work through which elements in nature are harnessed to produce plants and animals to meet the human needs. It is a biological production process, which depends on the growth and development of selected plants and animals within the local environment.
- 4) Agriculture is the systematic raising of useful plants and livestock under the management of man
- 5) Agriculture is the growing of both plants and animals for human needs
- 6) Agriculture is the deliberate effort to modify a portion of Earth's surface through the cultivation of crops and the raising of livestock for sustenance or economic gain.
- 7) Agriculture includes farming in all branches and, among other things, includes the cultivation and tillage of soil, dairying, the production, cultivation, growing and harvesting of any agricultural and horticultural commodities, the raising of livestock or poultry, and any practices performed by a farmer on a farm as an incident to or in conjunction with such farming operations,
- 8) Agriculture, Agricultural Enterprise or Agricultural Activity means the cultivation of the soil, planting of crops, growing of fruit trees, including the harvesting of such farm products, and other farm activities and practices performed by a farmer
- 9) Agriculture is the science of cultivating the soil, harvesting crops, and raising livestock and also as the science or art of the production of plants and animals useful to man and in varying degrees the preparation of such products for man's use and their disposal.
- 10) Agriculture is practiced for the purpose of producing food and other human needs such as clothing, shelter, medicines, weapons, tools, ornaments, and indefinitely many more including livestock feed. It is likewise practiced as a business for economic gain.
- 11) This high-quality agricultural production is the key to success achieved by Japan because agricultural technology is more advanced than in other countries.
- 12) Corn is America's Largest Crop in 2019



The list of topics include the following:

- 1) History of Agriculture
- 2) Scope of Agriculture
- 3) Branches of Agriculture
- 4) Importance of Agriculture & Modern Economy
- 5) Scientific Agriculture
- 6) Natural Resources for Agriculture
- 7) Agricultural Technology.
- 8) Agricultural Safety
- 9) Agricultural Productivity in Crop Production
- 10) Agricultural Quality

- 11) Agricultural Cost Reduction
- 12) Agricultural Equipment
- 13) Agricultural Business Management
- 14) Agricultural Statistics
- 15) Agricultural Survey
- 16) Agriculture Sensors
- 17) Sustainable Agriculture
- 18) Application of Machine Learning in Agriculture
- 19) Types of Crops
- 20) Cost of Cultivation of Principal Crops
- 21) Crop Cultivation Systems
- 22) Crop Alteration/Modification Techniques
- 23) Crop Improvement
- 24) Consumer Ethics for Food and Agriculture
- 25) Impact of Environmental, Political, Economic factors on local Agriculture practices
- 26) Climate Resilient Agriculture
- 27) Smart Agriculture
- 28) Livestock in Agriculture
- 29) Bio Technology in Agriculture
- 30) Farming System
- 31) Small and Family Farms
- 32) Farmer Education
- 33) Food Security
- 34) Soil Testing Pesticides
- 35) Fertilizer Recommendations
- 36) Agricultural Employment
- 37) Bank Loans for Agriculture
- 38) Agricultural Drought
- 39) Conclusions & Recommendations

## **II. HISTORY OF AGRICULTURE**

The history of agriculture is the story of humankind's development and cultivation of processes for producing food, feed, fiber, fuel, and other goods by the systematic raising of plants and animals. Prior to the development of plant cultivation, human beings were hunters and gatherers. The knowledge and skill of learning to care for the soil and growth of plants advanced the development of human society, allowing clans and tribes to stay in one location generation after generation. Archaeological evidence indicates that such developments occurred 10,000 or more years ago.

The origin of agriculture was around ten thousand years ago or approximately four hundred human generations back in time and prehistory, before written records were kept. What is known is based on evidence gathered from archaeological sites. Agriculture started independently in at least three places in the world, each with a distinctive cluster of plants drawn from the local flora: Mesoamerica (Mexico/Guatemala: corn, beans, squash, papaya, tomatoes, chili, peppers), the Fertile Crescent (Middle East from the Nile Valley to the Tigris and Euphrates Rivers: wheat, barley, grapes, apples, figs, melons, lentils, dates), and north China (mid-reaches of the three-thousand-mile-long Yellow River: rice, soybeans, peaches, Chinese cabbages such as bok choy). From these regions and possibly others, notably Africa (sorghum, cowpeas, yams, oil palm), South America (potatoes, sweet potatoes, cassava, peanuts, pineapples), and a broad band of tropical southeast Asia (oranges, mangoes, bananas, coconuts, sugarcane), the invention of agricultures spread to encompass the entire world by two thousand years ago.

The earliest agriculture of southeast Asia was typically based on roots and tubers such as yams and taro, tree crops such as coconut and banana, and perennials such as sugarcane. In the Americas, vegiculture developed with cassava, sweet potatoes, arrowroot, and peanuts, and moved up the eastern slopes of the Andes, ultimately domesticating the potato. These crops spread quickly throughout the world after European contact. Potatoes displaced wheat and barley in cold soils of northern Europe and bananas became the fruit of choice in the New World tropics.

Seed agriculture dominates where either a pronounced dry season or a frost results in a single crop per year. In south China rice is the summer crop, sweet potato the winter crop. In India rice is the monsoon crop, wheat the winter crop. Sometimes intercropping (different crops in alternate rows) and relay planting (starting the next crop before the previous one is harvested) are part of the multiple-crops-per-year cycle. Sequential cropping is where one crop follows another without seasonal fallowing, sometimes in double-cropping but more often in triple-cropping.

Evidence suggests that irrigation first appeared in Egypt and Mesopotamia in the sixth millennium B.C. Various people groups began digging and repairing canal networks, which helped to regulate the flow of rivers, such as the Nile River in Egypt.

Between the 17th century and the 19th century Britain experienced a dramatic increase in agricultural productivity known as the British Agricultural Revolution. This "revolution" consisted of a variety of improvements to agricultural methods, which took place more or less simultaneously. Farmers developed new methods of crop rotation, began cultivating land that had been marshy or forested, and planted new crops such as the turnip.



Despite the great gains in industry, agriculture remained the nation's basic occupation. The revolution in agriculture -- paralleling that in manufacturing after the Civil War -- involved a shift from hand labor to machine farming, and from subsistence to commercial agriculture. Between 1860 and 1910, the number of farms in the United States tripled, increasing from 2 million to 6 million, while the area farmed more than doubled from 160 million to 352 million hectares. Between 1860 and 1890, the production of such basic commodities as wheat, corn and cotton outstripped all previous figures in the United States. In the same period, the nation's population more than doubled, with largest growth in the cities. But the American farmer grew enough grain and cotton, raised enough beef and pork, and clipped enough wool not only to supply American workers and their families but also to create ever-increasing surpluses. Other farm machines were developed in rapid succession: the automatic wire binder, the threshing machine and the reaper-thresher or combine. Mechanical planters, cutters, huskers and shellers appeared, as did cream separators, manure spreaders, potato planters, hay driers, poultry incubators and a hundred other inventions.

### III. SCOPE OF AGRICULTURE

Modern agriculture practices are increasingly turning out to be knowledge-based and hence gaining expertise in them is not an easy task for many of our rural farmers.

India does require education at all levels so that India farmers are better equipped to handle the threats of globalization. These days with the entry of Foreign Direct Investment (FDI) in the sector, many MNCs have forayed into the segment with dozens of agro-products; subsequently this has resulted as a threat to Indian farmers who lack professional expertise to better deal with the issue. Hence the need of the hour is to give agricultural education a high priority.



Despite rapid strides by the agriculture sector, still there exist many grey areas which require immediate attention. Keeping into account of the fact that increased productivity and production must be the sole objective of agricultural research, our scientific

community is leaving no stone unturned for bringing about paradigm changes in agriculture education in the country. Government of India has come up with the following assistance to facilitate better education in agriculture sector:

#### IV. BRANCHES OF AGRICULTURE

The different branches of agriculture are as follows:

- 1) Agronomy
- 2) Genetics
- 3) Plant breeding
- 4) Soil science & Soil chemistry
- 5) Plant physiology
- 6) Entomology
- 7) Horticulture
- 8) Agricultural Extension
- 9) Agricultural Economics
- 10) Agricultural Engineering
- 11) Animal Husbandry
- 12) Plant Pathology

Agronomy is a science and a practice that looks at agriculture from an integrated, holistic perspective. In agronomy, it's important to understand the properties of the soil and how the soil interacts with the growing crop; what nutrients (fertilizers) the crop needs and when and how to apply these nutrients, the ways that crops grow and develop, how climate and other environmental factors affect the crop at all stages, and how best to control weeds, insects, fungi, and other crop pests.

The process of genetic inheritance (the transmission of characteristics or qualities from parents to offspring) allows farmers and breeders to improve food security by increasing both yields and the nutritive qualities of crop varieties and livestock breeds. Modern genetics began with the work of the Augustinian friar Gregor Johann Mendel. His work on pea plants, published in 1866, established the theory of Mendelian inheritance. With the basic patterns of genetic inheritance established, many biologists turned to investigations of the physical nature of the gene. The foundation of Mendelian genetics enabled plant breeders to cross plants with new precision, carefully manipulating the plant genome to produce new, improved varieties. These breeding techniques have been used to develop higher-yielding varieties, including plants resistant to pests or disease.

