The Flash's

Articles

For

NABARD Gr. A & B

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#1

DEFINITION OF AGRICULTURE, MEANING AND SCOPE OF AGRONOMY

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DEFINITION OF AGRICULTURE

- The term agriculture is derived from the Latin words "***ager***" or "***agri***" meaning "***soil***" and '***cultra***' meaning '***cultivation***'
- Agriculture is a very broad term encompassing all aspects of crop production, Livestock farming, fisheries, forestry etc.
- Agriculture may be defined as the art, the science and the business of producing crops and livestock for man's use and employment.
- Agriculture is the cultivation of lands for production of crops for a regular supply of food and other needs for progress of the nation.
- Agriculture is influenced by a large number of factors, some of which can be controlled by man (soil and irrigation) which others are beyond the control (climate)

History of Agriculture in India

1947	CTRI at Rajmundry (Tobacco)/Food Policy Committee
1949	CPRI at Patna
1956	CPRI shifted to Simla
1950	IARI established at New Delhi
1951	Fertilizer factory at Bihar
1952	IISR at Lucknow (sugarcane)
1955	NDRI at Karnal (Dairy)
1956	PIRRCOM Project for intensification of regional research on cotton, oil seeds and millets. (Central Cotton Research Institute–Regional Centre)
1959	CAZRI at Jodhpur (Rajasthan) (Arid zone)
1960	IADP (Intensive Agriculture District Programme)
1960	IRRI, Philippines
1962	IGFRI at Jhansi, Uttar Pradesh; G.B. Pant Nagar Agricultural University and Technology at Pant Nagar
1963	CTCRI, Trivandrum (Tuber crops)/National Seed Corporation (NSC)
1965	IAAP (Intensive Agriculture Area Programme)
1966	HYVP at Bangalore (Horticulture)
1969	CSSRI (Central Soil Salinity Research Institute) at Karnal (Haryana)
1970	CPCRI at Kasargod (Kerala) (Plantation crops)/Drought Prone
1971	TNAU (Tamil Nadu Agricultural University) at Coimbatore) and All India Co-ordinated Project for Dry land Agriculture
1972	ICRISAT at Patancheru, Hyderabad/National Commission on Agriculture
1974	Command Area Development
1976	IRDP (Integrated Rural Development Programme)
1977	T&V (Training and Visit System)
1979	NARP (National Agricultural Research Project)
1980	Wealth Tax on Agriculture was abolished
1982	NABARD (National Bank for Agriculture and Rural Development)
1985	NAEP (National Agricultural Extension Project)
1995	NRCB at Tiruchirappalli, Tamil Nadu (Banana)
1998	NATP (National Agricultural Technology Project)
2006	NAIP (National Agricultural Innovation Project)

BRANCHES OF AGRICULTURE

Agriculture has 3 main spheres viz., Geoponic (Cultivation in earth-soil), Aeroponic (cultivation in air) and Hydroponic (cultivation in water). Agriculture is the branch of science encompassing the applied aspects of basic sciences. The applied aspects of agricultural science consists of study of field crops and their management (**Arviculture**) including soil management.

Crop production - It deals with the production of various crops, which includes food crops, fodder crops, fibre crops, sugar, oil seeds, etc. It includes agronomy, soil science, entomology, pathology, microbiology, etc. The aim is to have better food production and how to control the diseases.

Horticulture - Branch of agriculture deals with the production of flowers, fruits, vegetables, ornamental plants, spices, condiments (includes narcotic crops-opium, etc., which has medicinal value) and beverages.

Agricultural Engineering - It is an important component for crop production and horticulture particularly to provide tools and implements. It is aiming to produce modified tools to facilitate proper animal husbandry and crop production tools, implements and machinery in animal production.

Forestry - It deals with production of large scale cultivation of perennial trees for supplying wood, timber, rubber, etc. and also raw materials for industries.

Animal Husbandry - The animals being produced, maintained, etc. Maintenance of various types of livestock for direct energy (work energy). Husbandry is common for both crop and animals. The objective is to get maximum output by feeding, rearing, etc. The arrangement of crops is done to get minimum requirement of light or air. This arrangement is called geometry. Husbandry is for direct and indirect energy.

Fishery Science - It is for marine fish and inland fishes including shrimps and prawns.

Home Science - Application and utilization of agricultural produces in a better manner. When utilization is enhanced production is also enhanced. *e.g.,* a crop once in use in south was found that it had many uses now.

On integration, all the seven branches, first three is grouped as for crop production group and next two for animal management and last two as allied agriculture branches. Broadly in practice, agriculture is grouped in four major categories as,

A. Crop Improvement	(*i*) Plant breeding and genetics (*ii*) Bio-technology
B. Crop Management	(*i*) Agronomy (*ii*) Soil Science and Agricultural Chemistry (*iii*) Seed technology (*iv*) Agricultural Microbiology (*v*) Crop-Physiology (*vi*) Agricultural Engineering (*vii*) Environmental Sciences (*viii*) Agricultural Meteorology
C. Crop Protection	(*i*) Agricultural Entomology (*ii*) Plant Pathology (*iii*) Nematology
D. Social Sciences	(*i*) Agricultural Extension (*ii*) Agricultural Economics
Allied disciplines	(*i*) Agricultural Statistics (*ii*) English and Tamil (*iii*) Mathematics (*iv*) Bio-Chemistry etc.

Financing Agriculture	Financing other sectors
(i) Farmers are not aware of credit policies and procedures	They are aware of banking procedures.
(ii) Difficult to estimate the efficiency of farming in the absence of farm records.	Efficiency can be assessed as all returns are recorded.
(iii) Farming is exposed to natural calamities and uncertainties.	Risk and uncertainties involved in an enterprise can be foreseen and managed.
(iv) Frequent supervision and follow-up after loan disbursement are difficult as farms are scattered.	Monitoring is easy and less time consuming.
(v) Land as major security being immovable is not highly liquid.	Apart from immovable assets, movable assets are also taken as security which can be easily liquidated.
(vi) Ownership of land is difficult to verify as land records are not updated.	Identification of ownership can be easily done by verifying records.
(vii) As farm products are perishable, they are subjected to distress sales.	As industrial products are non-perishable, producers can fix prices.
(viii) Long gestation period between investment and returns.	Very short gestation period.
(ix) Since income is seasonal, repayment schedule is drawn in accordance with income generation from investment.	As income generation is a continuous process, repayments will be made continuously.
(x) Adequate infrastructural facilities are not available to implement new technologies.	Sufficient infrastructure is available to implement their schemes.
(xi) Farmers are susceptible to external influence and hence some vested interests exploit them and guide them in wrong direction.	Entrepreneurs are not usually misled by external influence as they are well organized.

Importance of basic sciences for development of Agricultural science

• Basic science is the study of basic principles and fundamentals of the respective subject.
• Applied science is the study in which the basic principles and fundamentals of respective subject are applied in a practical field.
• Agricultural sciences are essentially applied sciences and are dependent on basic sciences of Botany, Physiology, bio-chemistry, ecology, zoology, chemistry, physics, mathematics, economics etc.

For example

1. Knowledge of Botany is helpful in plant breeding and plant genetics and is making possible for evolution of different varieties in crops suitable to particular agro-climatic condition.
2. The knowledge of zoology (basic science of entomology) is helping the farmer to identify the insect pests which are responsible for damage to agricultural produce.
3. Soil chemistry helps in understanding the plant nutrient status in the soil and the deficiency symptoms in plants.
4. Physics helps in understanding the weather phenomena and soil conditions
5. Mathematics is helpful in agricultural research and experimentation through statistics and Agricultural economics.
6. Study of economics is helpful in estimating the costs and returns and existing conditions of farmers in villages for effecting the improvements. Without basic science there can be no development in applied science. In the Field of Agriculture basic and applied sciences are interrelated to each other.

IMPORTANCE EVENTS OF AGRICULTURE IN INDIA

1788 First attempt at cotton crop improvement in Bombay province
1827 First agricultural society at Calcutta
1864 First model agricultural farm at Saidapet, Tamil Nadu
1871 Department of Agriculture created
1878 Higher Education in Agriculture at Coimbatore
1880 First Report of Famine Commission (Famine during 1876-77
1893 Second report of Famine Commission
1901 Third report of Famine Commission
1901 First Irrigation Commission
1902 Introduction of large scale cultivation of groundnut
1903 Imperial Agricultural research Institute at Pusa, Bihar
1904 Introduction of Cambodia cotton
1912 Imperial Sugarcane Breeding Station at Coimbatore
1926 Royal Commission on Agriculture
1929 Imperial (Indian) Council of Agricultural Research at Delhi
1936 IARI shifted to Delhi
1942 Grow More Food Campaign
1946 Central Rice Research Institute
1947 Fertilisers and Chemicals, Travancore
1956 Project for Intensification of Regional Research on Cotton, Oilseeds and Millets (PIRRCOM)
1960 Intensive Agriculture District Programme (IADP)
1963 National Seed Corporation
1965 Intensive Agriculture Area Programme (IIAP)
1965 National Demonstration Programme

1965 All India Coordinated Rice Improvement Project, Hyderabad
1966 HYV Programme
1966 Multiple Cropping Schemes
1970 Drought Prone Area Programme
1971 All India Coordinated Project for Dryland Agriculture
1972 ICRISAT
1973 Minikit Trails Programme
1974 Command Area Development
1975 Release of first cotton hybrid in India
1976 Report of National Commission on Agriculture
1976 Integrated Rural Development Programme (IRDP)
1977 Training and Visit (T&V) System
1979 National Agriculture Research Project (NARP)
1982 National Bank for Agriculture and Rural Development (NABARD)
1986 Establishment of Technology mission on oilseeds
1993 Release of First rice hybrid in India
1998 National Agricultural Technology Project (NATP)
ITDA - Integrated Tribal Development Agency
SFDA - Small Farmers Development Agency
HADP - Hill Area Development Project Special Programme for Horticultural Crops
DRDA - District Rural Development Agency

Functions of ICAR: Coordinating Agricultural activity between states and center financing research problems. Maintaining National Research Centers and Institutes

Agricultural research is carried out by: ICAR research centers SAUs (State Agricultural Universities)

NATIONAL AND INTERNATIONAL RESEARCH INSTITUTES IN INDIA

NATIONAL RESEARCH INSTITUTES:

CAZRI : Central Arid Zone Research Institute, Jodhpur, Rajasthan
CFTRI : Central Food Technological Research Institute, Mysore, Karnataka
CICR : Central Institute for Cotton Research, Nagpur, Maharashtra
CPRI : Central Potato Research Institute, Simla, H.P.
CRIJAF : Central Research Institute for Jute and Allied Fibres, Barrack Pore, W.B.
CIAE : Central Institute of Agriculture Engineering, Bhopal, M.P.
CPCRI : Central Plantation crops Research Institute, kasargod, Kerala
CRIDA : Central Research Institute for Dryland Agriculture, Hyderabad, A.P.
CRRI : Central Rice Research Institute, Cuttack, Orissa
CSWCRTI : Central Soil and Water Conservation Research and Training Institute, Dehradun, U.P.
CTCRI : Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala
CSSRI : Central Soil Salinity Research Institute, Karnal, Haryana
CTRI : Central Tobacco Research Institute, Rajahmundry, A.P.
DOR : Directorate of Oilseeds Research, Hyderabad, A.P.
DRR : Directorate of Rice Research, Hyderabad, A.P.
DWR : Directorate of Wheat Research, Karnal, Haryana

