AGRICULTURE

TOPIC

BASICS OF AGRICULTURE

By AgrilearnerApp Team

Agriculture
Student (Notes, Agri Jobs) Agrilearner

Techno India

Education

UNINSTALL  OPEN

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1 Introduction:

**AGRICULTURE**: Agriculture is defined as an art, science and business of producing crops and livestock for economic purposes.

**Derivation of word Agriculture**

| AGER | Soil | CULTURA | Cultivation | Origin: Latin |

2 **BRANCHES OF AGRICULTURE**

Agriculture is mainly divided into following seven branches:

1. Agronomy
2. Horticulture- Fruits- Pomology; Vegetables- Olericulture
3. Forestry- Silviculture
4. Animal husbandry
5. Fishery science- Pisciculture
6. Agricultural Engineering and
7. Home science

3 **IMPORTANT CHRONOLOGICAL EVENTS IN AGRICULTURE**

<table>
<thead>
<tr>
<th>Name</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Francis Bacon (1561-1624 A.D)</td>
<td>Found the water as nutrient of plants</td>
</tr>
<tr>
<td>G.R.Glanber (1604-1668 A.D)</td>
<td>Salt peter(KNO3) as nutrient and not water</td>
</tr>
<tr>
<td>Jethrotull (1674-1741 A.D) FATHER of TILLAGE</td>
<td>Fine soil particle as plant nutrient</td>
</tr>
<tr>
<td>Priestly (1730-1799 A.D)</td>
<td>Discovered the oxygen</td>
</tr>
<tr>
<td>Francis Home (1775 A.D)</td>
<td>Water, air, salts, fire and oil form the plant nutrients</td>
</tr>
<tr>
<td>Thomas Jefferson (1793 AD)</td>
<td>Developed mould board plough</td>
</tr>
<tr>
<td>Theodore de-Saussure</td>
<td>Found that plants absorb CO2 from air &amp; release O2; soil</td>
</tr>
<tr>
<td>Justus van Liebig (1804- 1873)</td>
<td>supply N2</td>
</tr>
<tr>
<td>Lord Dalhousie (1848-1856)</td>
<td>‘Upper Bari Doab Canal’ in Punjab was constructed. Improvement of agriculture started only in his period.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

2 agrilearner.com / Agrilearner App
In Lord Curzon (1898-1905). His period is called as ‘Golden period of agriculture’. ‘Great Canal system of Western Punjab’ was constructed.

<table>
<thead>
<tr>
<th>1928-RCA</th>
<th>Royal Commission on Agriculture was setup and was responsible for giving recommendation to dug canals, lay roads.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880 - Department of Agriculture was established</td>
<td>1903 - Imperial Agricultural Research Institute (IARI) was started at Pusa, Bihar.</td>
</tr>
<tr>
<td>1912 - Sugarcane Breeding Institute(SBI) was established in Coimbatore</td>
<td>1929 - Imperial Council of Agricultural Research at New Delhi (then ICAR) after independence becomes ICAR.</td>
</tr>
<tr>
<td>1936 - Due to earth quake in Bihar, IARI was shifted to New Delhi and the place was called with</td>
<td></td>
</tr>
<tr>
<td>1965-67 - Green revolution in India due to introduction of HYV –Wheat, rice, use of fertilizers, construction of Dams and use of pesticides</td>
<td></td>
</tr>
<tr>
<td>ICAR (Imperial Council of Agricultural Research) was started in 1929</td>
<td>Based upon the recommendation of Royal Commission.</td>
</tr>
<tr>
<td>In 1962, a Land Grant College was started in Pantnagar (UP).</td>
<td>It is the first Agriculture university</td>
</tr>
</tbody>
</table>

4 IMPORTANT AGRICULTURE RESEARCH INSTITUTE

<p>| CRI | Central Rice Research Institute, Cuttack |
| IIPR | Indian Institute of Pulses Research, Kanpur |
| CTRI | Central Tobacco Research Institute, Rajahmundry |
| IISR | Indian Institute of Sugarcane Research, Lucknow |
| SBI | Sugarcane Breeding Institute, Coimbatore |
| CICR | Central Institute of Cotton Research, Nagpur |
| CRIJAF | Central Research Institute for Jute and Allied Fibres, Barrackpore |
| IGFRI | Indian Grassland and Fodder Research Institute, Jhansi |</p>
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIHR</td>
<td>Indian Institute of Horticultural Research, Bangalore</td>
</tr>
<tr>
<td>CISTH</td>
<td>Central Institute of Sub Tropical Horticulture, Lucknow</td>
</tr>
<tr>
<td>CITH</td>
<td>Central Institute of Temperate Horticulture, Srinagar</td>
</tr>
<tr>
<td>CIAH</td>
<td>Central Institute of Arid Horticulture, Bikaner</td>
</tr>
<tr>
<td>IIVR</td>
<td>Indian Institute of Vegetable Research, Varanasi</td>
</tr>
<tr>
<td>CPRI</td>
<td>Central Potato Research Institute, Shimla</td>
</tr>
<tr>
<td>CTCRI</td>
<td>Central Tuber Crops Research Institute, Trivandrum</td>
</tr>
<tr>
<td>CPCRI</td>
<td>Central Plantation Crops Research Institute, Kasargod</td>
</tr>
<tr>
<td>CARI</td>
<td>Central Agricultural Research Institute, Port Blair</td>
</tr>
<tr>
<td>IISR</td>
<td>Indian Institute of Spices Research, Calicut</td>
</tr>
<tr>
<td>CSWCRTI</td>
<td>Central Soil and Water Conservation Research &amp; Training Institute, Dehradun</td>
</tr>
<tr>
<td>IISS</td>
<td>Indian Institute of Soil Sciences, Bhopal</td>
</tr>
<tr>
<td>CSSRI</td>
<td>Central Soil Salinity Research Institute, Karnal</td>
</tr>
<tr>
<td>CRIDAP</td>
<td>Central Research Institute of Dryland Agriculture, Hyderabad</td>
</tr>
<tr>
<td>CAZRI</td>
<td>Central Arid Zone Research Institute, Jodhpur</td>
</tr>
<tr>
<td>NIASM</td>
<td>National Institute of Abiotic Stress Management, Malegaon, Maharashtra</td>
</tr>
<tr>
<td>CIAE</td>
<td>Central Institute of Agricultural Engineering, Bhopal</td>
</tr>
<tr>
<td>CIPHET</td>
<td>Central Institute on Post Harvest Engineering and Technology, Ludhiana</td>
</tr>
<tr>
<td>IINRG</td>
<td>Indian Institute of Natural Resins and Gums, Ranchi</td>
</tr>
<tr>
<td>CIRCT</td>
<td>Central Institute of Research on Cotton Technology, Mumbai</td>
</tr>
<tr>
<td>IASRI</td>
<td>Indian Agricultural Statistical Research Institute, New Delhi</td>
</tr>
<tr>
<td>CSWRI</td>
<td>Central Sheep and Wool Research Institute, Avikanagar, Rajasthan</td>
</tr>
<tr>
<td>CIRG</td>
<td>Central Institute for Research on Goats, Makhdoom</td>
</tr>
<tr>
<td>CIRB</td>
<td>Central Institute for Research on Buffaloes, Hissar</td>
</tr>
<tr>
<td>NIANP</td>
<td>National Institute of Animal Nutrition and Physiology, Bangalore</td>
</tr>
<tr>
<td>CARI</td>
<td>Central Avian Research Institute, Izatnagar</td>
</tr>
<tr>
<td>CMFRI</td>
<td>Central Marine Fisheries Research Institute, Kochi</td>
</tr>
<tr>
<td>CIBA</td>
<td>Central Institute Brackishwater Aquaculture, Chennai</td>
</tr>
</tbody>
</table>