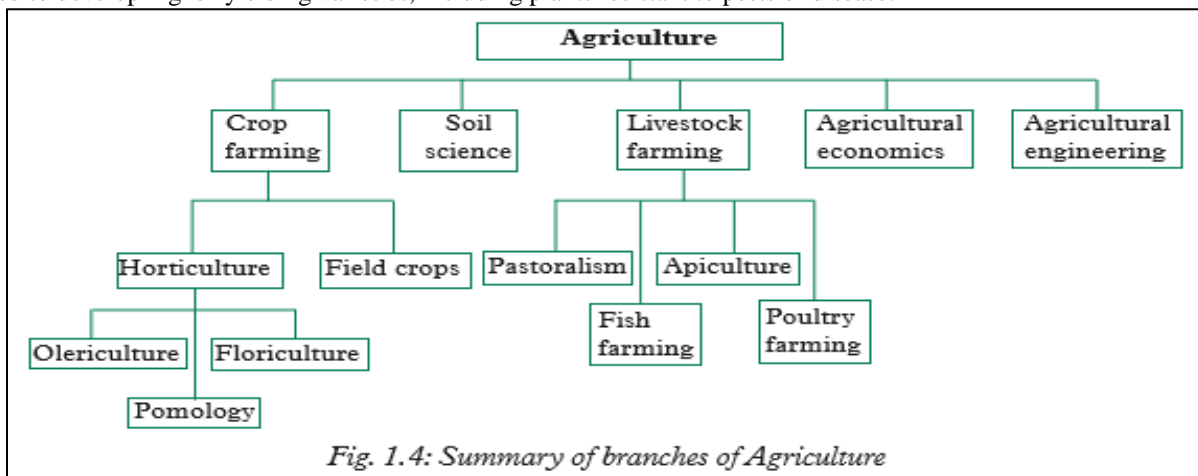


Fig. 1.4: Summary of branches of Agriculture

Plant breeding is a way to modify and improve plant species to achieve the needs and wants of humankind. Breeding is necessary to develop resistance to diseases and pests, to drought and temperature extremes, and to improve quality factors that can positively impact the lives of people throughout the world. International development agencies believe that breeding new crops is important for ensuring food security by developing new varieties that are higher yielding, disease resistant, drought tolerant or regionally adapted to different environments and growing conditions.

##### A. Methods of Plant Breeding

- 1) Selection: Selection is the most ancient and basic procedure in plant breeding.
- 2) Hybridization: The most frequently employed plant breeding technique is hybridization
- 3) Polyploidy: Most plants are diploid
- 4) Induced mutation

Soil is mixture of different material including minerals, rock, water and air that lies on top of the land containing living and dead matter. Soil science is the study of natural resource on the Earth surface called soil which includes soil classification, formation and mapping along with chemical, biological, physical and fertility properties of soils in relation to soil management. The branch of soil science involving chemistry, formation, morphology and classification of soil is pedology while edaphology includes

influence of soil on microorganisms and plants. The classification and nomenclature is based on physical and chemical properties in layers or horizons of soil. Soil Taxonomy in soil classification system uses color, structure, texture and other properties related to soil surface. Soil scientists are qualified to evaluate soil and interpret soil related data for the purpose of understanding soil resources in agricultural production, environmental quality and management or protection of environmental and human health. They also conduct research in soil classification, tillage, drainage and irrigation, soil fertility, plant nutrition and other related areas. Soil sustains life by providing food in form of essential minerals and nutrients; water and air to help survival and growth of plants, worms, fungi and bacteria. Soil not only soaks useful water and prevents the evaporation from the surface but also initiates crop growth, bio-materials production, anchor roots, allows transport of water and nutrients to the soil interface and roots of plants. Soil filters water to help in regulating the earth's temperature and important greenhouse gases. It also provides the foundation for basic ecosystem function promoted by advances in natural resource and environmental sciences. Study of soil resources is critical to the environment, food and fibre production. Understanding techniques to improve soil conservation like cover crops, crop rotation, planted wind breaks and conservation tillage that affect both soil fertility and erosion are also important. Soil plays an important role in farm ecosystem by providing nutrients essential for the growth of agricultural and horticultural crops. Fertile soil is rich in nutrients and water highly suitable for agriculture and serves as the primary nutrient base for healthy crops. Rich soil contains pH and primary plant nutrients like, nitrogen, phosphorus and potassium because of its previous or decaying content of organic matter along with minor nutrients that help in plant growth. Some of functions associated with soil include ;nutrient cycling; water regulation; ecological role in providing plant growth medium, recycling organic wastes and nutrients, modifying the atmosphere, water supply and purification, habitat for soil organisms and other normal processes that occur in the ecosystem to benefit water quality, food production and flood control that improves the economy and quality of life. Important benefits of soil include natural protector of seeds and plants; dispersal and germination of seeds within soil ecosystem; physical support system for plants; retaining and delivery of nutrients to crops.

Crop physiology is important in agriculture as well as horticultural crops because: It studies the entire plant and its communities. They deal with a plant in terms of knowledge from the different field such as soil science, plant physiology, botany etc. It aims to "increase the yield" of the plant economically." Fundamental processes such as photosynthesis, respiration, plant nutrition, plant hormone functions, tropisms, nastic movements, photoperiodism, photomorphogenesis, circadian rhythms, environmental stress physiology, seed germination, dormancy and stomata function and transpiration, both parts of plant water relations. Julius Sachs is the father of plant physiology.

Though entomology is the study of insects, medical entomology has a broader scope in that it incorporates other arthropods that may affect human health - this means arachnids such as spiders, mites, ticks and also come under the scope of a medical entomology researcher. They pollinate our crops, they serve as food sources to many humans, they also provide products we use (silk, honey, shellac, dyes and chitin). Entomology is not only focused on the agricultural area, it also can be beneficial for other fields for example textile industry.

Horticulture is the growing of flowers, fruits and vegetables, plants and nuts. and marketing of ornamental plants. Horticulture deals with intensively cultured and high-value crops. Horticultural crops include the vegetables, fruits, and nuts which are directly used by man for food, the flowers and other ornamental plants for aesthetic uses or visual enjoyment, and those used for medicinal purposes. Horticulture requires some controlled conditions, special techniques and equipment's. Whereas agriculture in bulk requires general conditions and knows how and does not need sophistication. Horticulture is subdivision of agriculture which deals with gardening of plants. Agriculture deals with cultivation of crops and also animal farming whereas Horticulture deals with cultivation only.

Agricultural extension is another name for agricultural advisory services. In practical terms, extension means giving farmers – for us, smallholders in developing countries – knowledge of agronomic techniques and skills to improve their productivity, food security and livelihoods.

Agricultural economics is defined as the economic system that produces, distributes, and consumes agricultural products and services. This represents a large interconnected supply chain on a global scale. This rapid expansion coupled with the essential role of food in our society has generated a field of economics solely dedicated to observing and predicting trends within the agriculture market landscape. Basic macro and micro-economic principles apply to farming, as do the existence of externalities such as climate change and nutritional health.

Agricultural engineering is the branch of engineering that applied engineering science disciplines and technology practices to the efficient production and processing of food, feed, fiber and fuels. This is made after merging the principles of animal biology, plant biology, mechanical, civil, electrical and chemical engineering.

The animal husbandry is the practice of breeding and raising domestic animals. The branch of agriculture concerned with the care and breeding of domestic animals such as cattle, hogs, sheep, and horses.

Plant pathology is a science that studies plant diseases and attempts to improve the chances for survival of plants when they are faced with unfavorable environmental conditions and parasitic microorganisms that cause disease. Plant Pathology has advanced techniques to protect crops from losses due to diseases. The science of plant pathology has contributed disease free certified seed production. These measures are seed treatment in seed borne diseases, soil treatment and crop rotations.

## V. IMPORTANCE OF AGRICULTURE & MODERN ECONOMY

- 1) Civilization began with agriculture, and though humanity has changed significantly, agriculture still remains very important. In certain countries, its significance is more obvious, but the reality is that every country in the world depends on agriculture for one thing or another. Here are ten reasons why agriculture is important:
- 2) It's the main source of raw materials: Many raw materials, whether it's cotton, sugar, wood, or palm oil, come from agriculture. These materials are essential to major industries in ways many people aren't even aware of, such as the manufacturing of pharmaceuticals, diesel fuel, plastic, and more. In fact, raw materials are so important in production that the economic health of a country strongly depends on how many raw materials it possesses.
- 3) It's important to international trade: Raw materials from agriculture make up a huge portion of what's traded internationally. Countries with plenty of those supplies export them and trade for materials they don't have. If a country's agriculture suffers for some reason, prices can go up and it disrupts the flow of trade. Currently, the EU is the first trader of agricultural products in the world, both for imports and exports.
- 4) It plays a big role in a nation's revenue: Speaking of trade, developing countries still get most of their national income from agricultural exports. While developed countries don't depend on agriculture as much as they used to, their economies would definitely take a hit if all exports suddenly stopped.
- 5) It provides employment: The agricultural industry is still one of the biggest sources of employment and in many areas, it's actually booming. Whether it's working as a farmer, harvester, technician for farm equipment, scientist, and so on, there are plenty of jobs available in this field. In developing countries, agricultural jobs help reduce high rates of unemployment. When it comes to reducing poverty, evidence shows that focusing on agriculture is significantly more effective than investing in other areas.
- 6) It's crucial to a country's development: Economic development is tied to a country's agriculture sector. When trade, national revenue, and employment are combined in a positive way, a country enjoys reduced poverty and boosted economic growth. Because strong agriculture results in benefits fairly quickly, focusing on it is one of the best ways to speed up development and improve a country's standing in the world.
- 7) It can help heal the environment: Agriculture possesses the power to harm or heal. When farmers prioritize biodiversity on their land, it benefits the earth. Having more biodiversity results in healthier soil, less erosion, better water conservation, and healthier pollinators. This is all good news for the environment as a whole, making agriculture an important part of the cycle of life.
- 8) It's the source of our food supply: Arguably the most important aspect of agriculture is that it's the source of the world's food supply. No matter where or what you are eating, the ingredients in your meals came from somewhere. All roads lead to agriculture. In countries dealing with food insecurity and severe malnourishment, it's because their agriculture sectors are suffering. When agriculture thrives, fewer people go hungry.



- 9) It drives innovation in technology: Because healthy agriculture is so essential to a country's well-being, it's been the setting of some of the most exciting innovations in technology. Through artificial intelligence, blockchain software, gene manipulation, and more, scientists and farmers have been figuring out ways to increase crop productivity, use less water, and reduce negative impacts on the environment. For scientists and tech companies, agribusiness is one of the most fascinating and productive fields to work in.
- 10) The state of agriculture reflects our future: When it comes to pollution and climate change, the environment and agriculture suffer the quickest and with the most clear consequences. If effective changes aren't made, climate change's impact on agriculture will decimate a country's economy and eventually wipe out the food supply. To get a better idea about where humanity is going to end up, look at agriculture. What's being done to adapt to a rapidly-changing climate? What will our food supply look like? The state of agriculture is a good litmus test of what we can expect the future to look like.