DWMR : Directorate of Water Management Research Institute, Jhansi, U.P.
FRI : Forest Research Institute, Dehradun, U.P.
IARI : Indian Agriculture Research Institute, Pusa, New Delhi
IGFARI : Indian Grassland Fooder and Agroforestry Research Institute, Jhansi, U. P.
IISR : Indian Institute of Sugarcane Research, Lucknow, U.P.
IISS : Indian Institute of Soil Science, Bhopal, M.P.
IIPR : Indian Institute of Pulse Research, Kanpur, U.P.
IIHR : Indian Institute of Horticultural Research, Bangalore, Karnataka.
ILRI : Indian Lac Research Institute, Ranchi, Bihar
JTRL : Jute Technological Research Laboratory, Kolkata, W.B.
NCMRT : National Centre for Mushroom Research and Training, Solan, H.P.
NRCG : National Research Centre for Groundnut, Junagadh, Gujarat
NRCS : National Research Centre for Sorghum, Hyderabad, A.P.
NRC for Soybean, Indore, M.P.
NRC for Spices, Calicut, Kerala
NRC for Cashew, Pattur, Karnataka
NRC for Citrus, Nagpur, Maharasthra
NRC for Rapeseed and Mustard, Bharatpur, Rajasthan
NRC for Oil Palm, Pedavegi, Andhra Pradesh.
NCWS : National Centre for Weed Science, Jabalpur, M.P.
NBPGR : National Bureau of Plant Genetic Resources, New Delhi
NAARM : National Academy of Agricultural Research Management, Hyderabad
NBSSLUP : National Bureau of Soil Survey and Land Use Planning, Nagpur, Maharashtra
NPPTI : National Plant Protection Training Institute, Hyderabad, A.P.
PDCSR : Project Directorate for Cropping Systems Research, Meerut, U.P.
SBI : Sugarcane Breeding Institute, Coimbatore, Tamil Nadu

INTERNATIONAL INSTITUTES:

CGIAR : Consultative Group on International Agricultural Research, Washington, D.C.
CIFOR : Centre for International Forestry Research, Bogor, Indonesia
CIAT : Centre International de Agricultural Tropical, Cali, Columbia
CIMMYT : Centre International de la Mejoramientode Maizy Trigo, Mexico
CIP : Centre International de la papa (International Potato Centre) Lima, Peru
IBPGR : International Board for Plant Genetic Resources, Rome, Italy
ICARDA : International Center for Agricultural Research in the Dry Areas, Aleppo, Syria
ICRAF : International Centre for Research in Agro-Forestry, Nairobi, Kenya
ICRISAT : International Crops Research Institute for Semi-Arid Tropics, Hyderabad, India
IFPRI : International Food Policy Research Institute, Washington, U.S.A
IITA : International Institute for Tropical Agriculture, Ibadan, Nigeria
IIMI : International Irrigation Management Institute, Colombo, Sri Lanka
ILRI : International Livestock Research Institute, Nairobi, Kenya
IRRI : International Rice Research Institute, Manila, Philippiness

ISNAR : International Service for National Agricultural Research, The Hague, The Netherlands
WARDA : West Africa Rice Development Association, Ivory Coast, West Africa

Entity ID	Headquarters
1	Indian Council of Agricultural Research, New Delhi
	ICAR Institutes
2	Indian Agricultural Research Institute, New Delhi
3	Indian Agricultural Statistics Research Institute, New Delhi
4	National Academy of Agricultural Research Management, Hyderabad, Andhra Pradesh
5	Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh
6	Central Soil Salinity Research Institute, Karnal, Haryana
7	National Dairy Research Institute, Karnal, Haryana
8	Central Avian Research Institute, Bareilly, Uttar Pradesh
9	Indian Veterinary Research Institute, Bareilly, Uttar Pradesh
10	Central Institute for Cotton Research, Nagpur,
11	Central Institute for Research on Buffaloes, Hisar, Haryana
12	Central Institute for Research on Cotton Technology, Mumbai, Maharashtra
13	Central Institute of Fisheries Education, Mumbai
14	Central Institute for Research on Goats, Mathura, U.P.
15	Indian Institute of Sugarcane Research, Lucknow, U.P.
16	Central Institute for Subtropical Horticulture, Lucknow, U.P.
17	Central Institute of Agricultural Engineering, Bhopal, M.P.
18	Indian Institute of Soil Science, Bhopal, Madhaya Pradesh
19	Central Institute for Arid Horticulture, Bikaner, Rajasthan
20	Central Institute of Brackishwater Aquaculture, Chennai
21	Central Institute of Post Harvest Engineering & Technology, Ludhiana, Punjab
22	Central Institute of Temperate Horticulture, Srinagar, J&K
23	Central Marine Fisheries Research Institute, Cochin
24	Central Institute of Fisheries Technology, Cochin
25	Central Plantation Crops Research Institute, Kasaragod
26	Central Arid Zone Research Institute, Jodhpur, Rajasthan
27	Central Potato Research Institute, Shimla, H.P.
28	Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal
29	Central Inland Fisheries Research Institute, Barrackpore
30	Central Rice Research Institute, Cuttack, Orissa
31	Central Sheep and Wool Research Institute, Avikanagar
32	Central Soil and Water Conservation Research and Training Institute, Dehradun, Uttarakhand
33	Central Tobacco Research Institute, Rajamundry, A.P.
34	Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala
35	ICAR Research Complex for Eastern Region, Patna, Bihar
36	ICAR Research Complex for Goa, Goa
37	ICAR Research Complex for NEH Region, Ri Bhoi,
38	Central Agricultural Research Institute, Port Blair, A&N
39	Indian Grassland & Fodder Research Institute, Jhansi, U.P.
40	Indian Institute of Horticultural Research, Bengaluru
41	National Institute of Animal Nutrition and Physiology, Bengaluru, Karnataka
42	Indian Institute of Natural Resins and Gums, Ranchi
43	Indian Institute of Pulses Research, Kanpur, U.P.
44	Indian Institute of Spices Research, Marikunnu, Kerala
45	Indian Institute of Vegetable Research, Varanasi, U.P.
46	National Institute of Research on Jute and Allied Fibre Technology, Kolkata, West Bengal
47	National Institute of Abiotic Stress Management, Malegaon, Pune, Maharashtra
48	Sugarcane Breeding Institute, Coimbatore, Tamil Nadu
49	Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand
50	Central Institute of Freshwater Aquaculture, Bhubaneshwar, Orissa

AGRONOMY

- The term "***Agronomy***" is derived from Greek words "***Agros***" meaning "***field***" and "***nomos***" meaning "***to manage***"
- Agronomy is a branch of agricultural science which deals with principles and practices of soil, water and crop management.
- Agronomy deals with methods which provide favourable environment to the crop for higher productivity.

Scope of Agronomy

Agronomy is a dynamic discipline with the advancement of knowledge and better understanding of plant and environment, agricultural practices are modified and new practices developed for high productivity, for example availability of chemical fertilizer has necessitated the generation of knowledge on the method, quantity and time of application of fertilizers. Similarly availability of herbicides for the control of weeds has led to development of knowledge about selectivity, time and method of application of herbicides. To overcome the problems different management practices are developed.

Population pressure is increasing but area under cultivation is static, therefore more number of crops have to be grown on the same piece of land to increase the yield. As a result, intensive cropping has come into practice.

New technology has to be developed to overcome the effect of moisture stress under dryland conditions. As new varieties of crops with high yield potential become available package of practices have to be developed to exploit their full potential.

Restoration of soil fertility, preparation of good seed bed, use of proper seed rates, correct dates of sowing for each improved variety, proper conservation and management of soil moisture and proper control of weeds are agronomic practices to make our limited land and water resources more productive.

Relation of Agronomy to other sciences

Agronomy is a synthesis of several disciplines like soil science, Agricultural chemistry, crop physiology, plant ecology, biochemistry and economics. Soil physical, chemical and biological properties have to be understood thoroughly to effect modification of soil environment. Similarly it is necessary to understand the physiology of crops to meet their requirements. Advances in economic analysis helped in production of crops economically.

Agronomist aims to obtain maximum production at minimum cost. He exploits the knowledge developed by basic and applied science for higher crop production. Whatever may be the research findings of other scientists? Agronomist has to test their suitability in the field and accept them finally and also judge the reactions of farming community. He is a key person with working knowledge of all agricultural disciplines and coordinator of different subject matter specialists.

AGRO-CLIMATIC ZONES

Based on the criteria of homogeneity in agro-characteristics such as rainfall, temperature, soil, topography, cropping and farming systems and water resources, the country has been divided into 15 agro-climatic regions.

1. WESTERN HIMALAYAN REGION:

This consists of three distinct sub-zones of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh hills. The region consists of skeletal soils of cold region, podsolic soils, mountain meadow soils and hilly brown soils. Lands of the region have steep slopes in undulating terrain. Soils are generally salty loam with altitudinal variations. They are and prone to erosion hazards and slides and slips are quite common. Rice, maize, millets, wheat and barley are the main crops. The productivity level of all crops is lower than the all India average. Ginger, saffron, many temperature flowers and vegetables are grown in this region. This zone is having highest area (45.3%) under forests. Land use planting based on the concept that land up to 30% slope is suitable for agriculture on terraces, 30-50% slopes for horticulture and silvi-pastoral programmes, and above 50% slopes for forestry is a suggested strategy for development of the region. With the full backing of storage and cold storage facilities for transport, marketing and processing, this region will be able to supply fruits and vegetables to rest of the country.

2. EASTERN HIMALAYAN REGION

Sikkim and Darjeeling hills, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Assam and Jalpaiguri and coochbehar districts of West Bengal fall under this region, having high rainfall and high forest cover. Shifting cultivation (Jhum), practiced in nearly one third of the cultivated area, has caused denudation and degradation of soils, with the resultant heavy runoff, massive soil erosion and floods in the lower reaches and basins. Since this area has a high potential for agriculture including forestry and horticulture, a complete package of supply of inputs (quality seeds, saplings, fertilizers and pesticides) coupled with marketing and processing, has to be organized for each sub-zone.

3. LOWER GANGETIC PLAINS

The West Bengal – Lower Gangetic Plains region consists of four sub-regions. This zone accounts for about 12% of the country's rice production. Floods and inundation of fields in Barind and Central plains often destroy standing crops. Sesamum, Jute, mustard, *rabi* maize and potato are emerging as new crops of this zone. The per capita land availability here is very low (0.095 hectares) as this zone has highest density of population (692 per km2). Marine fisheries programme are well developed but need to be more organized. Scope for forage production and livestock rearing is very high.