**Important International Institutions on Agricultural Research**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVRDC</td>
<td>Asian Vegetable Research and Development Centre, Taiwan</td>
</tr>
<tr>
<td>CIP</td>
<td>Centro Internacional da la Papa (International potato research institute (Lima, Peru, South America)</td>
</tr>
<tr>
<td>CIMMYT</td>
<td>Centro International de Mejoramiento de Maizy Trigo (International Centre for maize and Wheat development (Londress, Mexico)</td>
</tr>
<tr>
<td>IITA</td>
<td>International Institute for Tropical Agriculture, Ibadon in Nigeria, Africa</td>
</tr>
<tr>
<td>ICARDA</td>
<td>International Center for Agricultural Research in the Dry Areas (Aleppo, Syria)</td>
</tr>
<tr>
<td>Organisation</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>IIMI-</td>
<td>International Irrigation Management Institute, Colombo, SRILANKA IRRI – International Rice Research Institute (Los Banos, Philippines)</td>
</tr>
<tr>
<td>ISNAR-</td>
<td>International Service In National Agricultural Research The Hague, Netherlands WARDAS - West African Rice Development Association Ivory coast, Africa. IBPGR - International Board for Plant Genetic Resources, Rome, Italy</td>
</tr>
<tr>
<td>CGIAR –</td>
<td>Consultative Group on International Agricultural Research, Washington D.C</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organization, Rome Meteorological</td>
</tr>
<tr>
<td>WMO-</td>
<td>World Organization, Vienna.</td>
</tr>
<tr>
<td>IFPRI-</td>
<td>The International Food Policy Research Institute</td>
</tr>
<tr>
<td>IMPACT-</td>
<td>International Model for Policy Analysis of Agricultural Commodities and Trade</td>
</tr>
<tr>
<td>IFAD-</td>
<td>The International Fund for Agricultural Development (Rome, Italy)</td>
</tr>
</tbody>
</table>

5 SOME CURRENT STATISTICS

➢ At 2011-12 prices, composition of GVA (approx. % Composition) Agriculture & allied, Industry, and Services sector are 17.4%, 28.83 %, and 55.20%, respectively (2017-18).
### Table 1. Agriculture Sector – Key indicators
(per cent change at constant 2011-12 prices)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth in GVA in Agriculture &amp; Allied Sectors #</td>
<td>1.5</td>
<td>5.6</td>
<td>-0.2</td>
<td>0.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Share of Agriculture &amp; Allied Sectors in total GVA at current prices #</td>
<td>18.2</td>
<td>18.6</td>
<td>18.0</td>
<td>17.5</td>
<td>17.4</td>
</tr>
<tr>
<td>Share of Agriculture &amp; Allied Sectors in total Gross Capital Formation *</td>
<td>7.6</td>
<td>8.5</td>
<td>7.8</td>
<td>6.9</td>
<td>n.a.</td>
</tr>
<tr>
<td>Share of Crops *</td>
<td>6.4</td>
<td>7.1</td>
<td>6.4</td>
<td>5.7</td>
<td>n.a.</td>
</tr>
<tr>
<td>Share of Livestock *</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
<td>n.a.</td>
</tr>
<tr>
<td>Share of Forestry and logging *</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>n.a.</td>
</tr>
<tr>
<td>Share of Fishing *</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

*Source: Central Statistics Office*

### Area, production and yield of major crops

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area (Lakh hectare)</th>
<th>Production (Million Tonnes)</th>
<th>Yield (kg/hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>441.10</td>
<td>434.99</td>
<td>431.94</td>
</tr>
<tr>
<td>Wheat</td>
<td>314.65</td>
<td>304.18</td>
<td>305.97</td>
</tr>
<tr>
<td>Coarse cereals</td>
<td>251.70</td>
<td>243.89</td>
<td>247.71</td>
</tr>
<tr>
<td>Pulses</td>
<td>235.54</td>
<td>249.12</td>
<td>294.65</td>
</tr>
<tr>
<td>Foodgrains</td>
<td>1243.00</td>
<td>1232.18</td>
<td>1290.26</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>255.96</td>
<td>260.87</td>
<td>262.06</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>50.66</td>
<td>49.27</td>
<td>43.89</td>
</tr>
<tr>
<td>Cotton@</td>
<td>128.19</td>
<td>122.92</td>
<td>108.45</td>
</tr>
<tr>
<td>Jute &amp; Mesta#</td>
<td>8.10</td>
<td>7.82</td>
<td>7.66</td>
</tr>
</tbody>
</table>

* 4th advance estimates @ Production in million bales of 170 kg each.
# Production in million bales 180 Kg. each.
### 6. Agroclimatic Zones (ACZ)

**What is an Agro-Climatic Zone?** It is a land unit uniform in respect of climate and length of growing period (LGP) which is climatically suitable for a certain range of crops and cultivars (FAO, 1983).
Classification of ACZ by Planning Commission

Planning Commission of India (1989) divided country into different agro climatic regions based on homogeneity in rainfall, temperature, topography, cropping and farming systems and water resources. India is divided into 15 agro-climatic regions.
7. Eastern plateau and hills

- This region includes the Chhotanagpur Plateau, extending over Jharkhand, Orissa, Chhattisgarh.
- Climate is moist subhumid to dry subhumid.
- Annual rainfall is 1271–1436 mm.
- The region is deficient in water resources due to plateau structure and non-perennial streams.
- Important crops are rice, millets, maize, oilseeds, ragi, gram and potato.
- Soils are red and yellow with occasional patches of laterites and alluvium.