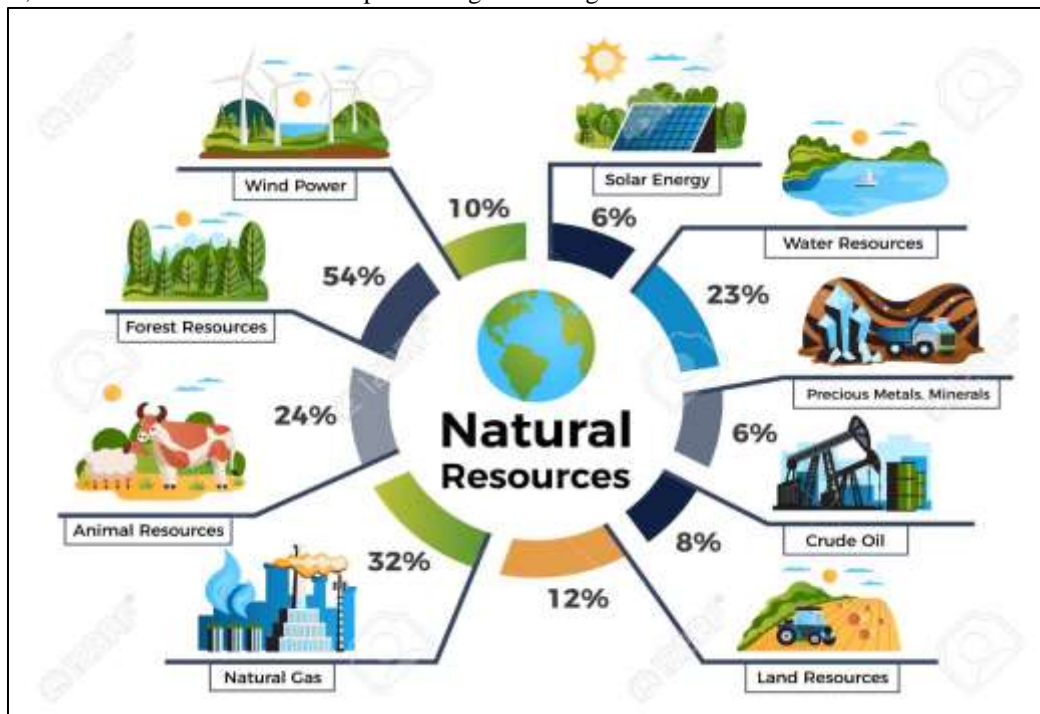
11) In many developed and developing countries worldwide, agriculture contributes a huge percentage of the national income. In fact, most developing countries' annual revenue is over 50% dependent on agriculture. Taxes collected from industries, workers, as well as those imposed on agricultural products are very important towards the effective development of the national economy.

## VI. SCIENTIFIC AGRICULTURE

The application of soil and plant sciences to land management and crop production. Agricultural biotechnology is a specific area of agricultural science involving the use of scientific tools and techniques, including genetic engineering, molecular markers, molecular diagnostics, vaccines, and tissue culture, to modify living organisms: plants, animals, and microorganisms. Agricultural sciences, sciences dealing with food and fibre production and processing. They include the technologies of soil cultivation, crop cultivation and harvesting, animal production, and the processing of plant and animal products for human consumption and use.

## VII. NATURAL RESOURCES FOR AGRICULTURE

Natural resources, especially those of soil, water, plant and animal diversity, vegetation cover, renewable energy sources, climate, and ecosystem services are fundamental for the structure and function of agricultural systems and for social and environmental sustainability, in support of life on earth. In addition, agriculture that practices tillage, fertilization, and pesticide application also releases ammonia, nitrate, phosphorus, and many other pesticides that affect air, water, and soil quality, as well as biodiversity. Agriculture, food, and natural resources workers produce agricultural goods.



This includes food, plants, animals, fabrics, wood, and crops. You might work on a farm, ranch, dairy, orchard, greenhouse, or plant nursery. You could also work in a clinic or laboratory as a scientist or engineer. Some agriculture, food, and natural resources workers market, sell, or finance agricultural goods. For example, you might market products made from plants and animals. Or, you might sell services that farmers and ranchers use to improve products. You could also work to conserve natural resources or protect the environment.

## VIII. AGRICULTURAL TECHNOLOGY

Agricultural technology or agrotechnology (abbreviated agritech, AgriTech, or agrotech) is the use of technology in agriculture, horticulture, and aquaculture with the aim of improving yield, efficiency, and profitability. Farmers and scientists have used plant selection and breeding techniques to improve crop yield for years. Modern machines can control the efforts of farmers. They reduce the time used to supply water to the crops. While Machines are useful in sowing the seeds. This technology gives farmers an additional tool to help increase crop yields. In recent years, the adoption of digital technologies in precision agriculture has been adjusting the ways that farmers treat crops and manage fields. GIS software and GPS agriculture. Satellite imagery. Drone and other aerial imagery. Examples of agricultural technology include

- 1) Indoor Vertical Farming.
- 2) Weather Tracking.
- 3) Agricultural Robots.
- 4) Advanced AI.
- 5) Precision Agriculture.
- 6) Satellite Imaging.
- 7) Mini-chromosome Technology.



**A. The Advantages/Pros/Benefits of Technology in Agriculture:**

- 1) Modern machines can control the efforts of farmers.
- 2) They reduce the time.
- 3) Used supply water to the crops.
- 4) While Machines are useful in sowing the seeds.
- 5) they are used in the transportation.
- 6) Irrigational technology.
- 7) Application of synthetic fertilizers.
- 8) Chemical pest control.
- 9) They increase the price and demand of the products.
- 10) Better marketing and exposure to the price.
- 11) Facilities in online trading and E-Commerce.
- 12) Further, Improve the fertility of the soil.
- 13) Decrease the use of water, Fertilizers which keeps the prices down.
- 14) Low run of chemicals and also waste materials into seas and water.
- 15) Reduce impact on the ecosystem.
- 16) Suitable for the campus environment.

**B. The Disadvantages/Cons/Benefit of Technology in Agriculture:**

- 1) The excessive use of chemicals by the help of machines reduces the fertility of the land.
- 2) Lack of practical knowledge the farmers cant handle the machines properly.
- 3) While the cost of maintenance is very high.
- 4) Overuse of machines may lead to environmental damage.
- 5) It is efficient but has many side effects and drawbacks.
- 6) Furthermore, Driverless agriculture machine is a liability to access the technology.
- 7) Improve the scouting programmes.
- 8) The robotic machine could not change their culture, we have to set their programme manually.
- 9) Most of the farmers are illiterates so they are unable to use the modern machines.

**IX. AGRICULTURAL SAFETY**

According to the National Institute for Occupational Safety and Health (NIOSH), One key piece of machine guarding farmers should consider is a rollover protection structure (ROPS), which is a frame or other protective device on a tractor to provide protection for the operator. According to OSHA, Workers should also be aware of hazards involving dust, hand tools, lifting, livestock handling, manure pits, mud and ponds. In industrial work environments, machine guards are required in locations to protect employees by the moving parts of machines. Machine guards can also protect employees on farms, many times significantly. Proper preparations like machine guarding, personal protective equipment (PPE) and safety training all play a role in keep[ing farm workers safe.

## X. AGRICULTURAL PRODUCTIVITY IN CROP PRODUCTION

Agricultural production means the production of any growing grass, crops, or trees attached to the surface of the land or farm animals with commercial value. Agricultural production means any activity related to maintaining an agricultural animal at an animal facility or a crop on crop operation property. Total harvest of the plot is obtained by multiplying total number of units harvested by the average unit weight. Crop productivity can then be calculated by dividing total production by the area from where the production came from. The general factors determining agricultural productivity are as follows:

- 1) Pressure of Population on Agriculture
- 2) Rural Environment
- 3) Role of Non-farm Services
- 4) Size of Holdings
- 5) Pattern of Land Tenure

In reality, production refers to the volume of output, while productivity signifies the output in relation to resources expanded. Therefore, agricultural productivity can be defined as a measure of efficiency in an agricultural production system which employs land, labour, capital and other related resources. There are some common categories used when discussing agricultural practices. Goods that come from the raising of crops and/or animals. While some agricultural goods, such as corn or beef, are direct products of the earth, others, like high fructose corn syrup, are derived from them. The trade of agricultural goods gave rise to the first exchanges in the Middle Ages. Items on this top list of agricultural products in the US fall into these categories, including:

1) Rice	29) Seeds
2) Wheat	30) Nuts
3) Pulses	31) Sugar crops
4) Livestock	32) Oil crops
5) Crops	33) Cotton
6) Edible forestry products (almonds, walnuts, etc.)	34) Herbs
7) Dairy (milk products)	35) Lavender
8) Chicken,	36) Cocoa
9) Pork	37) Coffee
10) Lamb	38) Tea
11) Mutton, goat	39) Tobacco
12) Fish farming	40) Sugarcane
13) Animals or livestock	41) Maize
14) Plants or fungi	42) Mustard
15) Barley	43) Millets
16) Cereals	44) Bamboo
17) Roots and Tubers	45) Cactus
18) Legumes	46) Jowar
19) Medicinal plants	47) Spices
20) Vegetables (Potato, Tomato, lettuce, onions, cabbage, green beans, broccoli, eggplant, spinach, carrots, okra, cucumbers, tomatoes, and pumpkins etc.,)	48) Soybeans
21) Fruits (Pears, grapes, apples, peaches, plums, mangoes, bananas, oranges, papayas, guava, sapota, pineapple, watermelons, pomegranete etc.,)	49) Ginger
22) Flowers	50) Cattle
23) Grains	51) Hay
24) Food for livestock	52) Poultry
25) Eggs/dairy	53) Hogs
26) Corn	54) Miscellaneous ag products
27) Honey	55) Peas, B
28) Meat (hogs, cattle, etc.)	56) ajra,
	57) Tur,
	58) Moong,
	59) Urad,
	60) Jute
	61) Groundnut,

## XI. AGRICULTURAL QUALITY

In developed countries, quality control measures to ensure that food products meet certain safety and quality standards play a key role in agricultural processing. The quality and safety supervision system of agricultural products along the path from farm to table has been established. With the continuous development of Internet-related technology and its application in the production,

transportation, inventory, sales, and information management of products, “Internet + agricultural products” will become an important model and development trend in agricultural production, sales, and consumption. Quality control is one of the most important aspects of supply chain management

## **XII. AGRICULTURAL COST REDUCTION**

Tips to help you reduce production costs while maintaining yield

- 1) Fine-Tune Pest Management
- 2) Lower Seed Cost
- 3) Postpone Machinery Upgrades
- 4) Boost Fertilizer Efficiency
- 5) Vary Nitrogen Rates
- 6) Target Fertilizer Applications Based on Soil Test Results
- 7) Change Your Rotation
- 8) Negotiate Lower Rent
- 9) Prepare for Future Profit
- 10) Adoption of Eco Friendly Agriculture Paradigm:- “shifting from the dominant and conventional “external input- driven” agriculture to “knowledge, skill-based and local natural resource” model.”