4. MIDDLE GANGETIC PLAINS:

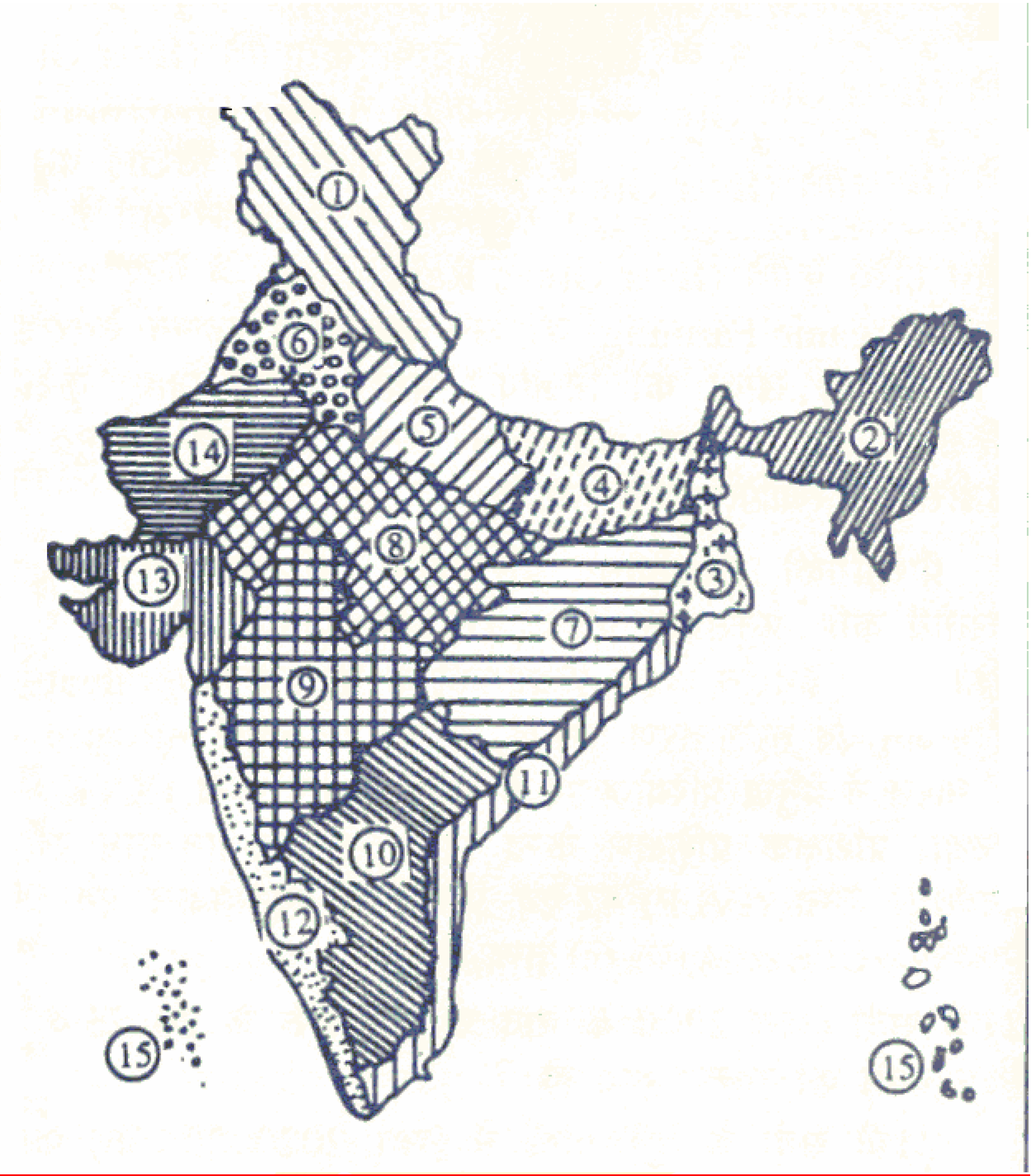
This zone consists of 12 districts of eastern Uttar Pradesh and 27 districts of Bihar plains. Eastern U.P. has been further sub-divided into nine regions based on the heterogeneity in soil, land use, topography and climatic factors. This region has a geographical area of 16 m. ha. And a high population of 85 million. The rainfall is high and 30% of the gross cropped area is irrigated and the cropping intensity is 142%. There is large area under salt affected (usar) lands. Rice is the principal crop but its productivity is low. Zinc deficiency in rice is wide spread. There is urgent need to improve the yield, through a technological backup along with supply of seeds of high yielding varieties and adoption of improved package of practices by the farmers. It is suggested to put uncultivable wasteland under silvi-pasture and cultural land under agro-forestry. Poultry, dairying and inland riverine fishery also should receive priority.

5. UPPERGANGETIC PLAINS:

This zone consists of 32 districts of Uttar Pradesh divided into three sub-zones ofCentral, North- West and South –West U.P. The zone has 144% cropping intensity. Irrigation is largely through canals and tube wells. A good potential for exploitation of ground water exists. Growth in agriculture has to come through increasing productivity as net sown area is already exploited. In all the Diara lands (flood prone areas) development of fruit trees is important. Milk production from cows is very low. Genetic improvement through cross breeding and increasing the area under fodder crops is important.

6. TRANS-GANGETIC PLAINS

This zone consists of Punjab and Haryana, Union Territories of Delhi and Chandigarh and Sriganganagar district of Rajasthan. It is delineated into three sub-zones, namely, foothills of Shiwalik and the Himalayas, plains (Semi arid) and arid zone bordering the Thar desert. The major characteristics of the area are: highest net sown area, highest irrigated area, least poverty level, high cropping intensity (170%) and high ground water utilization. Rice-wheat system is prevalent. There is need to evolve short duration genotypes and also to diversify of the cropping. Food processing industries should be established in areaswhere farmers have started taking up cultivation of vegetables and fruit crops.



7. EASTERN PLATEAU AND HILLS

The eastern Plateau and Hills region consists of the following sub-regions:
I. Sub-region of Wainganga, Madhya Pradesh Eastern Hills and Orissa inland,
II. Orissa Northern and M.P. Eastern Hills and plateau
III. Chotanagpur North and Eastern Hills and plateau
IV. Chotanagpur South and West Bengal Hills and Plateau, and
V. Chattisgarh and South-Western Orissa Hills.
The soils of the region are shallow and medium in depth and the topography is undulating with a slope of 1 to 10%. Rainfall is nearly 1300 mm. Integrated water shed development approach to conserve soil and rainwater should be strengthened.
Tank irrigation is significant for sub-zone 2 and sub-zone 5. Irrigation by tube wells is significant in sub-zone 1. In *kharif*, 82% of the area is under rice. Most soils are acidic and in some areas application of

lime is necessary. Cultivation of crops like redgram, groundnut, and soybean in uplands is to be encouraged. Mustard and vegetables are to be grown in irrigated areas. The rehabilitation of degraded peripheral forests is to be taken up on a large scale. Nearly 30% of the forestland is estimated as degraded. Inland fisheries programme needs to be encouraged.

8. CENTRAL PLATEAU AND HILLS

This zone comprises of 46 districts of Madhya Pradesh, Uttar Pradesh and Rajasthan. Irrigation and intensity of cropping are low. The literacy percentage is low and the poverty ratio is high. Per capita availability of land is very high (0.446 ha). Since 75% of the area is rainfed, a watershed management programme is to be implemented. Food crops should be replaced by oil seeds.

9. WESTERN PLATEAU AND HILLS

This zone comprises of major parts of Maharashtra, parts of Madhya Pradesh and one district of Rajasthan and is divided into four sub-zones. This region forms a major part of peninsular India, with an annual average rainfall of 904 mm. Net sown area is 65% and only 12.4% area is irrigated. Sorghum and Cotton are the major crops in nearly half of the cultivated area. This zone is known for the best quality oranges, grapes and bananas. The area under fruit crops is about one lakh hectares. Farmers are adopting sprinklers and the drip methods of irrigation, particularly, for fruit and vegetable crops.

10. SOUTHERN PLATEAU AND HILLS:

This zone comprises of 35 districts of Andhra Pradesh, Karnataka and Tamil Nadu, which are typically semi-arid zones. Rainfed farming is adopted in 81% of the area and the cropping intensity is 111%. Low value cereals and minor millets predominate in the cropping systems. The adoption of proven dryland technology in the watershed areas should aid agriculture in this area. Crop diversification has to be intensified and crops that require less moisture should be preferred. Poultry has developed quickly in many areas of the zone.

11. EAST COAST PLAINS AND HILLS:

This zone consists of six sub-zones

i) Orissa coastal
ii) North Coastal Andhra and Ganjam,
iii) South Coastal Andhra,
iv) North Coastal Tamil Nadu,
v) Thanjavur and
vi) South Coastal Tamil Nadu.

Rice and groundnut are the important crops. Nearly 70% of the cultivated area does not have irrigation facility and, therefore, a watershed management programme can be taken up to 6.45 m. ha. Tanks account for nearly 20% of the irrigated area in the zone and programmes such as desilting tanks, strengthening of bunds and structures and improvement of field channels need to be taken up through a community approach. Drainage programmes, particularly in the south coastal Andhra Pradesh (Krishna – Godavari delta) and Cauvery delta areas are a vital need, because water logging is a critical constraint affecting crop yields. Alkaline-saline soils in the region total up to 4.9 lakh hectares. Area under waste lands estimate to 25.33 lakh ha. Waste land development programmes should be given priority. The zone with over 2,000 km of coastline and many inland waterways is suitable for fisheries.

Brackish water fisheries and aquaculture hold great promise in this area. Roughly 40% of the marine potential is taken advantage of in Andhra Pradesh and 46% in the Tamil Nadu Coast.

12. WEST COAST PLAINS AND GHATS:

This zone runs along the west coast, covering parts of Tamil Nadu, Kerala, Karnataka, Maharastra and Goa with a variety of crop patterns, rainfall and soil types. This is an important zone for plantation crops and spices and fisheries. Literacy is the highest in Kerala and so is unemployment. Cropping intensity is 124%. Productivity of rice and millets is low and there is need for diversification to horticulture crops such as Mango, Banana and Coconut. Fruit marketing and processing should be systematized by developing appropriate infrastructure.The approach of homestead (group farming) system (one of the agro-forestry systems) of reclaiming and using khar lands (saline soils) or pokhali lands (acidic soils) needs to be planned and implemented. This zone is important for multi-storeyed cropping.

13. GUJARAT PLAINS AND HILLS:

This zone consists of 19 districts of Gujarat classified into seven sub-zones. The zone is arid with low rainfall in most parts and only 22.5% of the area is irrigated, largely through wells and tube wells. Only 50% of the cultivated area is under food crops resulting in food deficit. However it is an important oilseed zone. The cropping intensity is 114% and nearly 60% of the zone is considered drought prone. The major thrust should be on rainwater harvesting, dry farming and canal and ground water management. The long coastline and river deltas should be used fully for developing marine fishing and brackish/backwater aquaculture.

14. WESTERN DRY REGION

This region comprises of nine districts of Rajasthan and is characterized by hot sandy desert, erratic rainfall, high evaporation, no perennial rivers and scanty vegetation. The ground water is deep and often brackish. Famine and drought are common features forcing people and animals to migrate to other places in search of water, food and fodder. The land-man ratio is high (1.73 ha/person). The average annual rainfall is only 395 mm with wide fluctuations from year to year. The forest area is only 1.2%. The land under pastures is also low (4.3%). The cultural waste and fallow lands are substantial, accounting for nearly 42% of the geographical area.