8. Central plateau and hills

- The region includes 46 districts of M.P., Chhattisgarh, U.P and rajasthan.
- Undulating soil topography, ravines are present.
- Climate is semi arid to dry sub humid.
- Annual rainfall is 400–1550 mm.
- Main crops are Wheat, Gram, Jowar, Bajra, Paddy, millets, oilseeds, cotton and sunflower.
- Soils are mixed red, yellow and black.
- Scarcity of water is major constraint.
9. Western plateau & hills
- This region includes Malwa plateau and Deccan plateau (Maharashtra), some parts of M.P and Rajasthan.
- It covers maximum parts of peninsular area.
- This is a region of the red (black) soil.
- Climate is semi-arid.
- Annual rainfall: 602–1040 mm.
- Net sown area: 65%, forest area: 11%, irrigated area: 12.4%.
- Major crops: jowar, bajra, cotton and wheat.
- Irrigation is mainly done by canals.
- This region provides 50% jowar of our country and best quality of orange, grape and banana.

10. Southern plateau & hills
- This region includes the greater parts of Karnataka, Andhra Pradesh, and Tamil Nadu.
- It is an area of dry zone agriculture.
- Annual rainfall: 677–1000 mm.
- 81% dry land farming and 11% cropping intensity.
- Major crops: Coffee, tea, cardamom and spices.

Suggestions:
- Proper utilization of dry land technology in watershed area.
- Increase fertilizer use efficiency.
- Minor irrigation use programme.

11. East coast plains
- This region includes east coast of Tamil Nadu, A.P and Orissa.
- Climate is semi-arid and dry sub humid.
- Annual rainfall: 780–1287 mm.
- Soils are mainly alluvial and coastal sands and are troubled by the problem of alkalinity.
- Irrigation through canals and tanks.
- Major crops: Rice, Ragi, Jowar & Bajra.
- This region contributes 20.3% in total rice production and 17.5% in groundnut production.
- 75% area is irrigated.

12. West coast plains and ghats
- This region includes west coast of Tamil Nadu, Kerala, Karnataka, Maharashtra & Goa.
- Climate is dry sub humid to humid.
- Annual rainfall: 2226–3640 mm.
- The soils are laterite and coastal alluvial.
- Main occupation is cultivation of spices and plantation crops which are raised along the hill slopes of the Western Ghats.
- Major crops: Rice, Ragi, Groundnut, Tapioca.
13. Gujarat plains and hills
- This region includes 19 districts of Gujarat.
- It is an arid and semi-arid region.
- Annual rainfall—340-1793 mm.
- 32.5% land is irrigated through wells and tube wells.
- Main crops—maize, wheat, groundnut, tobacco, cotton, jowar, bajra.
- This zone is famous for oilseed crop hence known as oilseed region.
- Cropping intensity is 114%.
- About 60% area is drought prone.
- 78% area is rainfed.
- Soils are regur in the plateau region, alluvium in the coastal plains, and red and yellow soils in Jamnagar area.

14. Western dry region
- This region includes 9 districts of Rajasthan.
- This region has an erratic rainfall of an annual average of 95 mm.
- The desert climate further causes high evaporation.
- This region has scanty vegetation and no perennial rivers.
- Drought occurs frequently.
- Main crops—bajra, gram, wheat, rapeseed.
- This region has 1.2% forest area, 4.5% pasture area, 6.3% irrigated area.
- Cropping intensity is 105%.

15. Island regions
- This region includes Andaman & Nicobar and Lakshwadeep.
- Climate is humid.
- Annual rainfall is 300 mm spread over 8-9 months.
- Largely forest zone with undulating land.
- Main crops are rice, maize, millets, pulses, arecanut, turmeric and cassava.
- Nearly half of the cropped area is under coconut.
### Agro-climatic zones of India

**Map:** Overall view of AGROCLIMATIC ZONES as per Planning commission

<table>
<thead>
<tr>
<th>Zone Number</th>
<th>Zone Name</th>
<th>States/Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Western Himalayan Region</td>
<td>J&amp;K, HP, UP, Utrachal</td>
</tr>
<tr>
<td>2</td>
<td>Eastern Himalayan Region</td>
<td>Assam, Sikkim, West Bengal &amp; North-Eastern states</td>
</tr>
<tr>
<td>3</td>
<td>Lower Gangetic Plains Region</td>
<td>West Bengal</td>
</tr>
<tr>
<td>4</td>
<td>Middle Gangetic Plains Region</td>
<td>UP, Bihar</td>
</tr>
<tr>
<td>5</td>
<td>Upper Gangetic Plains Region</td>
<td>UP</td>
</tr>
<tr>
<td>6</td>
<td>Trans-Gangetic Plains Region</td>
<td>Punjab, Haryana, Delhi &amp; Rajasthan</td>
</tr>
<tr>
<td>7</td>
<td>Eastern Plateau and Hills Region</td>
<td>Maharashtra, UP, Orissa &amp; West Bengal</td>
</tr>
<tr>
<td>8</td>
<td>Central Plateau and Hills Region</td>
<td>MP, Rajasthan, UP</td>
</tr>
<tr>
<td>9</td>
<td>Western Plateau and Hills Region</td>
<td>Maharashtra, MP &amp; Rajasthan</td>
</tr>
<tr>
<td>10</td>
<td>Southern Plateau and Hills Region</td>
<td>AP, Karnataka, Tamil Nadu</td>
</tr>
<tr>
<td>11</td>
<td>East Coast Plains and Hills Region</td>
<td>Orissa, AP, TN, &amp; Pondicherry</td>
</tr>
<tr>
<td>12</td>
<td>West Coast Plains and Ghat Region</td>
<td>TN, Kerala, Goa, Karnataka, Maharashtra</td>
</tr>
<tr>
<td>13</td>
<td>Gujarat Plains and Hills Region</td>
<td>Gujarat</td>
</tr>
<tr>
<td>14</td>
<td>Western Dry Region</td>
<td>Rajasthan</td>
</tr>
<tr>
<td>15</td>
<td>The Islands Region</td>
<td>Andman &amp; Nicaobar, Lakshya Deep</td>
</tr>
</tbody>
</table>
ICAR - CLASSIFICATION
The State Agricultural Universities were advised to divide each state into sub-zones, under the National Agricultural Research Project (NARP) under ICAR. Based on the rainfall pattern, cropping pattern and administrative units, 127 agro-climatic zones are classified. The zones of state are given below.