## **XIII. AGRICULTURAL EQUIPMENT**

### **A. Agricultural Tools**

- 1) Hand Sickle. A sickle is a hand-held agricultural tool with a variously curved blade typically used for harvesting grain crops or cutting succulent forage chiefly for feeding livestock (either freshly cut or dried as hay)
- 2) Shovel & Spade
- 3) Axe
- 4) Pickaxe
- 5) Hoe
- 6) Cutlass.
- 7) Bolt and nut.
- 8) Garden fork.
- 9) Hand fork.
- 10) Screwdriver

### **B. Tractor and power**

- Tractor / Two-wheel tractor
- Tracked tractor / Caterpillar tractor

### **C. Soil cultivation**

- Cultivator (of two main variations)
- Dragged teeth (also called shanks) that pierce the soil.
- Rotary motion of disks or teeth. Examples are: Power tiller / Rotary tiller / Rototiller / Bedtiller / Mulch tiller / Rotavator
- Cultipacker
- Chisel plow
- Harrow (e.g. Spike harrow, Drag harrow, Disk harrow)
- Land imprinter
- Plow or plough {various specialized types}
- Stone / Rock / Debris removal implement (e.g. Destoner, Rock windrower / rock rake, Stone picker / picker)
- Subsoiler
- Rotator
- Roller
- Strip till toolbar (and a variation called Zone till subsoiler)

### **D. Planting**

- Trowel (khurpi)
- Seed drill (Box Drill, Air Drill)
- Planter

**E. Adding fertilizers, pesticides, and organic manure**

- Liquid manure/slurry spreader and Liquid manure fertilizerspreader (e.g. slurry tanker or Terragator)
- Dry Manure spreader (e.g. Terragator)
- Sprayer

**F. Irrigation**

- Drip irrigation/micro spray heads
- Sprinkler system
- Center pivot irrigation
- Hydroponics
- Produce sorter

**G. Blemish sorter.**

- Color sorter
- Density Sorter
- Diameter sorter
- Internal/taste sorter
- Shape sorter
- Weight sorter

**H. Harvesting / post-harvest**

- Buckrake—for silage making
- Grain cart (with built in Grain Auger)
- Conveyor belt
- Cotton picker
- Farm truck
- Grain dryer
- Harvester / harvester built for harvesting specific crops. (e.g. Bean harvester, Beet harvester, Carrot harvester, Combine (grain) harvester / Stripper, Header, Corn harvester, Forage or silage harvester, Grape Harvester, Over-the-row mechanical harvester for harvesting apples, Potato harvester, Potato spinner/digger which is becoming obsolete, and Sugarcane harvester. Variations of harvesters are stripper cleaners and stripper loaders.
- Haulm topper
- Mechanical Tree Shaker and other Orchard Equipment
- Mower
- Rake
- Reaper-binder (now mostly replaced by the Swather)
- Rice huller
- Swather (more common in the northern United States and Canada)
- Wagon (and variations of Gravity wagons, Trailers—e.g. Silage trailers, grain hopper trailers and lighter, two-wheeled Carts)



**I. Hand harvesting**

- Flail
- Sickle (hand-held)
- Winnowing (mechanized into the winnowing machine, which has been replaced by the combine harvester)

#### **J. Hay making**

- Bale lifter (also called Bale mover or Bale spike)
- Bale wrapper
- Baler
- Hay rake
- Hay tedder
- Mower-conditioners
- Loader wagon / self-loading wagon – used in Europe, but not common in USA

#### **K. Hand hay tool**

- Hay fork



#### **L. Loading**

- Backhoe/backhoe loader
- Front end loader
- Skid-steer loader
- Telescopic handler
- Tractor-mounted forklift

#### **M. Milking**

- Bulk tank
- Milking machine
- Milking pipeline

#### **N. Animal Feeding**

- Grinder-mixer

#### **O. Other**

- Agricultural robots
- Allen Scythe
- Aquatic weed harvester
- Feed grinder
- Bale splitter
- Mixer-wagon (Diet feeder)
- Chillcuring
- Conveyor analyzer
- Hedge cutter
- Hedge trimmer
- Livestock trailer
- Mulching machine
- Post driver (and hand tool)
- Shear Grab (and power link box)
- Trailer
- Yard scraper



- 7) Population involved in agriculture (e.g. basic demographic characteristics of the holder, holder's household members working in the holding, hired workers on the holding, days of work, etc.).

## XVII. AGRICULTURE SENSORS

Sensors play a vital role in agricultural technological revolution. Key sensors in smart agriculture technology are as follows:

- 1) pH Sensors in Agriculture: The availability of nutrients is as essential to plant growth as it is to animals and living organisms. In optimizing a plant's growth potential and yielding highly productive harvests, it's imperative to have a deep and quantitative understanding of the soil conditions from which agricultural products come. Using pH sensors provides critical feedback regarding soil nutrient deficiencies or the presence of unwanted chemicals. These sensors help smart agriculture monitor daily, weekly, monthly and annual fluctuations in soil pH and nutrient levels to continue to educate the agricultural industry.
- 2) GPS Sensors: Typically associated with the automotive and cellular communication industries, GPS sensors are also advantageous to smart agriculture. From ancient settlers herding sheep with wooden staffs to the cattle drives of the Old West, keeping track of their flocks has always been of utmost importance to farmers. Modern GPS tracking of livestock has heightened the ability to monitor animals with a simple push of a button. On the mechanical side of agriculture, plant harvesting and related farming techniques have recently adopted GPS technology in highly precise vehicle guidance systems. In many farming applications, such as tilling a field, the use of auto-guided systems can optimize field routing, reduce process overlap and ultimately reduce the amount of time required to complete a task.
- 3) Agricultural Temperature Sensors: Temperature Sensors are crucial in two key categories of smart agriculture — ambient condition monitoring and mechanical asset monitoring. Ice wine harvesting, for example, is known to occur within the narrow temperature window when ambient temperatures first reach between  $-10^{\circ}\text{C}$  and  $-12^{\circ}\text{C}$  during a harvesting season. Highly accurate temperature and humidity sensors and precise predictive temperature forecasts are imperative to the ice wine industry. Temperature sensors not only play a significant role in monitoring the ambient conditions of physical space, but they play an essential role in nearly all smart agriculture asset monitoring applications.



- 4) Asset Monitoring: Asset monitoring is another application in smart agriculture in which temperature sensing plays a critical role. In addition to monitoring the plants that are harvested, temperature sensors observe the equipment that gathers these plants. Temperature sensors send out alerts whenever an equipment system requires minor maintenance, is underperforming, or is critically failing. They're used in nearly every predictive and reactive maintenance system to protect against overheating and detrimental failure.
- 5) Accelerometer Sensor: Similar to the use of temperature sensors in predictive maintenance, accelerometers are widely utilized across the smart agriculture industry to predict and assist with required maintenance. Primarily used on moving components and motors, accelerometers detect slight variations in movement and vibration inconsistencies and predict when standard maintenance is required or a compromised component needs replacement. Although not commonly associated with farming and other agriculture, accelerometers play a valuable role in the maintenance of vital smart agriculture equipment. Accelerometers are also used in a variety of automated systems and tracking methods. For example, a low-power accelerometer makes it simple to monitor the status of an adjustable spray nozzle on the end of a fertilization beam. In more recent technology, autonomous drone use in smart agriculture relies heavily on accelerometers and IMU (inertial measurement units) to track motion, speed, crash events, and even position in space.
- 6) Smart Cameras use in Agriculture: While smart camera technology is far from a stereotypical analog sensor, it has been increasingly adopted for a variety of smart agriculture applications. Companies such as Blue River Technology, a division of John Deere, have implemented smart camera technology to detect weeds and other plant locations to automatically and accurately dispense herbicides and fertilizer. This optimizes chemical utilization and increases overall productivity while decreasing chemical usage. Additionally, pest control has consistently been one of the most significant challenges in agriculture. Farmers now utilize smart cameras for real-time pest detection and monitoring to effectively seek action against pests without harming agriculturally helpful non-target insects. Smart

cameras can also replace semi-legacy sensing devices such as ambient light monitoring, which enables system simplification and a reduction in the component count.

### XVIII. SUSTAINABLE AGRICULTURE

Sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will over the long term i.e., Satisfy human food and fiber needs. Agriculture often places significant pressure on natural resources and the environment. Sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility. Sustainable agriculture integrates three main goals – environmental health, economic profitability, and social equity. A variety of philosophies, policies and practices have contributed to these goals, but a few common themes and principles weave through most definitions of sustainable agriculture. Here are the top 5 sustainable farming practices which guarantee a green and environmentally friendly growth of vegetables and plants.