The net irrigated area is only 6.3% of the net sown area. Cropping intensity is 105%. Pearl millet, cluster bean (guar) and moth are the lead crops in kharif and wheat and gram in rabi, but the yield levels per hectare are low. Any change in the cropping pattern is not advocated because of the fodder value of the crops. The acute shortage of fuel, fodder anforage warrants stringent efforts for development of silvipastoral systems and energy plantations to meet the scarcity and to stabilize partially the sand dunes. The Indira Gandhi Nahar Project and DDP are the two main water sources of great potential in this zone. The small area of 0.31 m. ha. under forests is also in a degraded condition. Increasing tree cover is important to (a) check desertification, (b) provide fodder to livestock, (c) meet the fuel needs of the population, and (d) provide timber implements.

15. ISLANDS REGION:

This zone covers the island territories of the Andaman and Nicobar and Lakshadweep, which are typically equatorial. Rainfall of 3,000 mm is spread over eight to nine months. It is largely a forest zone having large undulating areas leading to heavy loss of soil due to runoff. Nearly half of the cropped area is under coconut. This is the smallest zone with a high literacy rate and low poverty levels.

CROPPING SYSTEMS –DEFINITION & TYPES

Cropping pattern: - It means the proportion of area under various crops, at a point of time in a unit area. It indicates the yearly sequence and spatial arrangement of crops and fallow in an area. Decrease keeping the field vacant

Cropping System: It is an order in which the crops are cultivated on a piece of land over a fixed period this is cropping system.

Mono-cropping: or Monoculture refers to growing of only one crop on a piece of land year after year.

Ex: Rice – Rice (In Godavari belt) Groundnut every year in Anantapur dist.

Disadvantage in Mono-cropping

- Improper use of moisture and nutrients from the soil
- Control of crop associated pests and weeds become a problem.

Crop rotation: It is a process of growing different crops in succession on a piece of land in a specific period of time with an object to get maximum profit from least investment without impairing soil fertility.

Principles of crop rotation:

1. The crops with tap roots should be fall by those which have a fibrous root system
2. The leguminous crops should be grown after non leguminous crops.
3. More exhaustive crops should be followed by less exhaustive crop.
4. Selection of crops should be demand based.
5. Selection of crops should be problem based.
6. The crops of the same family should not be grown in succession because the act like alternate hast for insects, pests and disease pathogens.
7. An ideal crop rotation is one which provides maximum employment to the family and farm labour, the machines and equipment's are efficiently used then all the agriculture operations are done simultaneously.

Multiple cropping

Growing two or more crops on the same piece of land in one agriculture year is known as '***Multiple cropping***'.

It is the intensification of cropping in time and space dimensions i.e., more number of crops within a year and more number of crops on the same piece of land.

It includes intercropping, mixed cropping and sequence cropping.

Inter Cropping:

It is growing two or more crops simultaneously on the same piece of land with a definite row pattern.

Ex: Setaria + Redgram in 5:1 ratio

Groundnut + Redgram in 7:1 ratio

(a). Additive series

(b). Replacement series

Mixed cropping

It is the process of growing two or more crops together in the same piece of land. This system of cropping is generally practiced in areas where climatic hazards such as flood, drought, frost etc. are frequent and common.

Sequence cropping

It can be defined as growing of two or more crops in sequence on same piece of land in a farming year. Depending on number of crops grown in a year. It is called double, triple and quadruple cropping involving two, three and four crops respectively.

Relay cropping:

It is analogous to a relay race where crop hands over land to next crop in quick succession.

Ex: Maize – Early Potato – Wheat – Mungo

Overlapping system of cropping:

In this the succeeding crop is sown in standing proceeding crop thus in this system before harvesting one crop the seeds of next crop are sown. Ex: Maize potato onion bendi in North India.

Ratoon cropping: It refers to raising a crop with re growth coming out of roots or stalks after harvest of the crop. Ex: Sugarcane.

Multi Storeyed System: Growing of plants of different heights in same field at the same time is termed as multi-storeyed cropping. Ex: Coconut – Piper - banana – Pineapple.

Difference between intercropping and mixed cropping

SNO.	INTERCROPPING	MIXED CROPPING
1	The main objective is to utilize the space left between two rows of main crop especially during early growth period of main crop.	Main objective is to get at least one crop under any climatic hazards (flood, drought or frost) conditions
2	More emphasis is given to the main crop and subsidiary crops are not grown at the cost of main crop thus there is no competition between main and subsidiary crop.	All crops are given equal care and there is no main or subsidiary crop. Almost all the crops compete with one another.

3	Subsidiary crops are of short duration and they are harvested much earlier than main crop.	The crops are almost of same duration.
4	Both the crops are sown in rows. The sowing time may be the same or the main crop is sown earlier than subsidiary crop.	Crops may be broad casted and sowing time for all the crops is the same .

DRYLAND FARMING-INTRODUCTION AND DEFINITION AND IMPORTANCE

Dry farming: is cultivation of crops in regions with annual rainfall less than 750 mm. Crop failure is most common due to prolonged dry spells during the crop period. These are arid regions with a growing season (period of adequate soil moisture) less than 75 days. Moisture conservation practices are necessary for crop production.

Dryland farming: is cultivation of crops in regions with annual rainfall more than 750 mm. In spite of prolonged dry spells crop failure is relatively less frequent. These are semi-arid tracts with a growing period between 75 and 120 days. Moisture conservation practices are necessary for crop production. However, adequate drainage is required especially for vertisols or black soils.

Rain fed farming: is crop production in regions with annual rainfall more than 1150 mm. Crops are not subjected to soil moisture stress during the crop period. Emphasis is often on disposal of excess water. These are humid regions with growing period more than 120 days.

United Nations Economic and Social Commission for Asia and the Pacific distinguished dryland agriculture mainly into two categories: dryland and rain fed farming. The distinguishing features of these two types of farming are given below.

Dryland vs. rain fed farming

Constituent	Dryland farming	Rainfed farmin
Rainfall (mm)	<800	>800
Moisture availability to the crop	Shortage	Enough
Growing season (days)	<200	>200
Growing regions	Arid and semiarid as well as uplands of sub-humid and humid regions	Humid and sub humid regions

Cropping system	Single crop or intercropping	Intercropping or double cropping
Constraints	Wind and water erosion	Water erosion

Importance of Dry farming in Indian Agriculture

1. About 70% of rural population lives in dry farming areas and their livelihood depend on success or failure of the crops
2. Dryland Agriculture plays a distinct role in Indian Agriculture occupying 60% of cultivated area and supports 40% of human population and 60 % livestock population.
3. The contribution (production) of rain fed agriculture in India is about 42 per cent of the total food grain, 75 per cent of oilseeds, 90 per cent of pulses and about 70 per cent of cotton.
4. By the end of the 20th century the contribution of drylands will have to be 60 per cent if India is to provide adequate food to 1000 million people. Hence tremendous efforts both in the development and research fronts are essential to achieve this target.
5. More than 90 per cent of the area under sorghum, groundnut, and pulses is rain fed. In case of maize and chickpea, 82 to 85 per cent area is rain fed. Even 78 percent of cotton area is rain fed. In case of rapeseed/mustard, about 65.8 per cent of the area is rain fed. Interestingly, but not surprisingly, 61.7, 44.0, and 35.0 per cent area under rice, barley and wheat, respectively, is rain fed.
6. At present, 3 ha of dryland crop produce cereal grain equivalent to that produced in one ha irrigated crop. With limited scope for increasing the area under plough, only option left is to increase the productivity with the modern technology and inputs, since the per capita land availability which was 0.28 ha in 1990 is expected to decline 0.19 ha in 2010.
7. The productivity of grains already showed a plateau in irrigated agriculture due to problems related to nutrient exhaustion, salinity build up and raising water table. Therefore, the challenges of the present millennium would be to produce more from drylands while ensuring conservation of existing resources. Hence, new strategies would have to be evolved which would make the fragile dryland ecosystems more productive as well as sustainable. In order to achieve evergreen revolution, we shall have to make grey areas (drylands) as green through latest technological innovations.
8. Drylands offer good scope for development of agroforestry, social forestry, horti-sylvi-pasture and such other similar systems which will not only supply food, fuel to the village people and fodder to the cattle but forms a suitable vegetative cover for ecological maintenance.

Dimensions of the problem:

Majority of the districts in India are dry farming districts and covers 60 per cent of the total cultivated area. Most of this area is covered by crops like millets, pulses, oilseeds, cotton etc.,.These areas spread throughout the country i.e. Tamilnadu, Karnataka, Andhra Pradesh, Madhya Pradesh, Maharastra, Gujarat, Rajasthan, Punjab, Haryana and Uttar Pradesh. In south India the Deccan plateau which is rain shadow area consisting of parts of Karnataka, (Bellary, Raichur, Kolar, Tumkur, Dharwad, Belgam, Gulberga) and Maharastra (Sholapur, Parbani, Puna, Aurangabad). The dry farming areas in Andhra Pradesh are found in Kurnool, Anantapur, Kadapa, Mahaboobnagar, Chittoor, and Nalgonda districts.

a) The area under dryland agriculture is more in India (60 per cent of total cultivable area)
b) Areas of low rainfall (below 750 mm) constitute more than 30 per cent of total geographical area
c) About 84 districts in India fall in the category of low rainfall area
d) Providing irrigation to all the drylands is expensive and takes long time
e) Even after providing all the irrigation potential in India 55 per cent area remains as rain fed

AGRICULTURAL METEROLOGY

Atmosphere

The earth is elliptical in shape. It has three spheres. They are:

1. Hydrosphere: the water portion.
2. Lithosphere: the solid portion.
3. Atmosphere: the gaseous portion.

The atmosphere is defined as "The colourless, odourless and tasteless physical mixture of gases which surrounds the earth on all sides". It is mobile, compressible and expansible.

Uses of atmosphere for agriculture:

The uses of atmosphere are: It

1. Provides oxygen which is useful for respiration in crops.
2. Provides carbon-dioxide to build biomass in photosynthesis.
3. Provides nitrogen which is essential for plant growth.
4. Acts as a medium for transportation of pollen.
5. Protects crop plants on earth from harmful U.V. rays.
6. Maintains warmth to plant life.
7. Provides rain to field crops as it is a source of water vapour, clouds etc.

Agricultural Meteorology

Meteorology

Meteorology is defined as

- "The science of atmosphere".
- "A branch of physics of the earth dealing with physical processes in the atmosphere that Produce weather"

Climatology

It is defined as “The science dealing with the factors which determine and control the distribution of climate over the earth's surface”. Different factors affecting the climate of a region are:
1. Latitude.
2. Altitude
3. Land and water.
4. Winds and air masses
5. Low and high pressure belts.
6. Mountain barriers.
7. Ocean currents.
8. Extent of forests, etc.

The above factors are also known as “climatic elements”

Agricultural Meteorology

Agriculture is defined as **“**The art and science of production and processing of plant and animal life for the use of human beings”. It is also defined as “A system for harvesting or exploiting the solar radiation”.