<table>
<thead>
<tr>
<th>S.No</th>
<th>State</th>
<th>No. of Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J &amp; K</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Himachal Pradesh</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Punjab</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Haryana</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Rajasthan</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Uttarakhand</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Uttar Pradesh</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>West Bengal</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Assam</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>Arunachal Pradesh</td>
<td>2</td>
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</table>

<table>
<thead>
<tr>
<th>S.No</th>
<th>State</th>
<th>No. of Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Meghalaya</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Manipur</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Nagaland</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Tripura</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Bihar &amp; Jharkhand</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>Odisha</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>Madhya Pradesh and Chattisgarh</td>
<td>12</td>
</tr>
<tr>
<td>18</td>
<td>Gujarat</td>
<td>8</td>
</tr>
<tr>
<td>19</td>
<td>Maharashtra</td>
<td>9</td>
</tr>
<tr>
<td>20</td>
<td>Karnataka</td>
<td>10</td>
</tr>
<tr>
<td>21</td>
<td>Kerala</td>
<td>5</td>
</tr>
<tr>
<td>22</td>
<td>Andhra Pradesh</td>
<td>7</td>
</tr>
<tr>
<td>23</td>
<td>Tamil Nadu</td>
<td>7</td>
</tr>
</tbody>
</table>

7 Agro ecological Zones of India (AEZ)
An ecological region is characterized by distinct ecological responses to macroclimate as expressed in vegetation and reflected in soils, fauna and aquatic systems. Therefore, an agro ecological region is the land unit on the earth’s surface carved out of agro-climatic region when superimposed on different landform and soil conditions that act as modifiers of climate and length of growing period (LGP).

National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) of the ICAR has delineated 20 agro-ecological regions (AERs) in the country using the FAO 1978 concept of superimposition of length of growing periods and bio-climate maps on soil physiographic map.
Note: Rice can be called as an annual seasonal crop because of the following reasons:

a. Seasonal because it is suitable for growth during the Kharif season (suitable conditions for growth during this season)
b. Annual because its life cycle (from germination to harvest) is less than a year.

The plants are classified as annual, biennial and perennial based on their life cycle duration.

<table>
<thead>
<tr>
<th>System</th>
<th>LGP</th>
<th>Major areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arid ecosystem</td>
<td>Less than 90 days</td>
<td>Western Himalayas, Deccan plateau,</td>
</tr>
<tr>
<td>Semiarid ecosystem</td>
<td>90-105 days</td>
<td>Central highlands, Gujarat plains, Kathiawar peninsula,</td>
</tr>
<tr>
<td>Sub humid ecosystem</td>
<td>150-180 days or 180-210 days</td>
<td>Eastern plateau (Chotanagpur) and Eastern ghats hot sub-humid eco-region,</td>
</tr>
<tr>
<td>Humid-Perhumid ecosystem</td>
<td>210+</td>
<td>Bengal and Assam plain hot sub-humid</td>
</tr>
<tr>
<td>Coastal ecosystem</td>
<td>210+</td>
<td>Eastern coastal plain, Western ghat</td>
</tr>
<tr>
<td>Island ecosystem</td>
<td>210+</td>
<td>Andaman Nicobar and Lakshadeep,</td>
</tr>
</tbody>
</table>

LGP in different AER’s
Note: It is more important to remember LGP rather than areas in case of AER

8 Crop Classification
1. Based on ontogeny (Life cycle)
2. Based on economic use (Agronomic)
3. Based on Botany (Scientific)
4. Based on seasons
5. Based on climate

Based on ONTOGENY (Lifecycle)
Ontogeny is the origination and development of an organism; usually from the time of fertilization of the egg to the organism’s mature form—although the term can be used to refer to the study of the entirety of an organism’s lifespan.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>Wheat, rice, maize, mustard</td>
</tr>
<tr>
<td>Biennial</td>
<td>Sugar beet, beet root,</td>
</tr>
<tr>
<td>Perennial</td>
<td>Napier fodder grass, coconut,</td>
</tr>
</tbody>
</table>

Note: Rice can be called as an annual seasonal crop because of the following reasons:

a. Seasonal because it is suitable for growth during the Kharif season (suitable conditions for growth during this season)
b. Annual because its life cycle (from germination to harvest) is less than a year.

The plants are classified as annual, biennial and perennial based on their life cycle duration.
Based on economic use (Agronomic)

How the agricultural produce is classified based on economic usage-

<table>
<thead>
<tr>
<th>Group</th>
<th>Example</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>Rice, wheat, maize, barley, oats</td>
<td></td>
</tr>
<tr>
<td>Pulse</td>
<td>Black gram (v. mungo), Green gram (V. radiata)</td>
<td></td>
</tr>
<tr>
<td>Oil seed</td>
<td>Groundnut</td>
<td>Pod-50% oil, <strong>HAULM</strong>-cattle feed</td>
</tr>
<tr>
<td>Millet</td>
<td>Sorghum, pearl millet, Finger millet</td>
<td>Minor millet: Fox tail millet, little millet, kodo millet</td>
</tr>
<tr>
<td>Forage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibre</td>
<td>Cotton</td>
<td>seed fibre – cotton; Stem/ bast fibre – Jute, mesta; leaf fibre – <strong>Agave</strong>, pineapple.</td>
</tr>
<tr>
<td>Medicinal</td>
<td>Aloe vera, Rauwolfia</td>
<td></td>
</tr>
<tr>
<td>Beverage</td>
<td>Tea, coffee, cocoa</td>
<td></td>
</tr>
</tbody>
</table>

Based on Climatic Condition

The crops are classified according to their growing geographical regions

- **TROPICAL**
  - Coconut, sugarcane

- **TEMPERATE**
  - Wheat, barley

- **SUB TROPICAL**
  - Rice, cotton

- **POLAR**
  - All pines, pasture grasses

**What does Term Tropic, Sub tropic Temperate & Polar Mean?**
Based on Seasons
The Crops based on these criteria are majorly divided into three groups

Kharif
- **Sowing**: June-July
- **Climate**: Warm wet weather shorter day length for flowering.
- **Harvesting**: September–October
- Examples: Rice, maize, castor, groundnut.

Rabi
- **Sowing**: October–November
- **Climate**: Cold dry weather longer day length for flowering.
- **Harvesting**: January–February
- Examples: Wheat, mustard, barley, oats, potato, bengal gram, berseem, cabbage and cauliflower.

Zaid
- **Sowing**: February–March
- **Climate**: Dry weather day length for flowering.
- **Harvesting**: May–June
- Examples: Black gram, greengram, sesame, cowpea

9 Factors affecting crop production
There are many factors which affect growth of crops. Crop growth is a diverse mix of multiple factors which we shall be discussing now.