- Permaculture
- Aquaponics & Hydroponics
- Using Renewable Energy Resources
- Crop Rotation & Polycultures
- Trees Can Increase Crop Yields
- Wrapping It Up
- Optimize your current use of fossil fuels
- Eliminate waste
- Reduce, or eliminate, pollution
- Recycle
- Recover energy, don't turn it into heat
- Save Time.



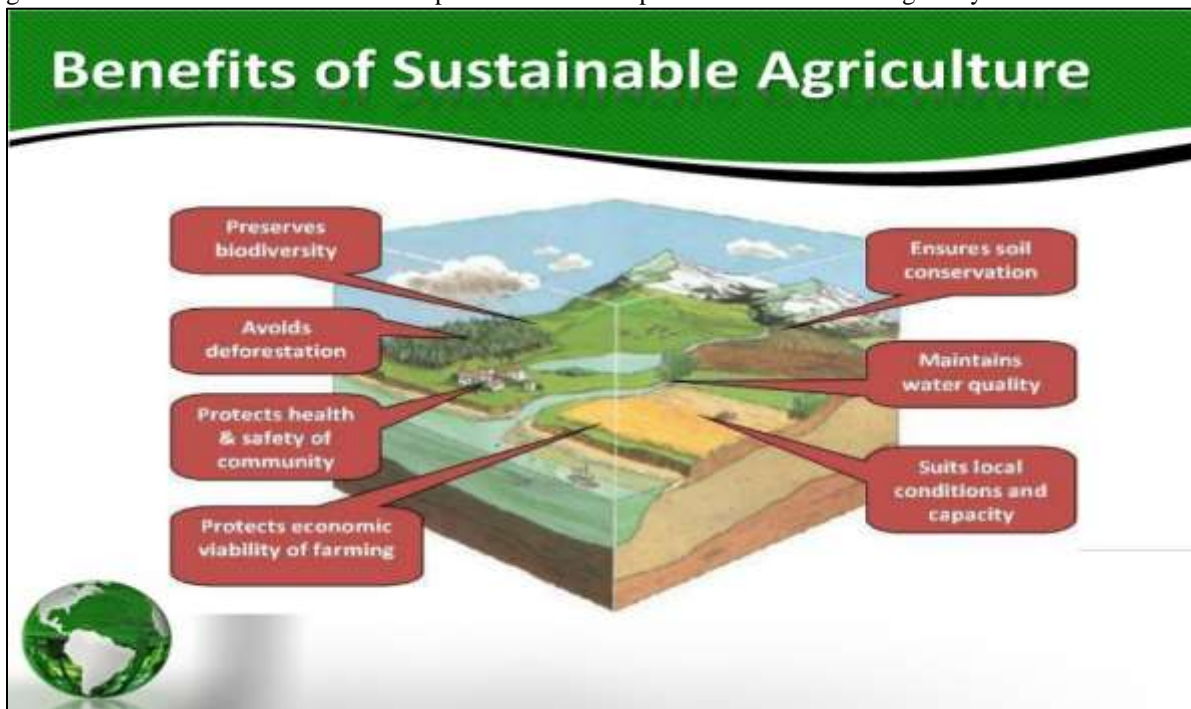
Over decades of science and practice, several key sustainable farming practices have emerged as listed below:

- Rotating crops and embracing diversity
- Planting cover crops
- Reducing or eliminating tillage
- Applying integrated pest management (IPM)
- Integrating livestock and crops
- Adopting agroforestry practices
- Green Space
- Sustainable Design and Construction
- Water Efficient Fixtures
- Renewable Clean Energy
- Waste to Energy Recycling
- Water Treatment

Here are the seven principles for sustainable agriculture listed in Greenpeace's report:

- Supply chain
- Food sovereignty
- Food production and consumption
- Biodiversity
- Soil fertility
- Ecological pest management
- Strengthen agriculture

In addition to preserving the earth's natural resources, sustainable agriculture benefits the environment through helping maintain soil quality, reducing erosion, and preserving water. The term sustainability is broadly used to indicate programs, initiatives and actions aimed at the preservation of a particular resource. However, it actually refers to four distinct areas: human, social, economic and environmental, known as the four pillars of sustainability. The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. Sustainable agriculture is a type of agriculture that focuses on producing long-term crops and livestock while having minimal effects on the environment. This type of agriculture tries to find a good balance between the need for food production and the preservation of the ecological system within the environment.



### XIX. APPLICATION OF MACHINE LEARNING IN AGRICULTURE

Machine learning is everywhere throughout the whole growing and harvesting cycle. It begins with a seed being planted in the soil, from the soil preparation, seeds breeding and water feed measurement, and it ends when robots pick up the harvest determining the ripeness with the help of computer vision. Let's discover how agriculture can benefit from Machine Learning at every stage



## A. Species Management

- 1) **Species Breeding:** Our favorite, this application is so logical and yet so unexpected, because mostly you read about harvest prediction or ambient conditions management at later stages. Species selection is a tedious process of searching for specific genes that determine the effectiveness of water and nutrients use, adaptation to climate change, disease resistance, as well as nutrients content or a better taste. Machine learning, in particular, deep learning algorithms, take decades of field data to analyze crops performance in various climates and new characteristics developed in the process. Based on this data they can build a probability model that would predict which genes will most likely contribute a beneficial trait to a plant.
- 2) **Species Recognition:** While the traditional human approach for plant classification would be to compare color and shape of leaves, machine learning can provide more accurate and faster results analyzing the leaf vein morphology which carries more information about the leaf properties.
- 3) **Field Conditions Management**
- 4) **Soil management:** For specialists involved in agriculture, soil is a heterogeneous natural resource, with complex processes and vague mechanisms. Its temperature alone can give insights into the climate change effects on the regional yield. Machine learning algorithms study evaporation processes, soil moisture and temperature to understand the dynamics of ecosystems and the impingement in agriculture.
- 5) **Water Management:** Water management in agriculture impacts hydrological, climatological, and agronomical balance. So far, the most developed ML-based applications are connected with estimation of daily, weekly, or monthly evapotranspiration allowing for a more effective use of irrigation systems and prediction of daily dew point temperature, which helps identify expected weather phenomena and estimate evapotranspiration and evaporation.
- 6) **Crop Management**
- 7) **Yield Prediction:** Yield prediction is one of the most important and popular topics in precision agriculture as it defines yield mapping and estimation, matching of crop supply with demand, and crop management. State-of-the-art approaches have gone far beyond simple prediction based on the historical data, but incorporate computer vision technologies to provide data on the go and comprehensive multidimensional analysis of crops, weather, and economic conditions to make the most of the yield for farmers and population.
- 8) **Crop Quality:** The accurate detection and classification of crop quality characteristics can increase product price and reduce waste. In comparison with the human experts, machines can make use of seemingly meaningless data and interconnections to reveal new qualities playing role in the overall quality of the crops and to detect them.
- 9) **Disease Detection:** Both in open-air and greenhouse conditions, the most widely used practice in pest and disease control is to uniformly spray pesticides over the cropping area. To be effective, this approach requires significant amounts of pesticides which results in a high financial and significant environmental cost. ML is used as a part of the general precision agriculture management, where agro-chemicals input is targeted in terms of time, place and affected plants.
- 10) **Weed Detection:** Apart from diseases, weeds are the most important threats to crop production. The biggest problem in weeds fighting is that they are difficult to detect and discriminate from crops. Computer vision and ML algorithms can improve detection and discrimination of weeds at low cost and with no environmental issues and side effects. In future, these technologies will drive robots that will destroy weeds, minimizing the need for herbicides.

## B. Livestock Management

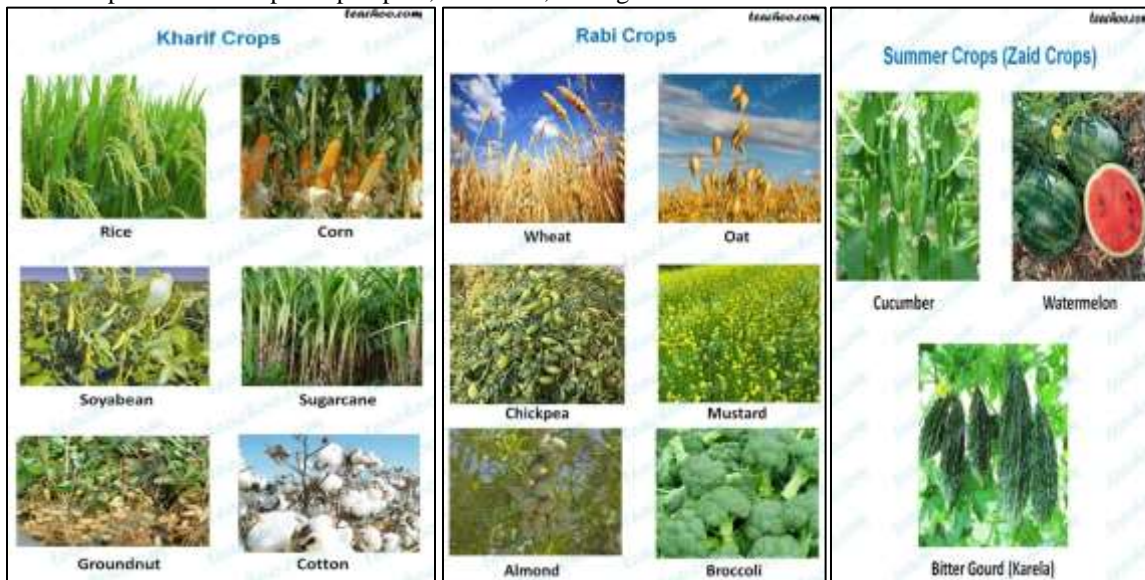
- 1) **Livestock Production:** Similar to crop management, machine learning provides accurate prediction and estimation of farming parameters to optimize the economic efficiency of livestock production systems, such as cattle and eggs production. For example, weight predicting systems can estimate the future weights 150 days prior to the slaughter day, allowing farmers to modify diets and conditions respectively.
- 2) **Animal Welfare:** In present-day setting, the livestock is increasingly treated not just as food containers, but as animals who can be unhappy and exhausted of their life at a farm. Animals behavior classifiers can connect their chewing signals to the need in diet changes and by their movement patterns, including standing, moving, feeding, and drinking, they can tell the amount of stress the animal is exposed to and predict its susceptibility to diseases, weight gain and production.
- 3) **Farmer's Little Helper:** This is an application that can be called a bonus: imagine a farmer sitting late at night and trying to figure out the next steps in management of his crops. Whether he could sell more now to a local producer or head to a regional fair? He needs someone to talk through the various options to take a final decision. To help him, companies are now working on development specialized chatbots that would be able to converse with farmers and provide them with valuable facts and analytics. Farmers' chatbots are expected to be even smarter than consumer-oriented Alexa and similar helpers, since they would be able not only to give figures, but analyze them and consult farmers on tough matters.