Agriculture deals with three most complex entities viz., soil, plant and atmosphere and their interactions. Among these three, atmosphere is the most complex entity over the other two. It is defined as

- "The study of those aspects of meteorology that have direct relevance to agriculture". It is also defined as
- “A branch of applied meteorology which investigates the responses of crops to the physical conditions of the environment”.
- “An applied science which deals with the relationship between weather/climatic conditions and agricultural production”.
- “A science concerned with the application of meteorology to the measurement and analysis of the physical environment in agricultural systems”.
- The word `Agro meteorology’ is the abbreviated form of agricultural meteorology.

Practical Utility / Importance / Economic Benefits / Significance of Study of Agricultural Meteorology:

In a broad manner the study of agricultural meteorology helps in

1. Planning cropping systems / patterns.
2. Selection of sowing dates for optimum crop yields.
3. Cost effective ploughing, harrowing, weeding etc.
    - Reducing losses of applied chemicals and fertilizers.
    - Judicious irrigation to crops.
    - Efficient harvesting of all crops.
    - Reducing or eliminating outbreak of pests and diseases.
    - Efficient management of soils which are formed out of weather action.

- Managing weather abnormalities like cyclones, heavy rainfall, floods, drought etc. This can be achieved by ;
  - **Protection:** When rain is forecast avoid irrigation. But, when frost is forecast apply irrigation.
  - **Avoidance:** Avoid fertilizer and chemical sprays when rain is forecast.
  - **Mitigation:** Use shelter belts against cold and heat waves.
- Effective environmental protection.
- Avoiding or minimising losses due to forest fires.

Scope of agricultural meteorology

In addition to the points mentioned above, the influence of weather on agriculture can be on a wide range of scales in space and time. This is reflected in the scope of agricultural meteorology as detailed below:

1. At the smallest scale, the subject involves the study of micro scale processes taking place within the layers of air adjacent to leaves of crops, soil surfaces, etc. The agro meteorologists have to study the structure of leaf canopies which effects the capture of light and how the atmospheric carbon dioxide may be used to determine rates of crop growth.

2. On a broader scale, agro meteorologists have to use the standard weather records to analyse and predict responses of plants.
3. Although the subject implies a primary concern with atmospheric processes the Agro meteorologist is also interested in the soil environment because of the large Influence which the weather can have on soil temperature and on the availability of water and nutrients to plant roots.
4. The agro meteorologist also be concerned with the study of glass houses and other protected environments designed for improving agricultural production.

FARMING SYSTEMS

Farming system is a complex inter-related matrix of soil, plants, animal implements, power, labour, capital and other inputs controlled in part by farm families and influenced by varying degrees of political, economic, institutional and social forces that operate at many levels. In other words it is defined as unique and reasonably stable arrangement of farm enterprises that the household manages according to its physical, biological, economic and socio-cultural environment in accordance with the household's goals, preferences and resources. Conceptually it refers to a set of elements or components that are interrelated which interact among themselves. At the centre of the interaction is the farmer exercising control and choice regarding the type and result of interaction.

It is a resource management strategy to achieve economic and sustained production to meet diverse requirement of farm household while preserving resource base and maintaining a high level of environmental quality.

For example it represents integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry, sericulture, poultry etc. for optimal utilization of resources bringing prosperity to the farmer. The farm products other than the economic products, for which the crops are grown, can be better utilized for productive purposes in the farming systems approach.

Farming systems concept

In farming system, the farm is viewed in a holistic manner. Farming enterprises include crops, dairying, poultry, fishery, sericulture, and piggery, apiary tree crops etc. a combination of one or more enterprises with cropping when carefully chosen, planned and executed, gives greater dividends than a single enterprise, especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity, such that the end-products and wastes of one enterprise are utilized effectively as inputs in other enterprise. For example the wastes of dairying viz., dung, urine, refuse etc. are used in preparation of FYM or compost which serves as an input in cropping system. Likewise the straw obtained from crops (maize, rice, sorghum etc.) is used as a fodder for dairy cattle.

Further, in sericulture the leaves of mulberry crop as a feeding material for silkworms, grain from maize crop are used as a feed in poultry etc.

Sustainability is the objective of the farming system where production process is optimized through efficient utilization of inputs without infringing on the quality of environment with which it interacts on one hand and attempt to meet the national goals on the other. The concept has an undefined time dimension. The magnitude of time dimension depends upon ones objectives, being shorter for economic gains and longer for concerns pertaining to environment, soil productivity and land degradation.

Principles of farming system

- Minimization of risk
- Recycling of wastes and residues
- Integration of two or more enterprises
- Optimum utilization of all resources
- Maximum productivity and profitability
- Ecological balance
- Generation of employment potential
- Increased input use efficiency
- Use of end products from one enterprise as input in other enterprise

Characteristics of farming system

- Farmer oriented & holistic approach
- Effective farmers participation
- Unique problem solving system
- Dynamic system
- Gender sensitive
- Responsible to society
- Environmental sustainability
- Location specificity of technology
- Diversified farming enterprises to avoid risks due to environmental constraints
- Provides feedback from farmers

Objectives of farming system

Productivity- Farming system provides on opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises. Time concept by crop intensification and space concept by building up of vertical dimension through crops and allied enterprises.

Profitability - The system as a whole provides an opportunity to make use of produce/waste material of one enterprise as an input in another enterprise at low/no cost. Thus by reducing the cost of production the profitability and benefit cost ratio works out to be high.

Potentiality – Soil health, a key factor for sustainability is getting deteriorated and polluted due to faulty agricultural management practices viz., excessive use of inorganic fertilizers, pesticides, herbicides, high intensity irrigation etc. In farming system, organic supplementation through effective use of manures and waste recycling is done, thus providing an opportunity to sustain potentiality of Production base for much longer time.

Balanced food- In farming system, diverse enterprises are involved and they produce different sources of nutrition namely proteins, carbohydrates, fats &minerals etc. form the same unit land, which helps in solving the malnutrition problem prevalent among the marginal and sub-marginal farming households.

Environmental safety- The very nature of farming system is to make use or conserve the by product/waste product of one component as input in another component and use of bio-control measures for pest &disease control. These eco-friendly practices bring down the application of huge quantities of fertilizers, pesticides and herbicides, which pollute the soil water and environment to an alarming level. Whereas IFS will greatly reduce environmental pollution.

Income/cash flow round the year- Unlike conventional single enterprise crop activity where the income is expected only at the time of disposal of economic produce after several months depending upon the duration of the crop, the IFS enables cash flow round the year by way of sale of products from different enterprises viz., eggs from poultry, milk from dairy, fish from fisheries, silkworm cocoons from sericulture, honey from apiculture etc. This not only enhances the purchasing power of the farmer but also provides an opportunity to invest in improved technologies for enhanced production.

Saving energy- Availability of fossil fuel has been declining at a rapid rate leading to a situation wherein the whole world may suffer for want of fossil fuel by 2030 AD. In farming system, effective recycling of organic wastes to generate energy from biogas plants can mitigate to certain extent this energy crisis.

Meeting fodder crises- In IFS every inch of land area is effectively utilized. Alley cropping or growing fodder legume along the border or water courses, intensification of cropping including fodder legumes in cropping systems helps to produce the required fodder and greatly relieve the problem of non-availability of fodder to livestock component of the Farming system.

Solving timber and fuel crises- The current production level of 20 million m3 of fuel wood and 11 Million m3 of timber wood is no match for the demand estimated or 360 m3 of fuel and 64.4 million m3 of timber wood in 2000 AD. Hence the current production needs to be stepped up several-fold. Afforestation programmes besides introduction of agro-forestry component in farming system without detrimental effect on crop yield will greatly reduce deforestation, preserving our natural ecosystem.

Employment generation- Various farm enterprises viz., crop +livestock or any other allied enterprise in the farming system would increase labour requirement significantly and would help solve the problem of under employment. An IFS provides enough scope to employ family labour round the year.

Scope for establishment of agro- industries- When once the produce from different components in IFS is increased to a commercial level there will be surplus for value addition in the region leading to the establishment of agro-industries.

Enhancement in input use efficiency – An IFS provides good scope for resource utilization in different components leading to greater input use efficiency and benefit- cost ratio.

ORGANIC FARMING

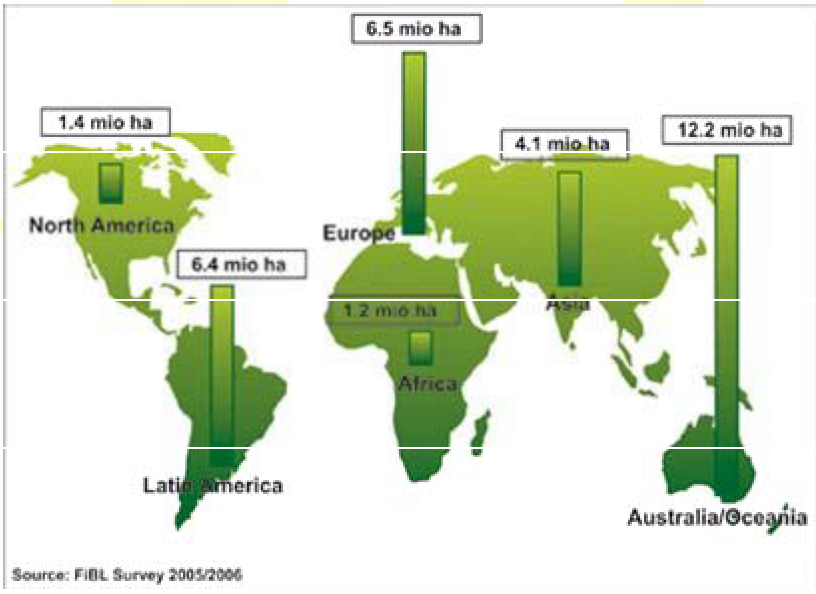
Definition

Organic farming "is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic agriculture systems rely upon crop rotations, crop residues, animal manure, legumes, green manure, off-farm organic wastes, mechanical cultivation, mineral bearing rocks, and aspects of biological pest control to maintain soil productivity, tilt, to supply plant nutrients, and to control insects, weeds, and other pests". (USDA, 1980).

The concept of the soil as a living system which must be "fed" in a way that does not restrict the activities of beneficial organisms necessary for recycling nutrients and producing humus is central to this definition.

"Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including bio-diversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using wherever possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system"(Codex, 1999).