1.1 Classification: Broadly we can classify it into two groups Environmental (External) & Genetic (Internal or Hereditary)

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The climatic factors include rainfall and water, light, temperature, relative humidity, air, and wind.

### Temperature

- The range of temperature for maximum growth of most of the agricultural plants is between 15 and 40°C.
- The minimum, maximum (above which crop growth ceases) and optimum temperature of individual’s plant is called as **cardinal temperature**.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Min temperature ºC</th>
<th>Optimum temp</th>
<th>Max temperature ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>10</td>
<td>32</td>
<td>36-38</td>
</tr>
<tr>
<td>Wheat</td>
<td>4.5</td>
<td>20</td>
<td>30-32</td>
</tr>
<tr>
<td>Maize</td>
<td>8-10</td>
<td>20</td>
<td>40-43</td>
</tr>
<tr>
<td>Sorghum</td>
<td>12-13</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Tobacco</td>
<td>12-14</td>
<td>29</td>
<td>35</td>
</tr>
</tbody>
</table>

**Note:** These values are very important from examination point of view.
| Relative Humidity (RH) | • Relative humidity is **ratio between the amount of moisture presenting the air to the saturation capacity of the air** at a particular temperature.  
• Relative humidity of **40-60%** is suitable for most of the crop plants. |

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Precipitation
- In heavy and evenly distributed rainfall areas, crops like rice in plains and tea, coffee and rubber in Western Ghats are grown.
- Low and uneven distribution of rainfall is common in dry-land farming where drought resistance crops like pearl millet, sorghum and minor millets are grown.

Solar Radiation
- **Photoperiodism** is a response of plant to day length
  - **Short day** – Day length is < 12 hours (Rice, Sunflower and cotton)
  - **long day** – Day length is > 12 hours (Barley, oat, carrot and cabbage)
  - **day neutral** – There is no or less influence on day length (Tomato and maize).

Photosynthetically Active Radiation (PAR - 0.4 – 0.7μ)

Wind Velocity
- Wind movement for 4 – 6 km/hour is suitable for most crops.
- Anemometer is used to measure wind velocity.

Atmospheric Gases
- CO2 – 0.03%,
- O2 - 20.95%,
- N2 - 78.09%,
- Argon - 0.93%,
- Others - 0.02%.

**Edaphic Factors**
These are the factors which are related to soil, the table below depicts important edaphic factors.

<p>| Factor |</p>
<table>
<thead>
<tr>
<th>Soil Moisture</th>
<th>Soil Moisture Terminologies:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• The field capacity is the amount of water remaining in the soil a few days after having been wetted and after free drainage has ceased. The matric potential at this soil moisture condition is around (-\frac{1}{10}) to (-\frac{1}{3}) bar.</td>
</tr>
<tr>
<td></td>
<td>• The total available water (holding) capacity is the portion of water that can be absorbed by plant roots.</td>
</tr>
<tr>
<td></td>
<td>• It is the amount of water available, stored, or released between field capacity and the permanent wilting point water contents.</td>
</tr>
<tr>
<td></td>
<td>✓ Gravitational water: Free water that moves through the soil due to the force of gravity. Gravitational water is found in the macropores. It moves rapidly out of well-drained soil and is not considered to be available to plants.</td>
</tr>
<tr>
<td></td>
<td>✓ Capillary water that remains in the soil after gravitational water is drained out, that is subject to the laws of capillary action.</td>
</tr>
</tbody>
</table>
of capillary movement, and that is in the form of a film around the soil grains.

- **Hygroscopic Water** absorbed from the atmosphere and held very tightly by the soil particles, so that it is unavailable to plants in amounts sufficient for them to survive.

### Soil Temperature
- It affects the physical and chemical processes going on in the soil.
- It influences the rate of absorption of water and solutes.
- Soil temperature controls the microbial activity.

### Soil Organic Matter
- It improves the texture of the soil.

### Soil Mineral Matter
- Note: Important takeaway- humus content- 33-50%
Soil Reaction

**Important takeaway:** Friends observe how availability of nutrients changes with pH which we shall be covering in detail in chapter Agricultural chemistry.

Soil Air

- Potato, tobacco, cotton linseed, tea and legumes need higher O2 in soil air
- Rice requires low level of O2 and can tolerate water logged condition.

<table>
<thead>
<tr>
<th>Name of gas</th>
<th>Percentage by volume</th>
<th>Soil air</th>
<th>Atmospheric air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>20.00</td>
<td>21.00</td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>78.60</td>
<td>78.03</td>
<td></td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.50</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Argon</td>
<td>0.90</td>
<td>0.94</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Observe the variation with respect to the atmospheric gases.

Biotic Factors:
These are the factors **having life**.

- **Flora:** Competitive and complementary nature among field crops when grown together
- **Fauna:** Honey bees and wasps help in cross pollination and increases yield and considered as beneficial organisms.

9.5 Physiographic factor

The factors include the **following aspects**:

<table>
<thead>
<tr>
<th>Physiological Factor</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
Topography

The nature of surface earth (leveled or sloppy) is known as topography. Topographic factors affect the crop growth indirectly.

Altitude

Increase in altitude causes a decrease in temperature and increase in precipitation and wind velocity (hills and plains).

Steepness of Slope

It results in run off of rain water and loss of nutrient rich top soil.

Exposure to Light and Wind

A mountain slope exposed to low intensity of light and strong dry winds may result in poor crop yields (coastal areas and interior pockets).

1.6 Genetic factors

These are those factors which affect plant growth and development involving genes, the chromosomes, the genomes, and all those which determine gene expression with the exclusion of environmental factors.

10 TILLAGE

The word tillage is derived from ‘Anglo-Saxon’ words Tilian and Teolian, meaning ‘to plough and prepare soil for seed to sow, to cultivate and to raise crops. Jethrotull, is considered as father of tillage.

Definition:

- Tillage is the mechanical manipulation of soil with tools and implements for obtaining conditions ideal for seed germination, seedling establishment and growth of crops.
- Tilth is the physical condition of soil obtained out of tillage (or) it is the result of tillage.

Primary tillage

The primary soil working operation designed to plough the soil deeply to reduce soil strength, cover plant materials and rearrange aggregates is called primary tillage. Country plough, mould board plough, bose plough, tractor and power tiller drawn implements are used for primary tillage.

Secondary tillage

Lighter and finer tillage operations performed in the soil after primary tillage to create proper soil tilt and surface configuration for seeding and planting are called secondary tillage operations. Secondary
tillage operations are generally done on the surface soil.
✓ **Planking** is done to crush the hard clods, level the soil surface and to compact the soil lightly.
11 Tilage Systems

Conservation tillage /Scientific tillage (30 percent or more crop residue left after planting)

Any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water or any system that maintains at least 1,120 kilogram per hectare of flat, small grain residue equivalent on the surface throughout the critical wind erosion period is called conservation tillage system.