## XX. TYPES OF CROPS

Major crops can be classified into

- 1) Food crops – for human needs (e.g. wheat, maize, legumes, rice, potatoes, tomatoes)
- 2) Feed crops – for cattle or livestock consumption (e.g. barley, beets, grasses for domestic animals to graze and store as hay or silage)

- 3) Cash crops- Sugarcane, Oilseeds, Horticulture crops, Tea, Coffee, Rubber, Cotton and Jute.
- 4) Fiber crops – for the sake of fibers used in clothes, bedding, industry, and household (hemp, cotton, flax, bamboo)
- 5) Oil crops – for oil manufacturing either for machinery fuel (rape) or food industry (sunflower, olives)
- 6) Ornamental crops – for home decoration and landscape design (garden or pot flowers and bushes)
- 7) Industrial crops – for industrial manufacturing (rubber)
  - 1) Kharif Crops: The word “Kharif” is for autumn since the season coincides with the beginning of autumn or winter. As cultivation of these crops happens in the monsoon season, another name for Kharif crop is monsoon crop. The Kharif season differs in every state of the country but is generally from June to September. We sow the crop at the beginning of the monsoon season around June and harvest by September or October. Rice, maize, bajra, ragi, soybean, groundnut, cotton are all Kharif crops.
  - 2) Rabi Crops: As these crops harvest in the springtime hence the name. The Rabi season usually starts in November and lasts up to March or April. Cultivation of Rabi crop is mainly through irrigation since monsoons are already over by November. In fact, unseasonal showers in November or December can ruin the crop. Farmers sow the seeds at the beginning of autumn, which results in a spring harvest. Wheat, barley, mustard and green peas are some of the major rabi crops that grow in India.
  - 3) Zaid Crops: There is a short season between Kharif and Rabi season in the months of March to July. In general, Zaid crops are crops that grow in this season. Also, these grow on irrigated lands. So we do not have to wait for monsoons to grow them. Some examples of Zaid crops are pumpkin, cucumber, bitter gourd.



S.No	Cropping Season	Time Period	Crops
1	Rabi	Sown: October-December Harvested: April-June	Wheat, barley, peas, gram, mustard etc.
2	Kharif	Sown: June-July Harvested: September-October	Rice, maize, jowar, bajra, tur, moong, urad, cotton, jute, groundnut, soybean etc.
3.	Zaid	Sown and harvested: March-July (between Rabi and Kharif)	Seasonal fruits, vegetables, fodder crops etc

## XXI. COST OF CULTIVATION OF PRINCIPAL CROPS

Cost of cultivation refers to the total expenses incurred in cultivating one hectare of pineapple. The average cost of cultivation is ascertained by dividing the total cost by the total area of land for each analysis. The cost of cultivation is worked out by input wise and operation wise together with their percentage to the total.

- 1) Total cost of cultivation = Total variable Cost + Total fixed cost.
- 2) Total income = Yield (kg) × Market price of the crop (Rs. / kg)
- 3) Net profit = Total income - Total cost of cultivation.
- 4) Benefit:cost Ratio = Cost of total benefit / Cost of production.

## XXII. CROP CULTIVATION SYSTEMS

Cultivation is the act of caring for or raising plants. Your desire to grow your own fruits and vegetables in the backyard means you'll be engaged in some heavy cultivation. The word cultivation is most often used to talk about the ways that farmers take care of crops. Top 13 Types of Agriculture include the following:

- 1) Shifting Cultivation. Shifting cultivation is commonly practiced in the tropics

- 2) Nomadic Herding
- 3) Rudimentary Sedentary Tillage
- 4) Livestock Ranching/Pastoral Farming
- 5) Commercial Plantations
- 6) Mixed Farming
- 7) Specialized Horticulture
- 8) Subsistence Farming
- 9) Intensive Subsistence Farming with/without Rice as a Dominant Crops
- 10) Mediterranean Agriculture
- 11) Dairy Farming
- 12) Commercial Grain Farming
- 13) Arable Farming

### **XXIII. CROP ALTERATION/MODIFICATION TECHNIQUES**

Each of these methods have similarities and differences, and some work better for some traits rather than others. Each of them modifies the genetic makeup of the plant in order to combine useful traits together to improve agriculture. The following are the crop modification techniques:

- 1) **Traditional Crossbreeding:** For millennia, traditional crossbreeding has been the backbone of improving the genetics of our crops. Typically, pollen from one plant is placed on the female part of the flower of another, leading to the production of seeds that are hybrids of the two parents. Then, plant breeders select the plants that have the beneficial traits they are looking for to go on to the next generation. Apple varieties such as the Honeycrisp apple were developed in this way – thousands of hybrid trees were made, grown, and tested to find just one great new variety with a combination of genes that has never existed before. Modern plant breeding often uses genetic markers to speed the selection process, and may incorporate genes from wild varieties and closely-related species. Crossbreeding can only make use of desirable traits if they are in the same or closely-related species, so additional techniques have been developed to create new traits for plant breeders to use.
- 2) **Mutagenesis:** In nature, new traits often arise through spontaneous mutations. In the past century, this process has been mimicked by scientists, who have used mutating chemicals (such as ethyl methanesulfonate) or radioactivity to generate random mutations in plants, and subsequently screening for new or desired traits. The mutations that they carry give these fruit their characteristic deep red color.
- 3) **Polyploidy:** Most species have 2 sets of chromosomes: one set inherited from each parent. This is known as diploidy. Polyploidy is the occurrence of more than 2 sets of chromosomes. It can occur naturally, but polyploidy can also be induced through the use of chemicals. This crop modification technique is usually used to increase the size of fruits or to modify their fertility.
- 4) **Protoplast Fusion:** When sperm cells in pollen combine with the ova in the ovaries of a flower, this is a fusion of two cells into one. Protoplast fusion is an artificial version of this process. Beneficial traits can be moved from one species to another by fusing the protoplasts ('naked' cells without the cell walls that give plants their structure) together and growing a plant from the newly fused cell. One of the most commonly used traits that has been developed with this process is the transfer of male sterility between species. If you have a male sterile plant, you can more easily make hybrid seeds – especially for plants that have small flowers and are difficult to cross. Male sterility was introduced to red cabbage from daikon radishes, making it easier to produce hybrid seeds of this crop.
- 5) **Transgenesis:** Transgenesis is the process by which you introduce one or more genes into an organism from another organism entirely. This usually involves handling and modifying the DNA itself in a test tube, and then packaging it to insert it into the new organism. There are several ways to introduce the new gene or 'transform' a plant such as biolistics (the "gene gun"), using *Agrobacterium* – a naturally occurring organism that inserts DNA into plants, or by using electricity – a process called electroporation. Transgenic plants have been generated with many useful traits, some of which have been commercialized. For instance, papayas were transformed with a gene from the virus that infects the plant to make it resistant to the virus. Other traits include insect resistance, herbicide tolerance, and drought tolerance, and more. The creation of these 'transgenic' crops works even though the genes can come from any other species because the genetic language is universal to all life on this planet. Genes that originated from the same species can be called 'cisgenic' or 'intra-genic'. For more information, see this paper.
- 6) **Genome editing:** Genome editing consists of using an enzyme system to change the DNA of a cell at a specified sequence. There are different systems that can be used for genome editing, the most promising of which is the CRISPR-Cas9 system (for more information on genome editing and how it works, please view this post). The sulfonylurea (SU) herbicide tolerant canola was developed to enable farmers to better control weeds and to enable crop rotation. The crop was created using a patented genome editing system known as Rapid Trait Development System (RTDS). You could conceivably edit the genome of any crop to alter any gene you wanted, from introducing new genes to restoring 'natural' alleles from the ancestors of our crops.

## XXIV. CROP IMPROVEMENT

Crop improvement refers to the genetic alteration of plants to satisfy human needs. In prehistory, human forebears in various parts of the world brought into cultivation a few hundred species from the hundreds of thousands available. In the process they transformed elements of these species into crops through genetic alterations that involved conscious and unconscious selection, the differential reproduction of variants. Through a long history of trial and error, a relatively few plant species have become the mainstay of agriculture and thus the world's food supply. This process of domestication involved the identification of certain useful wild species combined with a process of selection that brought about changes in appearance, quality, and productivity.

In the twentieth century plant breeding developed a scientific basis, and crop improvement was understood to be brought about by achieving favorable accumulations and combinations of genes. Taking advantage of known genetic diversity could facilitate this, and appropriate combinations were achieved through recombinations brought about by the hybridization process. Furthermore it was possible to move useful genes by special breeding strategies.