ORGANIC FARMING IN WORLD



Principles of organic farming

1. To produce food of high nutritional quality in sufficient quantity
2. To interact in a constructive and life enhancing way with all natural systems and cycles
3. To encourage and biological cycles with in the farming system, involving micro-organisms, soil flora and fauna, plants and animals and careful mechanical intervention
4. To maintain and increase long-term fertility of soils
5. To promote the healthy use and proper care of water, water resources and all life therein
6. To help in the conservation of soil and water
7. To use, as far as is possible, renewable resources in locally organized agricultural systems
8. To work, as far as possible, within a closed system with regard to organic matter and nutrient elements
9. To work, as far as possible, with materials and substances which can be reused or recycled, either on the farm or elsewhere
10. To give all livestock conditions of life which allow them to perform the basic aspects of their innate behaviour
11. To maintain all forms of pollution that may result from agricultural practices
12. .To maintain the genetic diversity of the production system and its surroundings including the protection of wild life habitats
13. To allow everyone involved in organic production and processing a quality of life confirming to the UN Human Rights Charter, to cover their basic needs and obtain an adequate return and satisfaction from their work, including a safe working environment
14. To consider the wider social and ecological impact of the farming system
15. To produce non-food products from renewable resources, which are fully degradable
16. Weed, disease and pest control relaying primarily on crop rotation, natural predators, diversity, organic maturing, resistant varieties, and limited (preferably minimal) thermal, biological and chemical intervention
17. To create harmonious balance between crop production and animal husbandry
18. .To encourage organic agriculture associations to function along democratic lines and the principle of division of powers
19. .To progress towards an entire production, processing and distribution chain which is both socially just and ecologically responsible

Relevance of organic farming

Interest in organic agricultural methods is growing, especially in areas where the present modern farming system has unleashed many agro-ecological and environmental problems both on and off the farm, which threaten food security. The following are some examples:

a) Degradation of soil quality (structured & fertility)
b) Pollution of soil, water and food with pesticides and nitrates
c) Health effects on farmers, farm workers, farm families, rural communities (apart from concerns about the non-intended effects of pesticides on human beings in general, sound use of pesticides requires a technical knowledge which is often lacking in developing countries)
d) Resistance of pests to pesticides

e) Dependence on off-farm agricultural inputs which can increase poor farmers' dependence on credit facilities (to purchase synthetic fertilizers, pesticides and seed), which may result in decreased local food security and self-reliance

Further consumer awareness of the environmental costs of agriculture is increasing. The awareness of environmental quality and health is often promoted by environmental groups, especially in developed countries. The resulting demand for organic products creates the opportunity to sell organic products at premium prices, enabling organic farmers to continue, and often expand. Some governments have begun to recognize the possibility that it may be cheaper to support organic agriculture than to rectify problems associated with certain resource- destruction production practices. For this reason, several governments have introduced subsidies for organic agriculture. For example, in Indonesia where, after a period of subsidies on pesticides, the use of this input was prohibited while efforts were put in IPM programmes. In China, pesticide problems in products both on the domestic and export market has resulted in government involvement in certification organizations for "green food", including also a small amount of organic produce. Both these policies facilitate a shift towards organic agriculture

Components of organic farming

Thus organic agriculture is comparatively free from the complex problems identified with modern agriculture. It is basically a farming system, devoid of chemical inputs, in which The biological potential of the soil and the underground water resources are conserved and protected from the natural and human induced degradation or depletion by adopting suitable cropping models including agro-forestry and methods of organic replenishment, besides natural and biological means of pest and disease management, by which both the soil life and beneficial interactions are also stimulated and sustained so that the system achieves self-regulation and stability as well as capacity to produce agricultural outputs at levels which are profitable, enduring over time and consistent with the carrying capacity of the managed agro-ecosystem.

Crop production and health in organic farming systems is attained through a combination of structural factors and tactical management components to ensure products of sufficient quality and quantity for human and livestock consumption.

1. Diverse crop rotations
2. Soil fertility management
3. Weed control
4. Natural pest and disease control
5. Integrated nutrient management
   - Bulky organic manures
   - Recycling of organic wastes
   - Bio-fertilizers
   - Green manuring

The Flash's

Articles

For

NABARD Gr. A & B

By:- Gaurav(The Flash)

#2

AGRONOMY (remaining topics)

&

SOIL AND WATER CONSERVATION (Part-I)

CLASSIFICATION OF FIELD CROPS

It is well known that there are more than 600 cultivated plant species, from which there are about 100-200 species play important role in the world trade. However, only fifteen plant species represent the most important economic crops. Therefore, these crop species must be classified or grouped in a convenient way to facilitate communication, dissemination and retrieval of scientific information as well as promotes the conservation, and improvement of certain plants. Generally, classification of these species is important for these reasons:

1. To get acquainted with crops.
2. To understand the requirement of soil & water different crops.
3. To know adaptability of crops.
4. To know the growing habit of crops.
5. To understand climatic requirement of different crops.
6. To know the economic produce of the crop plant & its use.
7. To know the growing season of the crop
8. Overall to know the actual condition required to the cultivation of plant.

The grown field crops are classified according to different stand points as follows:

1. Botanical classification.
2. Agronomic classification
3. Special- purpose classification.
4. Classification according to life span.
5. Classification according to root depth.
6. Classification according to growth habit.
7. Classification according to Co2 fixation.
8. Classification according to mode of pollinations.

1- Botanical Classification

Botanical classification is based upon similarity of plant parts and flower structure. This is the most important way of classification because it determines to what extent the plants are relatives. Field crops belong to the "**spermatophyte"**, or seed plant, division of "**plant kingdom"**, which includes plants reproduced by seeds. Within this division, the common crop plants belong to the subdivision of "**Angiosperm**", which are characterized by producing seeds with coats (covered seed). The "**angiosperm**", are then divided into two classes, namely, **monocotyledons** and the **dicotyledons**. All the grasses, which include the cereals and sugar cane are **monocotyledons**. The legumes and other plants except the grasses are classified as **dicotyledons**. Each of these two classes is still further divided into orders, **familes**, **genera**, **species** and **varieties**.

For example, maize crop (corn) which is monocotyledons belongs to the order "**herbaceous**"; family "**Gramineae**"; genus **Zea**; species **mays**; varieties; **S.C. 10** as follows:

Plant Kingdom

↓

Division → Spermatophyte

↓

Subdivision Angiosperms

↓

Class → monocotyledons

↓

Order → Herbaceous

↓

Family → Gramineae

↓

Genus → **Zea**

↓

Species → **mays**

↓

Variety → S.C. 10

1- **Monocotyledons**:

- **Gramineae**: includes the following crops: wheat, barley, rice, maize, oat, sugar cane, sorghum, rye grass, and sudan grass.

-**Liliaceae**: includes onion and garlic.

2- **Dicotyledons**:

- **Leguminosae**: includes: field bean, lupine, check pea, lentil, fenugreek, Egyptian clover, alfalfa, soybean, peanut, grass pea, caster bean, red clover and white clover.

- **Malvaceae**: includes: cotton.

- **Linaceae**: includes: flax.

- **Solanceae**: includes: potato, tomato, and tobacco.

- **Pedaliaceae**: includes: sesame.
- **Composite**: includes: sunflower, and safflower.

It is well known that the most important field crop families belong to two botanical families, the grass family (**gramineae**) and the legume family (**Legumioseae**). Therefore, we have to get an idea about the characteristics of both families.

Characteristics of grass family:

This family includes about three fourths of the cultivated forage crops and all the cereals. They have the following characters:

- They are winter annuals or perennials.
- They are almost herbaceous plants.
- Stems are usually hollow, cylindrical and made up of nodes and internodes.
- Leaves are alternative with parallel veins. The basal portions of the leaf sheath, encloses the stem, the sheath being open on the side opposite the blade. Where the blade of the leaf joins the sheath, there is usually found a peculiar appendage known as the "ligule".

- ❖ The roots are fibrous and new roots are formed each year.
- ❖ The flowers are perfect and collected in inflorescence at the top of plant.
- ❖ The grain may be free (wheat) or enclosed (oats).

Characteristics of legume family:

- ❖ It ranks next in importance to grass family.
- ❖ Legumes may be annual, biennial, or perennial.
- ❖ The leaves are alternate compound, stipulate, with netted veins.
- ❖ The flowers are buttery- like.
- ❖ The fruit in a pod that contains one to several seeds. The seeds are usually without an endosperm, the two cotyledons being thick and full of stored food.
- ❖ Legumes have relatively large taproot. The roots bear enlargements called "nodules" caused by the activities of a bacterium Rhizobium, which has the ability to fix atmospheric nitrogen in their bodies and eventually in the plant residues.

2- Agronomic classification

Field crops can be classified according to their economic importance as follows:

1- Cereal or grain crops: Cereals are grasses grown for their edible seeds such as wheat, oats, barley, rye, rice, maize, and grain sorghum,
2- Legumes of seeds such as faba bean, pea nuts, fenugreek, lupine, cowpea, soybean, chick pea, and lentil.
3- Sugar crops: they include sugar beet and sugar cane.
4- Oil crops: they include: flax, soybean, peanut, sunflower, safflower, sesame, caster bean and rape.
5- Fiber crops: they include cotton. Flax, jute, sisal, and ramie.
6- Fodder crops: they include alfalfa, Egyptian clover, sorghum, Suddan grass, grass pea, lablab, Napier grass, millet, white clover, and red clover.
7- Rubber crops: including para rubber, Castilla rubber, and guayule.
8- Tuber crops: such as potatoes and Jerusalem artichoke.
9- Root crops: such as sweet potatoes and sugar beet.
10- Medical plants: such as caster bean and others.
11- Stimulates such as tobacco, tea and coffee.

3- Special- purpose classification

These classifications are used to refer to plants having special advantages to the farmer himself in relation to his farming practices, and include

1- **Catch or emergency crops**: These crops are used to substitute crops that have failed on account of unfavourable conditions. They are usually quick-growth crops, such as rye, millet and clover. In Egypt. Clover can be grown and one cut can be obtained before planting cotton crop.

2- **Cash crop**: any short maturing crop which is grown to generate income while the main crop is still in its vegetative stage of growth; any crop grown to generate cash rather than for subsistence. Some crops may be cash crops one year but not the next, or for one farmer but not another.

3- **Cover crops**: these crops are planted to provide a cover for the soil and to prevent erosion such as clover and rye.

4- **Green manure crops**: these crops are turned under while still green in order to improve the soil properties and increase organic matter content. Several field crops can be used such as Egyptian clover, lupine and cowpea.

5- **Companion crops**: in this case a crop can be intercropped with another one and each crop is harvested separately. For example, onion and garlic can be intercropped with cotton crop, or soybean with maize.

6- **Silage crops**: these crops are preserved in a succulent condition by partial fermentation in a tight receptacle. They include corn, sorghum, forage grasses and legumes.

4- Classification according to life span.

All field crops can be divided into three categories according to the length of their life cycle as follows:
1- **Annual crops**: plants of this category complete their entire life cycle from seed to seed in a single growing season and then die. Most field crops are considered annual crops such as wheat, barely, rice, maize, sorghum, faba bean, lentil, check pea, lupine, flax, soybean, sesame, sunflower, safflower, and others.

2- **Biennial crops**: these plants complete their life cycle in two seasons. Vegetative growth occurs during the first season resulting in a rosette form but plants don't start flowering (blooming). In the second season, the green plants give flowers and seeds. The crops of this category are onion, sweet clover, and sugar beet. If you expose sugar beet plants, grown in the first year to low temperature they can start blooming and flowering and behaved as annual crops.

3- **Perennial crops**: these crops are grown in the soil for more than two years (they can persist for more than two years). They may either produce seed or not every year. In other words, they have and indefinite life period. They do not die after reproduction but continue to grow indefinitely from year to year. Sugar cane, white clover, and alfalfa are examples of perennial crops.

5- Classification according to root depth

It is clear that the root system of field crops differ in structure, function and extent. Therefore, field crops can be classified according to the depth of their roots as follows:
1- **Hallow root crops**: the root system of these crops extends in the soil to a depth of one meter such as wheat, barley and rye.
2- **Intermediate crops**: the depth of the root system of these crops ranges from 1- 1.5 meter in the case of faba bean and sugar beet.
3- **Deep root crops**: the root system of these plants extends in the soil to a depth more than 1.5 meter as in alfalafa.