Types:

No-till: No-till is defined as a system in which the soil is left undisturbed from harvest to planting except for nutrient injection.

Ridge-till: In ridge-till, the soil is also left undisturbed from harvest to planting except for nutrient injection. Planting is completed in a seed bed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges.

Mulch-till:
- The soil is disturbed before planting.
- Tillage tools such as chisels, field cultivators, disks, sweeps or blades are used. Weed control is accomplished with herbicides and/or cultivation.
- Mulch-till is a category that includes all conservation tillage practices other than no-till and ridge-till.

12 Other tillage systems (less than 30 percent crop residue left after planting)

Tillage systems that leave less than 30 percent crop residue after planting are not classified as conservation tillage. However, these systems may meet erosion control goals with or without other supporting conservation practices, such as strip cropping, contouring, terracing, etc.

Types:

Reduced-till: Reduced-till systems leave 15-30 percent residue cover after planting or 560 to 1,120 kilograms per hectare of small grain residue equivalent throughout the critical wind erosion period.

Conventional-till (clean tillage): Conventional-till systems leave less than 15 percent residue cover after planting, or less than 560 kilograms per hectare of small grain residue equivalent
throughout the critical wind erosion period. These systems generally involve plowing or some other form of intensive tillage.

13 Another Classification of Tillage Systems

There are two types of tillage namely:

- Conventional tillage or clean tillage and
- Conservation tillage

✓ **Conventional tillage or clean tillage**: Ploughing the entire field several times to prepare a seed bed is called conventional tillage.

✓ **Conservation tillage**: Ploughing the field with lesser number of passes over the entire land or ploughing only in the required space of the land and then sowing is called conservation tillage.

Different types of conservation tillage are as follows:

- **Minimum Tillage** - Minimum soil manipulation necessary to meet tillage requirements
- **Mulch Tillage** – Tillage operations in which nearly 30% of crop residue or other mulching materials are left on or near the soil surface is called mulch tillage.
- **Rotary Tillage** - Tillage operations employing rotary action of the tool to cut, break and mix the soil is called rotary tillage.
- **Strip Tillage** - In strip tillage system only isolated bands of soil are tilled.
- **Combined Tillage** – Tillage operations utilizing simultaneously two or more different types of tillage tools or implements to simplify, control or reduce the number of operations over a field is called combined tillage.

14 Types of tillage:

Tillage operations may be grouped into:

<table>
<thead>
<tr>
<th>On season tillage</th>
<th>Off season tillage</th>
<th>Special purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory Cultivation-Primary, Secondary, Seed Bed</td>
<td>Post-harvest tillage, summer tillage, winter tillage and fallow tillage</td>
<td>Dry tillage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean tillage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blind tillage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-soiling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Puddling</td>
</tr>
</tbody>
</table>

On-season tillage
Tillage operations that are done for raising crops in the same season or at the onset of the crop season are known as on-season tillage.

They may be preparatory cultivation and after cultivation.

**Off-season tillage:**

Tillage operations done for conditioning the soil suitably for the forthcoming main season crop are called off-season tillage. Off-season tillage may be, post-harvest tillage, summer tillage, winter tillage and fallow tillage.

**Special purpose tillage:** Tillage operations intended to serve special purposes are said to be special purpose tillage.

They are:

a. **Sub-soiling:** To break the hard pan beneath the plough layer, special tillage operation (chiseling) is performed to reduce compaction. Sub-soiling is essential and once in four to five years where heavy machineries are used for field operations, seeding, harvesting and transporting.

b. **Clean tillage:** It refers to working of the soil of the entire field in such a way no living plant is left undisturbed. It is practiced to control weeds, soil borne pathogen and pests.

c. **Blind tillage:** It refers to tillage done after seeding or planting the crop (in a sterile soil) either at the pre-emergence stage of the crop plants or while they are in the early stages of growth so that crop plants (sugarcane, potato etc.) do not get damaged, but, extra plants and broad-leaved weeds are uprooted.

d. **Dry tillage:** Dry tillage is practiced for crops that are sown or planted in dry land condition having sufficient moisture for germination of seeds. This is suitable for crops like broadcasted rice, jute, wheat, oilseed crops, pulses, potato and vegetable crops. Dry tillage is done in a soil having sufficient moisture (21-23%).

e. **Wet tillage or puddling:** The tillage operation that is done in a land with standing water is called wet tillage or puddling. Puddling operation consists of ploughing repeatedly in standing water until the soil becomes soft and muddy. Puddling creates an impervious layer below the surface to reduce deep percolation losses of water and to provide soft seed bed for planting rice.
15 Depth of Ploughing

The Vertical depth up to which seed may be placed for proper germination and growth.

- **Desirable depth** of ploughing is 12 to 20 cm for field crops.
- **Shallow rooted crops**: The depth of ploughing is 10-20 cm
- **Deep rooted crops**: 15-30 cm

**Number of ploughing**

Number of ploughing depends on soil conditions, time available for cultivation between two crops and type of cropping systems. *Zero tillage is practiced in rice fallow pulses.*

**Time of ploughing**

The optimum soil moisture content for tillage is 60% of field capacity.

- **Field Capacity** is the amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased.
  - This usually takes place 2–3 days after rain or irrigation in pervious soils of uniform structure and texture.

16 SEEDS:

Biologically, seed is a ripe, fertilized ovule and a unit of reproduction of flowering plants.

**SEED RATE**

- The required number of plants/unit area is decided by calculating the seed rate.
- The seed rate depends on spacing or plant population, test weight, germination percentage.

  *The formula is as follows.*

\[
\text{Seedrate (kg/ha)} = \frac{\text{Plant population (per ha)} \times \text{No. of seeds/hill} \times \text{Test weight (g)} \times 100}{1000 \times 1000 \times \text{Germination percentage (%)}}
\]

**SOWING METHODS**

1. Broadcasting
2. Dibbling
3. Sowing behind the country plough (manual and mechanical drilling)
17 GERMINATION

- Germination is a protrusion of radicle or seedling emergence.
- The thumb rule is to sow seeds to a depth of approximately 3 to 4 times diameter of the seed. The optimum depth of sowing for most of the field crops ranged between 3 and 5 cm depth.

Optimum plant population

- It is the number of plants required to produce maximum output or biomass per unit area.
- Under high plant population, individual plant yield will be low due to narrow spacing leading to competition between plants.
- Yield per plant decreases gradually as plant population per unit area is increased, but yield per unit area increases up to certain level of population. That level of plant population is called as optimum population.