A number of genetic techniques were developed and refined in twentieth-century breeding, such as improved techniques to search for and store increased genetic variability, different techniques to develop variable populations for selection, and improved methods of testing to separate genetic from environmental effects. The exact details of the process for crops necessarily differed among naturally cross-pollinated plants (such as maize) and naturally self-pollinated plants (such as soybean or tomato) as well as those plants in which vegetative propagation (usually cross-pollinated) permitted the fixing of improved types directly. Techniques, and methods regarding how to increase your crop yield are as follows:



- 1) Plant Early, Plant Effectively
- 2) Practice Seasonal Soil Rotation
- 3) Know The Yield Potential
- 4) Always Scout Your Fields
- 5) Ensure Proper Water Drainage
- 6) Utilize Fertilizers
- 7) Test Your Soil.
- 8) Weed Early and Often
- 9) Seed Quality
- 10) Access to New Technology
- 11) Planting Methods

## XXV. CONSUMER ETHICS FOR FOOD AND AGRICULTURE

Agricultural ethics is a form of practical ethics that addresses ethical issues or questions that arise in conjunction with the production and distribution of food and fiber goods. Ethical food production includes consideration of people (workers' welfare, whether on small farms, producer co-operatives, large estates or plantations), the environment (centred on environmental sustainability) and animals (mainly concerned with animal rights and welfare). Ethical Issues Facing the Agricultural Industry are as follows:

- Safety of Food. This is probably the one the general public knows the most about. ...
- Treatment of Animals. Next is the unethical treatment of animals
- Use of Chemicals. The use of pesticides and other chemicals has been an ongoing debate
- Farm Management
- Sustainability
- Trade Agreements
- Sharing Of Information

Being an ethical consumer means buying products which were ethically produced and/or which are not harmful to the environment and society. ... Being an ethical consumer can also involve watching your food miles: how much energy was used getting the product to you. The principles of consumer ethics are

- Beneficence
- Non-maleficence,
- Autonomy
- Justice
- Truth-telling
- Promise-keeping
- Accountability
- Fidelity
- Veracity

## **XXVI. IMPACT OF ENVIRONMENTAL, POLITICAL, ECONOMIC FACTORS ON LOCAL AGRICULTURE PRACTICES**

Environmental factors that influence the extent of crop agriculture are terrain, climate, soil properties, and soil water. It is the combination of these four factors that allow specific crops to be grown in certain areas. Environmental factors include temperature, food, pollutants, population density, sound, light, and parasites. Climate, land relief, soil and vegetation are the main factors which influence agricultural activity. The growth of plants depends on the temperature and humidity of the land and the amount of light it receives. We also cant grow plants in areas of severe drought. Political Factors, or government policies and administrative practices, can have a great impact on economic development, which is the movement from farming-based cultures to industrialized societies. Political factors influence economic development by positively or negatively influencing the process of development. Impact of Socio-economic factors on agriculture are as follows:

- Land Tenancy
- Size of Holdings and Fragmentation of Fields
- Consolidation of Holdings and Operational Efficiency
- Labour
- Capital
- Mechanization and Equipment's
- Transportation Facilities
- Marketing Facilities

## **XXVII. CLIMATE RESILIENT AGRICULTURE**

Agricultural resilience is about equipping farmers to absorb and recover from shocks and stresses to their agricultural production and livelihoods. Some shocks are short-term, others long-term. And some are more severe while others slowly erode farmers' ability to farm. Climate Resilient Agriculture can be defined as 'agricul- ture that reduces poverty and hunger in the face of climate. change, improving the resources it depends on for future. generations.' In terms of climate change, resilience means strengthening the ability of human and non-human systems to withstand and respond to changes in the earth's climate, and it can be thought of as a way to bridge the conceptual divide between mitigation approaches to climate change on the one hand and adaptation approaches. Climate resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks.

## **XXVIII. SMART AGRICULTURE**

Smart Farming is an emerging concept that refers to managing farms using modern Information and Communication Technologies to increase the quantity and quality of products while optimizing the human labor required. Climate-smart agriculture (CSA) is an integrated approach to managing landscapes—cropland, livestock, forests and fisheries--that address the interlinked challenges of food security and climate change. Overview. A growing global population and changing diets are driving up the demand for food. Smart Farming is focussed on the use of data acquired through various sources (historical, geographical and instrumental) in the management of farm activities. Smart systems differentiate themselves through their ability to record the data. It helps in automated farming with the collection of data for further analysis to provide the operator with accurate information for better decision making to gain high quality output of the product. The goal of smart agriculture research is to ground a decision making support system for farm management.



## XXIX. LIVESTOCK IN AGRICULTURE

Livestock agriculture is concerned with raising and maintaining livestock, primarily for the purposes of producing meat, milk, and eggs. Livestock agriculture is the market or consumer for a significant portion of U.S. crop agriculture. The use of livestock and its sub product manure are important in crop production. Livestock is a source of energy providing draught animal power while manure improves soil structure and fertility as well as water retention. Both uses are environmentally friendly improving energy and nutrient cycling. Livestock have also provided leather, wool, other raw materials, and transport. Livestock furnish high quality protein and energy foods, and function as part of integrated, renewable systems of plant and animal agriculture. Types of Livestock Farming are as follows:

- Intensive Livestock Farming.
- Semi-intensive Livestock Farming
- Extensive Livestock Farming
- Nomadic Livestock Farming
- Transhumant Livestock Farming
- Organic Livestock Farming



### A. Low Maintenance Farm Animals

- Rabbits. Rabbits are inexpensive, require a small amount of space and can be a great meat source
- Chickens. Many farmers start with chickens due to the fact that they serve many purposes
- Beef cattle are generally the most profitable and easiest livestock to raise for profit.
- Ducks. Ducks are another animal that require little space
- Honeybees
- Sheep
- Goat
- Pigs
- Elephants
- Horses
- Dairy Cattle

### XXX. BIO TECHNOLOGY IN AGRICULTURE

Agricultural biotechnology is a range of tools, including traditional breeding techniques that alter living organisms, or parts of organisms, to make or modify products; improve plants or animals; or develop microorganisms for specific agricultural uses. It helps in modifying plants, animals, and microorganisms and improve their agricultural productivity. Techniques like vaccines, tissue culture, genetic engineering are also used. Agriculture bio-technology includes the following:

- Vaccines
- Antibiotics
- Flowers
- Biofuels
- Plant and Animal Breeding
- Pest Resistant Crops
- Pesticide-Resistant Crops
- Nutrient Supplementation

#### **B. Biotechnology is divided into the following types:**

- Medical biotechnology involves the use of living cells to develop technologies for the improvement of human health
- Agricultural Biotechnology
- Nutrient Supplementation
- Abiotic Stress
- Industrial Biotechnology
- Strength Fibres
- Biofuels
- Healthcare

### XXXI. FARMING SYSTEM

A farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Farming system is a mix of farm enterprises such as crop, livestock, aquaculture, agro forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of the family goal. This farming system consists of two types of farming, namely: large-scale commercialized farming, and scattered small-holder farming. Both kinds of agriculture use a mixed system of agricultural production. The main crop grown are grains. Types of Farming are as follows:

- Arable: Crops
- Pastoral: Animals
- Mixed: Crops and animals
- Subsistence: Grown just for the farmer and his family
- Commercial: Grown to sell
- Intensive: High inputs of labour or capital usually small
- Extensive: Low inputs of labour or capital
- Sedentary: Permanently in one place
- Commercial Farming
- Nomadic Farming

### XXXII. SMALL AND FAMILY FARMS

Their choices are constrained, but they farm their own land and produce food for a substantial proportion of the world's population. Besides farming they take on multiple (often informal) economic activities to contribute towards their small incomes.



Family farms as “any farm organized as a sole proprietorship, partnership, or family corporation. Family farms exclude farms organized as nonfamily corporations or cooperatives, as well as farms with hired managers”. A farm is a tract of land cultivated for the purpose of agricultural production. A farm is classified of having \$1,000 or more of agricultural products being produced or sold. A Small Farm, according to USDA census is a farm that is 179 acres or less in size, or earns \$50,000 or less in gross income per year. Small farms are also better at conserving the natural resource base than larger farms. For example, in the U.S., small farms preserve 17% of the land as natural forest, compared to only 5% on large farms. What's more, they devote more than twice as much of their land to soil-improving practices.

### XXXIII. FARMER EDUCATION

Farmer education is complementary to the research and development activities that take place in the farm sector because the application of scientific knowledge for agricultural development becomes a major concern when the human resources involved in it are unskilled and incompetent due to mass illiteracy. Primarily, farmers are trained through hands-on experience and are not required to have a college degree. However, associate's and bachelor's degrees in farming or agriculture are available. Aspiring farmers can learn through apprenticeships or by being supervised and trained by experienced farmers. Education is important to the improvement of agricultural productivity such that formal education opens the mind of the farmer to knowledge, non-formal education gives the farmer hands-on training and better methods of farming and informal education keeps the farmer abreast with changing agricultural technology. Training helps farmers to incorporate the latest scientific advances and technology tools into their daily operations. The results of enhancing their operations with these tools increases efficiency and can also lead to: Less harm to the environment. Reduced food contamination.



### XXXIV. FOOD SECURITY

Food which provides Minimum Nutritional Value is a basic need of every citizen of country. Minimum nutritional value signifies food which provide minimum amount of nutrient like Proteins Vitamins, Iron, Calcium etc. per day. If government fails to provide food security in any part then that part suffers from Lack of Food Security. In our country, regions which are economically less

developed and regions which suffers from natural disasters where supplying of food is not possible uncertain food supply. Food security involves the following:

- Availability of food
- Access to food
- Utilisation of food
- Stability
- Malnutrition

**A. National Food Security System:**

- 1) The main objective of this system is to ensure food availability to all.
- 2) It also focuses on increasing the agricultural production and fixing the procurement price. Procurement price i.e. the price with which government purchase the crop from farmers.
- 3) It consists of two components
- 4) Buffer Stock
- 5) Public Distribution System (i.e. PDS)
- 6) Buffer Stock: Food Corporation of India (FCI), buys foodgrains from farmers with the assured minimum support price. It then maintain their stock and use this stock in case of shortage of food.
- 7) Public Distribution System(PDS):
- 8) With this program stored food grains and essential commodities are distributed to poor families at an affordable prices.
- 9) Based on income, families are divided into two categories Below Poverty Line (BPL) and Above Poverty Line (APL). Poverty line signifies minimum income needed to get necessities of life such as food, shelter and clothes. Prices for each category is different.
- 10) The problem with this system is that the number of deserving poor peoples are excluded from BPL category and some of the rich peoples are placed in BPL category.