6- Classification according to growth habit

Determining the best time of planting of any field crop is a very important task. That is because planting date must be in suitable time which ensure the best environmental conditions throughout the growing season of the crop. Crops need optimum levels of light, temperature, moisture and other environmental conditions to grow well and produce the highest productivity. Therefore, when field crops are classified according to growing season this means that the environmental requirements of such crop are prevail in such season. Accordingly, field crops can be classified as follows:

1. The Kharif Season:
Crops are sown at the beginning of south-west monsoon and harvested at the end of the south-west monsoon.
Sowing Season: May to July.
Harvesting Season: September to October.
Important Crops: Jowar, Bajra, Rice, Maize, Cotton, Groundnut, Jute, Hemp, Tobacco etc.
2. The Rabi Season:
Crops need cool climate during growth period but warm climate during the germination of seed and maturation.
Sowing Season: October to December
Harvesting Season: February to April
Important Crops: Wheat, Barley, Gram, Linseed, Mustard, Masoor & Peas.
3. The Zaid Season:
These Crops are raised throughout the year due to artificial irrigation.
1. Zaid Kharif Crops:

Sowing Season: August to September
Harvesting Season: December-January
Important Crops: Rice, Jowar, Rapeseed, Cotton, Oilseeds.
2. Zaid Rabi Crops:

Sowing Season: February to March.
Harvesting Season: April-May.
Important Crops: Watermelon, Tori, Cucumber & other vegetables.
Cereal Crops
Rice, Wheat and millets are consumed as important staple food all over the world. Cereals provide essential carbohydrates which are important source of energy for working. Cereals are monocotyledonous plants and are grown on large scale by Indian farmers. The economy of huge number of Indian farmers is largely dependent on cereals.

Pulse Crops
Pulse crops are legumes. The word legume is derived from the Latin word 'legere', with means 'to gather'. Pulses are important in crop rotations and crop mixtures practiced by farmers, as they help in maintaining the soil fertility. Pulses are rich in protein and they meet the major share of the protein requirements of the predominantly vegetarian population of India.

Oil seed crops
Importance of oilseeds crop in Indian farming:-

- They can be grown on all kinds of soil.
- Important constituent of the crop rotation with millets and pulses.
- Valuable cash crops and bring ready cash to the farmers.
- They are a source of foreign exchange.
- They provide raw material for many industries e.g. paints, varnishes,
- Soaps, lubricating oils etc.
- They contribute vegetable oils and fats to Indian diet.

- The edible oil cakes provide concentrates for the cattle.
- The non-edible oil cakes are used as manures and some oil cakes like

Cash, fiber and spice corps

Sugarcane is the important cash crop grown in India. Sugarcane is cultivated in UP, Bihar, Maharashtra, Karnataka and AP. on large scale. Sugarcane is the most important source of sugar and jaggery. The sugar factories have transformed the total scenario in the sugarcane tracts. Cotton is the most extensively grown commercial crop and the most important of all fibre crops of the world. Likewise turmeric is an important spice crop grown on commercial scale as a source of farm income. It is cultivated in the states of AP, Tamilnadu, Maharashtra, Orissa, Kerala and Assam.

7- Classification according to Co2 fixation

- C3 Plants
- C4 Plants
- Cam Plants

8- Classification according to mode of pollination

1. Naturally self-pollinated crops: - the predominant mode of pollination in these plants is self-pollination in which both pollen and embryo sac are produced in the same floral structure or in different flowers but within the same plant. Examples: rice, most pulses, okra, tobacco, tomato.

2. Naturally cross-pollinated crops: pollen transfer in these plants is from the anther of one flower to the stigma of another flower in a separate plant, although self-pollination may reach 5 percent or more. Examples: corn and many grasses, avocado, grape, mango, many plants with unisexual or imperfect flowers.

3. Both self- and cross-pollinated crops: these plants are largely self-pollinated but varying amounts of cross-pollination occur. Examples: cotton and sorghum.

Factors Affecting Crop Production

Crop production is concerned with the exploitation of plant morphological (or structural) and plant physiological (or functional) responses with a soil & atmospheric environment to produce a high yield per unit area of land. Growth is irreversible increase in size or weight.

Crop production provides the food for human beings, fodder for animals and fiber for cloths. Land is the natural resource which is unchanged & the burden of the population is tremendously increasing, thereby decrease the area per capita. Therefore it is necessary to increase the production per unit area on available land. This necessitates the close study of all the factors of crop production viz.

1. The soil in which crops are grown
2. The water which is the life of plant
3. The Plant which gives food to man & fodder to his animals
4. The skilful management by the farmer himself
5. The climate which is out of control of man & but decided the growth, development & production.
6. The genetic characters of crop plant which is the genetic makeup & can be exploited for crop

production.
Broadly, the factors that influence the growth of crop or crop production can be classified as:

Internal or Genetic Factors Genetic makeup decided the crop growth & its production. Crops vary in the genetic makeup which included desirable & undesirable characters as well. Breeders try to incorporate maximum desirable characters in one strain of crop & also try to exploit the hybrid vigour.

Desirable characters include:

1. High yielding ability under given environment condition.
2. Early maturity
3. Better resistance to lodging
4. Drought, flood & salinity tolerance
5. Greater tolerance to insect & diseases
6. Chemical composition of grains (Oil & Proteins)
7. Quality of grains (Fineness coarseness etc.)
8. Quality of straw (Sweetness juiciness)

These characters are inherent in each individual and are transmitted from one generation to another by genes.

External or Environmental Factors

1. **Edaphic or Soil Factors**
2. **Water**
3. **Plant Biotic Factor**
4. **Anthropic or Management**
5. **Climatic**

Edaphic or Soil factors: Soil can be defined as: Soil is a thin layer of the earth's crust which serves as a natural medium for the growth of plants. Soils are formed by the disintegrations & decomposition of parent rocks due to weathering and the action of soil organisms & also the interaction of various chemical substances present in the soil. Soil is formed from parent rock by the process of weathering over a long period by the action of rain water, temperature and plant & animal residues. A vertical cut of 1.5 to 2 m deep soil indicates a layer varying from a few cm to about 30 cm of soil, called surface soil, elbow that a layer of sub soil & at the bottom, the unrecompensed material which is the parent rock.

Role of soil:

1. Soil is the natural media to grow the crop.
2. Soil gives the mechanical support & act as an anchor,
3. Soil supplies the nutrients to the crop plants,
4. Soil conserves the moisture which is supplies to the crop plants
5. Soil is an abode (house) of millions of living organisms which act on plant residues & release food material to plants
6. Soil provides aeration for growth of crop and decomposition of organic matter.

Water:

Functions of water:

1. Major component of the plant body (90%).
2. Act as solvent for dissolving the nutrients & nutrient carrier.
3. Maintains/regulates the temperature of plant & soil as well
4. Maintains the turgidity of plant cells.
5. Essential for absorption of nutrients & metabolic process of the plants.

Plant tissues constitute about 90% of water. Rain and ground water are the sources of the water. Ground H2O is reused for irrigation through well, tank or canal, etc. Erratic rains are to be conserved properly so that plants make best use of it. Rainwater is to be supplemented by irrigation to meet the water requirement of crops for bumper yields.

Water Present in the soil helps the plants in many ways:

1. Supplies the essential raw material for production of carbohydrates by photosynthesis.
2. Promotes physical, chemical & biological activities in the soil.
3. Gaseous diffusion in soil for proper aeration.

Water is the life of plant & must be supplied in proper quantity. Too much water may suffocate the plant roots & too little may not be able to sustain the plant. The water requirement of crops differs from crop to crop & variety to variety as well, depending upon the growth habit, genetically & physiological make up, duration of the crop, etc. For example, sugarcane, rice, banana, wheat, groundnut, etc. are the high water requiring crops & Jowar, Mung, udid, Tur, gram, bajara etc. are the low water requiring crops.

Plant /Biotic factors: Biotic factors include plant, symbiosis & animals.

Plant: The soil & water are two variables which either has to be suitably adjusted for the plant to grow or the plant should be so bred & selected that it will adjust to a given soil & water condition, growing season, climatic requirement, etc. Some of the crops grow on only rain while some required irrigation water, Plant breeders are constantly at work to evolve varieties which will suit the given soil & water condition e.g. drought resistant, disease resistant, more nutrients absorbing capacity etc.

The unwanted plants, 'weeds' compete with crop plants from solar energy, water nutrients & also for space which need to be controlled for better crop growth & production at proper time & methods.

Symbiosis: There are the some organisms which have mutual relationship with each other & with the prevailing environment of the place. This biological inter relationship among the organisms is termed as symbiosis. The symbiotic relationship between legumes & Rhizobia which results in 'N' fixation is of great significance to crop production. The legume bacteria use the carbohydrates of their host as energy & fixes up atmospheric 'N' which in turn used by host plants. The free living organisms (Azotobacter) acquire their energy from soil OM, fix the free N & make it a part of their own tissue. When they die the 'N' available in their body tissues is used by the crop plants.

Animals: Soil organisms:

The soil organisms include:

1) Soil flora (plant kingdom) & **2)** soil fauna (animal Kingdom).
Soil flora is of two types: **i)** Macro flora e.g. Roots of higher plants **ii)** Micro flora e.g. Bacteria, fungi, actinomycetes & algae.

Soil fauna is of two types: **i)** Macro flora e.g. earthworm, moles, ants, and **ii)** Micro fauna e.g. protozoa, nematodes. The soil fauna including protozoa, nematodes, rotifers, snails, insects constitute a highly important part of the environment for plant roots. All these organisms contribute decomposition, when using the OM for their living. Among these insects, nematodes cause considerable damage as crop pests.

Beneficial organisms: Insects like bees, wasp, moths, butterflies, beetles help in pollination of crops. Burrowing by earthworm facilitates aeration & drainage and the ingestion of OM & mineral matter results in a constant mixing of these materials in the soil & tends to make better plant growth.

Small animals: Like rabbits, squirrels, rats cause extensive damage to field & garden crops.

Anthropic or Management /Man or skilful management by the man:

Finally, man must so manage the soil-water-plant complex to produce efficiently food & fodder and for that purpose a number of mechanical devices & useful cultivation practices have been evolved such as ploughs for ploughing, harrows for seeded preparation, hoes for hoeing, seed cum fertilizer driller for sowing the seeds & application of fertilizers. Man has to perform the operations at proper time such as land preparation sowing, thinning & gap filling and also the plant protection measures, optimum plant population, recommended fertilizer application at right time & depth, proper water mgmt. Practices. The soil, water, plant& management are the four factors, which govern successful crop production.

Climate: Another factor that influences the growth, development, & production of crop is the climate which is out of control by the man but mgt. practices of the crops can be altered to harvest maximum yield. Climate is the most dominating factor influencing the suitability of a crop to a particular region. The yield potential of a crop mainly depends on climate. More than 50% of variation in yield of crops is solar radiation, temperature & rainfall Relative humidity & wind velocity also influence crop growth to some extent. Atmospheric factors which affect the crop plants are called climatic factors which include.