18 PLANT GEOMETRY

The arrangement of the plants in different rows and columns in an area to utilize the natural resources efficiently is called crop geometry. It is otherwise area occupied by a single plant Ex. Rice – 20 cm x 15 cm.

What are the different types of crop geometry?

- Random Plant Geometry
- Square Plant Geometry
- Rectangular method of sowing
- Triangular method of sowing
- Quincunx or Diamond pattern

10.1 Different crop geometries are available for crop production

1) Random plant geometry
- Random plant geometry results due to broadcasting method of sowing and no equal space is maintained.
- Resources are either underutilized or over exploited.

2) Square plant geometry
The plants are sown at equal distances on either side. Mostly perennial crops, tree crops follow square method of cultivation.

- Ex. Coconut—7.5 x 7.5 m; banana—1.8 x 1.8 m. But, due to scientific invention, the square geometry concept is expanded to close spaced field crops like rice too.

**Advantages**

Light is uniformly available, movement of wind is not blocked and mechanization can be possible.

3) **Rectangular method of sowing**

There are rows and columns, the row spacing are wider than the spacing between plants.

The different types exist in rectangular method are:

a) **Solid row**: Each row will have no proper spacing between the plants. This is followed only for annual crops which have tilling pattern. There is definite row arrangement but no column arrangement, Ex. Wheat.

b) **Skip row**: A row of planting is skipped and hence there is a reduction in population. This reduction is compensated by planting an intercrop; practiced in rain-fed or dry-land agriculture.

4. **Triangular method of planting**: It is recommended for wide spaced crops like coconut, man etc. The number of plants per unit area is more in this system.

5. **Quincunx or diamond pattern**:

- The quincunx or diamond pattern of arranging row-planted crops is a modified form of the square pattern.
- It consists of a **square that is formed by 4 closest plants** with an **additional plant at the center of these 4 plants**.
- The 4 plants that form a square are the **main crops** while the crop at the center is called a **filler crop**.

**Paired Row arrangement**:

The paired row arrangement can be seen both in the Square and Rectangular plant geometry type. In some cases, we observe this in triangular method of plant geometry as well.
19 CROPPING PATTERN AND CROPPING SYSTEM

- **Cropping system**
  Usually refers to a combination of crops in time and space.
  
  - Combination in time occurs when crops occupy different growing period and combinations in space occur when crops are inter planted.

- **Cropping pattern**
  The yearly sequence and spatial arrangement of crops or of crops and fallow on a given area.

20 INTENSIVE CROPPING

- Intensive farming is an agricultural intensification and mechanization system that aims to maximize yields from available land through various means, such as heavy use of pesticides and chemical fertilizers.

- Intensive crop farming is a modern form of intensive farming that refers to the industrialized production of crops.

**Crop intensification technique includes:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inter cropping</td>
</tr>
<tr>
<td>2</td>
<td>Relay cropping</td>
</tr>
<tr>
<td>3</td>
<td>Sequential Cropping</td>
</tr>
<tr>
<td>4</td>
<td>Ratoon cropping</td>
</tr>
</tbody>
</table>

* All such systems come under the general term multiple cropping.
**Intensive cropping**: Growing number of crops on the same piece of land during the given period of time.

**Cropping intensity**: Number of crops cultivated in a piece of land per annum is cropping intensity. In Punjab and Tamil Nadu, the cropping intensity is more than 100% (i.e. around 140-150%). In Rajasthan, the cropping intensity is less.

**Multiple cropping**: The intensification of cropping in time and space dimensions. Growing two or more crops on the same field in a year.

### 20.1 Forms of multiple cropping

- **Intercropping**: Growing two or more crops simultaneously on the same field. Crop intensification is in both time and space dimensions. There is intercrop competition during all or part of crop growth.

  (a) **Mixed intercropping**: Growing two or more crops simultaneously with no distinct row arrangement. Also referred to as mixed cropping. Ex: Sorghum, pearl millet and cowpea are mixed and broadcasted in rain-fed conditions.

  (b) **Row intercropping**: Growing two or more crops simultaneously where one or more crops are planted in rows. Often simply referred to as intercropping. Maize + green gram (1:1), Maize + black gram (1:1), Groundnut + Red gram (6:1)

  (c) **Strip intercropping**: Growing two or more crops simultaneously in strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically. Ex. Groundnut + red gram (6:4) strip.

  (d) **Relay intercropping**: Growing two or more crops simultaneously during the part of the lifecycle of each. A second crop is planted after the first crop has reached its reproductive stage of growth, but, before it is ready for harvest. Often simply referred to as relay cropping. Rice- rice fallow pulse

- **Sequential cropping**: Growing two or more crops in sequence on the same field in a farming year. The succeeding crop is planted after the preceding crop has been harvested. Crop intensification is only in time dimension. There is no intercrop competition.
(a) **Double, triple and quadruple cropping**: Growing two, three and four crops, respectively, on the same land in a year in sequence


**Ratoon cropping**: The cultivation of crop re-growth after harvest, although not necessarily for grain. Ex. Sugarcane: ratoon; Sor ghum: ratoon (for fodder).

(b) The various terms defined above bring out essentially two underlying principles, that of growing crops simultaneously in mixture, i.e., intercropping; and of growing individual crops in sequence, i.e., sequential cropping.

The cropping system for a region or farm may comprise either or both of these two principles.

21 **INTEGRATED FARMING SYSTEM (IFS)**

**Definition:**
- A farming system is a collection of distinct functional units such as crop, livestock, processing, investments and marketing activities which interact because of the joint use of inputs they receive from the environment which have the common objective of satisfying the farmers (decision makers) aims.
- The definition of the borders of the options depends on circumstances; often it includes not only the farm (economic enterprise) but also the household (farm – household system)"

**Possible enterprises-**
- **Wetland based farming system**
  - Crop + Fish + Poultry/poultry/pigeon
  - Crop + Fish + Mushroom
- **Gardenland based farming system**
  - Crop + Dairy + Biogas
  - Crop + Dairy + Biogas + Sericulture
  - Crop + Dairy + Biogas + Mushroom + Silvi-culture
- **Dry land based farming system**
  - Crop + Goat + Agroforestry
  - Crop + Goat + Agroforestry + Horticulture

22 Organic farming
• Organic farming is a production system where all kinds of agricultural products are produced organically, including grains, meat, dairy, eggs, fibers such as cotton, flowers and processed food products.
• Organic farming avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives.