**XXXV. SOIL TESTING PESTICIDES**

There are two main options for testing for herbicide residues in soil. The first option is to send a soil sample to a lab for analysis. Chemical screens are performed by many labs for a wide array of herbicides. Soil can be degraded and the community of organisms living in the soil can be damaged by the misuse or over use of pesticides. Some pesticides are more toxic to soil organisms than others. Some pesticides may break down quickly when applied to soils, while others may persist for longer periods. The combination of electrolysis with other methods, such as the Fenton's reagent, ultrasound irradiation, and UV light, also present satisfactory results in removing pesticides in soil treatment. Under most situations we would encounter in an agricultural setting, a pesticide half-life can range from a few hours to 4-5 years. Most pesticides are broken down by microbes in the soil, so environmental conditions that reduce microbial activity (cold, dry conditions) will extend pesticide remaining in the soil. Pesticides secrete into soils and groundwater which can end up in drinking water, and pesticide spray can drift and pollute the air. The effects of pesticides on human health depend on the toxicity of the chemical and the length and magnitude of exposure.

**XXXVI. FERTILIZER RECOMMENDATIONS**

The fertilizer recommendation are made to apply enough fertilizers to both meet the nutrient requirements of the crop and to build up the nutrient level in the soil to a critical soil test level over a planned timeframe. In such a curve, the % yield (of maximum) is drawn versus the soil test level for each nutrient. There are four basic fertilizer recommendation approaches:

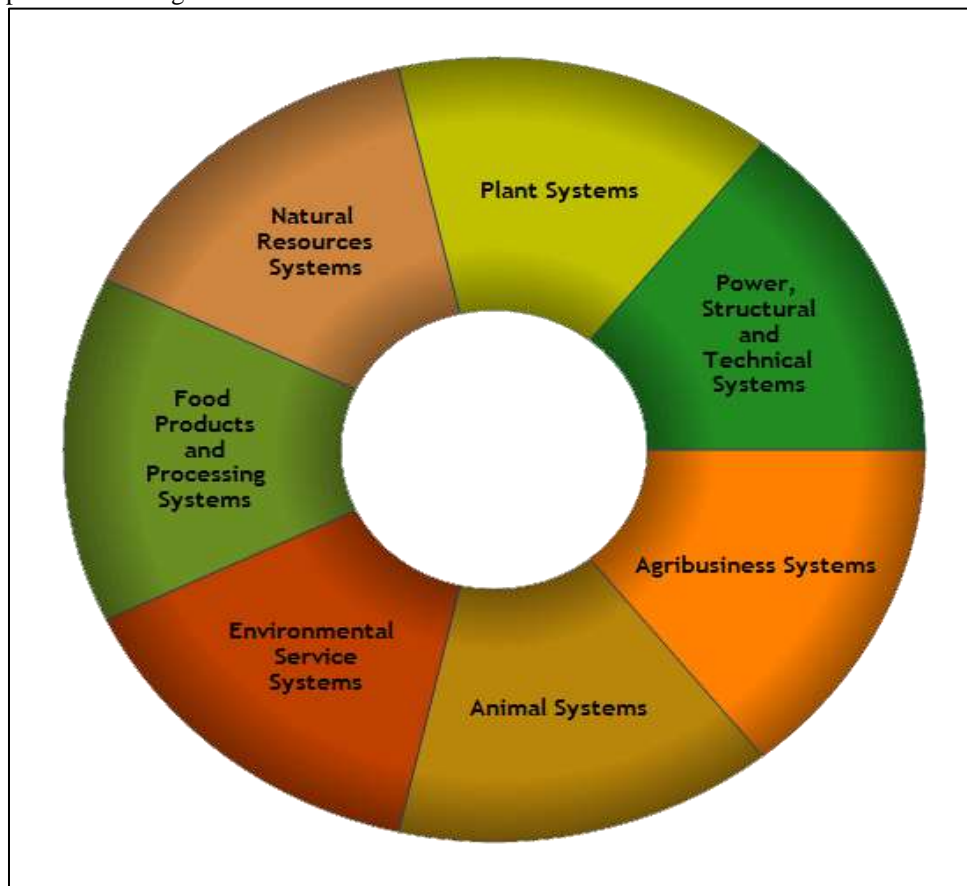
- 1) Buildup and Maintenance: The strategy here is to maintain soil fertility for future years. The goal is to apply more nutrients than the crop removes, so that the nutrient level in the soil is not limiting the yield.
- 2) Sufficiency: In the sufficiency approach, fertilizers are applied only to meet the nutrient requirements of the crop. The goal of this approach is to maximize profitability in a given year, while minimizing fertilizer applications and costs.
- 3) Basic cation saturation ratios: This approach assumes that a specific ratio of cations (cation= a positively charged ion) must exist in the soil in order to achieve maximum yield. It concerns only with recommendations for calcium, magnesium and potassium.
- 4) Quantitative approach: The quantitative approach uses the soil test values as the actual amounts of nutrients available in soil. The amount of nutrient that has to be applied is the difference between the total nutrient requirement of the crop and the amount of the nutrient available in the soil layer that was tested.

**XXXVII. AGRICULTURAL EMPLOYMENT**

Agricultural workers maintain crops and tend to livestock. They perform physical labor and operate machinery under the supervision of farmers, ranchers, and other agricultural managers With 1.3 billion people employed in the sector, agriculture is the

second greatest source of employment worldwide after services and it accounts 28% of global employment. While more than 2/3 of the population in poor countries work in agriculture, less than 5% of the population does in rich countries. Agriculture and its related industries provide 11 percent of U.S. employment. In 2018, 22.0 million full- and part-time jobs were related to the agricultural and food sectors—11.0 percent of total U.S. employment. Direct on-farm employment accounted for about 2.6 million of these jobs, or 1.3 percent of U.S. employment. Career in Agriculture is one of the largest industries and a good source of employment across the country. Agriculture also plays a vital role in Indian economy. At present, students from all over the country are selecting the agriculture field for their career prospective. Careers in agriculture include the following:

- Biochemist
- Environmental Engineer
- Bioinformatics Scientist
- Agronomy Sales Manager
- Agricultural Engineer
- Food Scientist
- Animal Geneticist
- Agricultural Operations Manager



### XXXVIII. BANK LOANS FOR AGRICULTURE

Agricultural loans in India are not only offered to farmers working towards the cultivation of food crops, but they are available to anyone who is engaged in other agriculture-related sectors like horticulture, aquaculture, animal husbandry, silk farming, apiculture and floriculture. Different types of agricultural finance include the following:

- Input finance for purchasing farm materials and livestock funding
- Emerging farmer finance
- Asset finance
- Establishment loans
- Installment finance
- Vehicle finance
- Special mortgage loan

Types of agricultural loans include

- Crop Loan

- Kisan Credit Card (KCC)
- Drip Irrigation Loan,
- Combine Harvester Loan
- Retail Agricultural Loan
- Long Term Agricultural Loan

### **XXXIX. AGRICULTURAL DROUGHT**

A drought is caused by drier than normal conditions that can eventually lead to water supply problems. Really hot temperatures can make a drought worse by evaporating moisture from the soil. A drought is a prolonged period with less-than-average amounts of rain or snow in a particular region. Agricultural drought is characterized by lack of sufficient moisture in the surface soil layers to support crop and forage growth. Indicators of agricultural drought often are precipitation, temperature and soil moisture to measure soil moisture and crop yield. Farmers may lose money if a drought destroys their crops. If a farmer's water supply is too low, the farmer may have to spend more money on irrigation or to drill new wells. Ranchers may have to spend more money on feed and water for their animals. As a result, the climatological community has defined four types of drought:

- Meteorological drought happens when dry weather patterns dominate an area.
- Hydrological drought occurs when low water supply becomes evident, especially in streams, reservoirs, and groundwater levels, usually after many months of meteorological drought.
- Agricultural drought and
- Socioeconomic drought. Meteorological drought happens when dry weather patterns dominate an area.

### **XL. CONCLUSIONS AND RECOMMENDATIONS**

- 1) Agriculture is an integral part of smart growth.
- 2) We are blessed with resources that have facilitated the development of a worldclass agricultural industry that provides safe, nutritious, and reliable food.
- 3) Agriculture is a diverse industry with very specific locational connections.
- 4) Certain crops can only be grown in specific locations where the combination of a variety of factors including soil, moisture, temperature, and topography is right.
- 5) When such areas are lost to agriculture, the ability to produce the crops that require that particular combination of factors is also lost.
- 6) The public needs to understand that agricultural land is a nonrenewable resource requiring appropriate management techniques.
- 7) Land use planning and irrigation are strategic planning exercise to assess the future potential of the agricultural sector and achieve accelerated growth through judicious management of land and water resources
- 8) As a consequence of various development endeavors ecological imbalances e.g. soil erosion, rapid situation of dams, shortage of ground water, land and water pollution, water logging etc. are growing adversely affecting the agricultural productivity
- 9) The efficient use of land, water and other natural resources are major thrust areas to be established for accelerated as well as sustainable economic development of agriculture
- 10) Among all the kharif crops; Jowar, Maize, Green gram and Black gram were rain fed crops and not required irrigation.
- 11) The kharif crops like Sesamum, Cluster bean and Bajra required very less supplement irrigation.
- 12) Among the twelve kharif crops, except Sesamum crop all the crops had income from by-product.
- 13) Among twenty rabi crops and three summer crops, except Onion, Garlic, Potato, Cumin, Fennel, Banana, Tobacco and Chikory; all the crops had also income from by-product.
- 14) It was found that from twelve kharif crops, Cotton (Long staple) gave the maximum profit but as it is twelve month crop.
- 15) The paddy required highest irrigation but due to the availability of canal water at nominal rate, the irrigation cost was found very less as compared to other crops which were cultivated with lift water

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