**Synonyms of organic farming**
• Eco-farming - *Feed the soil, not the plant* is the watchword and slogan of ecological farming.
• Biological farming
• Bio-dynamic farming
• Macrobiotic agriculture

### 23 Dry-land Agriculture

**Dryland Agriculture requirement**
It is the profitable production of useful crops, without irrigation, on lands (arid and semi-arid) that receive annual rainfall of less than **750mm**.

**Improved dryland technologies**
Following are the various improved techniques and practices recommended for achieving the objective of increased and stable crop production in dryland areas.

✓ Crop planning
✓ Planning for weather
✓ Crop substitution
✓ Cropping systems

Other technologies include: Watershed management, Rain water management, Alternate Land use etc.

### 24 Precision Farming

**Precision** agriculture (PA) or satellite *farming* or site-specific crop management (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops.

### 25 Irrigation

Irrigation is defined as the artificial application of water to the soil for the purpose of crop production in supplement to rainfall and ground water contribution.

According to Agricultural Census 2010-11, India’s total area under irrigation is 64.7 million hectares. Of this maximum 45% is shared by tube wells followed by Canals and wells.
IRRIGATION METHODS
✓ Surface
✓ Sub-surface
✓ Pressurized irrigation

Criteria for selection of irrigation method
- Water supply source
- Topography
- Quantity of water to be applied
- The crop
- Method of cultivation

A. Surface irrigation methods
Surface is grouped as:

<table>
<thead>
<tr>
<th>Flooding &amp; Surge</th>
<th>Check basin-Types</th>
<th>Furrow irrigations-Types</th>
<th>Border irrigation-Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rectangular, contour, ring</td>
<td>All furrow irrigation, alternate furrow irrigation</td>
<td>Straight Contour Ring</td>
</tr>
</tbody>
</table>
1. **Border irrigation**
   - The land is divided into number of long parallel strips called borders.
   - These borders are separated by low ridges.
   - The border strip has a uniform gentle slope in the direction of irrigation.
   - Each strip is irrigated independently by turning the water in the upper end.
   - The water spreads and flows down the strip in a sheet confined by the border ridges.

2. **Check basin irrigation**
   - It is the most common surface irrigation method.
   - Here, the field is divided into smaller unit areas so that each has a nearly level surface.
   - Bunds or ridges are constructed around the area forming basins within which the irrigation water can be controlled.
   - The water applied to a desired depth can be retained until it infiltrates into the soil.
   - The size of the basin varies from 10 sqm to 25 sqm depending upon soil type, topography, stream size and crop.

3. **Furrow irrigation**
   - It is used for row crops. The furrows are formed between crop rows.
   - The dimension of furrows depends on the crop grown, equipment used and soil type.
   - Water is applied by small running streams in furrows between the crop rows. Water infiltrates into soil and spreads laterally to wet the area between the furrows.
   - In heavy soils, furrows can be used to dispose the excess water.

4. **Surge irrigation**
   - Surge irrigation is the application of water into the furrows intermittently in a series of relatively short ON and OFF times of irrigation cycle.
   - It has been found that intermittent application of water reduces the infiltration rate over surges there by the water front advances quickly.
   - This also results in more uniform soil moisture distribution and storage in the crop root zone compared to continuous flow.
   - The irrigation efficiency is in between 85 and 90%.

B. **SUB-SURFACE IRRIGATION**
   - In subsurface irrigation, water is applied beneath the ground by creating and maintaining an artificial water table at some depth, usually 30-75 cm below the ground surface.
   - Moisture moves upwards towards the land surface through capillary action. Water is applied through underground field trenches laid 15-30 m apart.
Open ditches are preferred because they are relatively cheaper and suitable to all types of soil. The irrigation water should be of good quality to prevent soil salinity.

C. PRESSURIZED OR MODERN IRRIGATION SYSTEMS

Drip irrigation system
- Drip irrigation is sometimes called trickle irrigation and involves dripping water onto the soil at very low rates (2-20 liters/hour) from a system of small diameter plastic pipes fitted with outlets called emitters or drippers.
- Or trickle irrigation is one of the latest and modern methods of irrigation. It is suitable for water scarcity and salt affected soils.
- Water is applied in the root zone of the crop. Standard water quality test needed for design and operation of drip irrigation system.

Sprinkler irrigation system
- This is another important modern irrigation techniques followed all over the globe.
- Sprinkler irrigation is application simulating rainfall overhead so overhead sprinklers.
- The sprinkler (overhead or pressure) irrigation system conveys water to the field through pipes (aluminium or PVC) under pressure with a system of nozzles.
- This system is designed to distribute the required depth of water uniformly, which is not possible in surface irrigation.
- Water is applied at a rate less than the infiltration rate of the soil hence the runoff from irrigation is avoided.

26 Drainage
- Drainage is the artificial removal of water in excess of the quantity required for the crop.
- Drainage includes removal of excess water of both surface and subsurface in the root zone of crops.
- Irrigation and drainage go together and are not mutually exclusive.
- Irrigation aims at supplying optimum quantities of water throughout the crop period, whereas, drainage aims at removing excess quantity of water in a short time.

Critical stages for Irrigation: The most important stage in life cycle of crop when irrigation is must for its survival and grain production
27 **FERTILIZERS**

Fertilizers are industrially manufactured chemical containing plant nutrients. **Nutrient content is higher in fertilizers than organic manures and nutrients are released almost immediately.**

The fertilizers has three groups:
- ✓ Straight fertilizers – supplies single nutrient Ex: Urea, Muriate of Potash
- ✓ Complex fertilizers - supplies two or more nutrient Ex: 17:17:17 NPK complex
- ✓ Mixed fertilizers- supplies two or more nutrient Ex: Groundnut mixture

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28 **INTER CULTIVATION**

Cultivation practices taken up after sowing of crop is called inter-cultivation. It otherwise called as after operation.

There are three important after cultivation processes viz., Thinning and gap filling, weeding and hoeing and earthing up.

- ✓ Thinning and Gap filling
- ✓ Weeding and Hoeing
- ✓ Earthing up
Other inter cultivation practices

✓ Harrowing: Stirring or scraping the surface soil in inter and intra row spacing of the crop using tools or implements.
✓ Roguing: Removal of plants of a variety admixed with other variety of same crop.
✓ Topping: Removal of terminal buds. It is done to stimulate auxiliary growth. Practiced in cotton and tobacco.
✓ Propping: Provision of support to the crop is called propping. Practiced in sugarcane. Commonly. It is done to prevent lodging of the crop. Cane stalks from adjacent rows are brought together and tied with their own trash and old leaves.
✓ De-trashing: Removing of older leaves from the sugarcane crop.
✓ De-suckering: Removal of auxiliary buds and branches which are considered non-essential for crop production and which removes plant nutrients considerably are called suckers. Ex. Tobacco.

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