1. Precipitation,
2. Temperature,
3. Atmospheric humidity,
4. Solar radiation,
5. Wind velocity and atmospheric gases.

1. Precipitation: - It results from evaporation of water from sea water and land surfaces. The process involved in the transfer of moisture from the sea to the land & back to the sea again what is known as the hydrologic cycle. Continuous circulation of water between hydrosphere, atmosphere & lithosphere called as hydrologic cycle. Precipitation includes rainfall, snow or hail, Fog drip & dew also contribute to moisture. Fog consists of small water droplets while dew is the condensation of the water vapour present in the air. Precipitation influences the vegetation of a place. Most of crops receive their water supply from rainwater which is the source of soil moisture so essential for the life of a plant. The yearly precipitation, both in total amount & seasonal distribution greatly affects the choice of cultivated crops of a place.

2. Temperature: It is considered as a measure of intensity of heat energy. The range of maximum growth for most argil, plans is between 15 & 400C, every plant community has its own minimum, optimum & maximum temperature known as their cardinal points. Temperature is determined by the distance from the equator (latitude) and the altitude; Apart from the reduction in yield many injuries such as cold injury which included chilling injury, freezing injury, suffocation & heaving and heat injury. Maize & sorghum (8-100C, 300C, 40ºC) Rice (10-110C, 35ºC) Wheat (50C, 25ºC, 30º-320C)

3. Atmospheric humidity: Water which is present in the atmosphere in the form of invisible water vapor, termed as humidity of the air, ET of crop plants increases with the temperature but decreases with high relative humidity affecting the quantity of irrigation water, Moist air favours the growth of many fungi & bacteria which affect seriously the crop.

4. Solar radiation: Solar energy provides two essential needs of plants:

a) Light required for photosynthesis & for many other functions of the plant including seed germination, leaf expansion, growth of stem & shoot, and flowering, fruiting & even dormancy. **b)** Thermal conditions required for the normal physiological functions of the plant. Light helps in synthesis of chlorophyll pigment. Light affects the plants in four ways: intensity, quality (wave length), duration (Photoperiod) and direction.

5. Wind velocity: It affects growth mechanically (damage to crop) and physiologically (evaporation & transpiration), Hot dry winds may adversely affect photosynthesis & hence productivity, by causing closure of the stomata even when soil moisture is adequate. Moderate winds have a beneficial effect on photosynthesis by continuously replacing the $CO2$ absorbed by the leaf surfaces.

SEED PRODUCTION

Seed is any material used for planning & propagation whether it is in the form of seed (grain) of food, fodder, fiber or vegetable crop or seedlings, tubers, bulbs, rhizomes, roots, cuttings, grafts or other vegetative propagated material.

Seed is a fertilized ovule consisting of intact embryo, stored food (endosperm) and seed coat which is viable & has got the capacity to germinate.

As we say, "Reap as you sow", the good quality seed must have following characters:

1. Seed should be genetically pure & should exhibit true morphological & genetically characters of the particular strain (True to type).
2. It should be free from admixture of seeds of other strains of the same crop or other crop, weeds, dirt and inert material.
3. It should have a very high & assured germination percentage and give vigorous seedlings.
4. It should be healthy, well developed & uniform in size.
5. It should be free from any disease bearing organisms i.e. pathogens.
6. It should be dry & not mouldy and should contain 12-14% moisture.

Seed is the basic input in the crop production which should be of good quality.

Seed Germination

Seed Germination: Means the resumption of growth by embryo & development of a young seedling from the seed. Germination is an activation of dormant embryo to give rise to radical (root development) and plumule (stem development).Germination is the awakening of the dormant embryo. The proce4ss by which the dormant embryo wakes up & begins to grow is known as Germination.

Seed Emergence Means actually coming above and out of the soil surface by the seedling.

Changes During Germination:
1) Swelling of seed due to imbibition of water by osmosis.
2) Initiation of physiological activities such as respiration & secretion of enzyme.
3) Digestion of stored food by enzymes.
4) Translocation & assimilation of soluble food.

When seed is placed in soil gets favorable conditions, radical grows vigorously & comes out through micro Pyle & fixes seed in the soil. Then either hypo or epicotyls begins to grow.

Types of germination:

1. Hypogeal germination: The cotyledons remain under the soil. E.g.: cereals, gram.
2. Epigeal germination: The cotyledons pushed above the soil surface. E.g.: mustard, tamarind, sunflower, castor, onion.

Seed Dormancy

Seed Dormancy: Failure of fully developed & mature viable seed to germinate under favourable conditions of moisture & temperature is called resting stage or dormancy and the seed is said to be dormant.
Kinds of Dormancy in Seeds:

1. Primary dormancy: The seeds which are capable of germination just after ripening even by providing all the favourable conditions are said to have primary dormancy. E.g.: Potato.
2. Secondary dormancy: Some seeds are capable of germination under favourable conditions just after ripening but when these seeds are stored under unfavourable conditions even for few days, they become incapable of germination.
3. Special type of dormancy: Sometimes seeds germinate but the growth of the sprouts is found to be restricted because of a very poor development of roots & coleoptiles.

Causes of Dormancy:

The dormancy in seeds may be due to any single or a combination of more than one of the following causes.
1. Seed coats being impermeable to water: Some seeds have a seed coat which is impermeable to water. Such seeds even when fully matured & placed in favourable conditions; fail to germinate because of failure of water to penetrate into the hard seed coats. These seeds become permeable, if they are treated with H_2SO_4 or dipped in boiling water for few seconds. E.g.: Cotton.

2. Hard seed coat: Seeds of mustard, amaranths, etc. contain a hard & strong seed coat which prevents any appreciable expansion of embryo. Thus, if the seed coats fail to burst the embryo will remain dormant even after providing all the favourable conditions for germination.

3. Seed coats being impermeable to O: The seed coats are impermeable to O2 & if the seed coats do not rupture the seed fails to sprout.

4. Rudimentary embryo of seeds: The seeds which are apparently ripened contain a rudimentary or imperfectly developed embryo and the germination of such seeds naturally gets delayed until the embryo develops properly.

5. Dormant embryo: The seeds of an apple, peach, pinus, etc. do not germinate even though the embryos are completely developed and all the favourable conditions for germination are provided. In such seeds, physiological changes called after ripening take place during the period of dormancy which enables the seeds for germination.

6. Synthesis & accumulation of germination inhibitors in the seeds: Plant organs synthesize some chemical compounds which are accumulated in the seeds at maturity and these chemicals inhibit the germination of their seeds.

Multiplication & Distribution of Seeds

In India, farmers depend for their seed supply primarily on the state department of Agriculture and the National Seeds Corporation. The Department of Agriculture in all states has a planned programme of seed multiplication.

Classes of Quality seeds: The various classes of seed that are used in a seed production programme are:

1. Breeder seed: It is the seed or the vegetative propagating material produced by the breeder who developed the particular variety. The production & maintenance of breeders stock on main research station is controlled by the plant breeder. It is produced by the institution where the variety was developed in case the breeder who developed the variety is not available. In India, it is also produced by other Agri. Universities under the direct supervision of the breeder of the concerned crop working in that University, this arrangement is made in view of the large quantities of the breeder seed required every year. It is generally pure having high genetic purity (100%). Off type plants are promptly eliminated and care is taken to prevent out crossing or natural hybridization & mechanical mixtures.

2. Foundation seed: It is the progeny of the breeder seed and is used to produce registered seed or certified seed. It is obtained from breeder seed by direct increase. It is genetically pure and is the source of registered and/or certified seed. Production of foundation seed is the responsibility of NSC. It is produced on Govt. farms (TSF), at expt. stations, by Agri. Universities or by component seed growers under strict supervision of experts from NSC. It should be produced in the area of adaptation of the concerned variety.

3. Registered seed: It is produced from foundation seed or from registered seed. It is genetically pure & is used to produce certified seed or registered seed. It is usually produced by progressive farmers according to technical advice and supervision provided by NSC. In India, often registered seed is omitted and certified seed is produced directly from foundation seed.

4. Certified seed: It is produced from foundation, registered or certified seed. This is so known because it is certified by a seed certification agency, in this case state seed certification agency, to be suitable for raising a good crop. The certified seed is annually produced by progressive farmers according to standard seed production practices. To be certified, the seed must meet the prescribed requirements regarding purity & quality. It is available for general distribution to farmers for commercial crop production.

Seed Production Organizations

Seed Production Organizations: There are two types of Govt. / Public sector organizations responsible for seed production & certification in India. The first type of organization is represented by the National Seeds Corporation (NSC) which has responsibilities for the entire country. The second types of organizations are State Seeds Corporation (SSCs) and State Seed Certification agencies (SSCAs) that have state-wise responsibilities.

National Seeds Corporation: The NSC was initiated in 1961 under the ICAR. Later, on 7th March, 1963, it was registered as a limited company in the public sector. It was established to serve two main objectives:

1) To promote the development of seed industry in India and
2) To produce & supply the foundation seeds of various crops.

The present functions of NSC may be summarized as:
a. Production & supply of foundation seed,
b. To maintain improved seed stocks of improved varieties,
c. Interstate marketing of all classes of seed,
d. Export & import of seed,
e. Production of certified seed where required,
f. Planning the production of breeder seed in consultation with ICAR,
g. Providing technical assistance to Seeds Corporation & private agencies,
h. Coordinating certified seed production of State Seed Corporation,
i. Conducting biennial surveys of seed demand,
j. Coordinating market research & sales promotion efforts,
k. Providing training facilities,
l. Providing certification services to states lacking established and independent seed certification agencies.

General principles of Seed Production

Production of genetically pure and otherwise good quality pedigree seed is an exacting task requiring high technical skills and comparatively heavy financial investment. During seed production strict attention must be given to the maintenance of genetic purity and other qualities of seeds in order to exploit the full dividends sought to be obtained by introduction of new superior crop plant varieties. In other words, seed production must be carried out under standardized and well-organized condition.

Genetic Principle

1. Deterioration of varieties: Genetic purity (Truness to type) of a variety can deteriorate due to several factor during production cycles. The important factors of apparent and real deterioration of varieties) are as follows:

a. Developmental variation: When the seed crops are grown in difficult environment, under different soil and fertility conditions, or different climate conditions, or under different photoperiods, or at different elevation for several consecutive generations, the developmental variation may arise sometimes as differential growth response. To minimize the opportunity for such shifts to occur in varieties it is advisable to grow them in their areas of adaptation and growing seasons.
b. Mechanical mixtures: This is the most important source of variety deterioration during seed production. Mechanical mixtures may often take place at the time of sowing, if more than one variety is sown with same seed drill; through volunteer plants of the same crop in the seed field; or through different varieties grown in adjacent fields. Often the seed produce of all the varieties are kept on same threshing floor, resulting in considerable varietal mixture. To avoid this sort mechanical contamination it would be necessary to rogue the seed fields, and practice the utmost care during the seed production, harvesting, threshing and further handling
c. Mutations: This is not a serious factor of varietal deterioration. In the majority of the cases it is difficult to identify or detect minor mutation.
d. Natural crossing: In sexually propagated crops, natural crossing is another most important source of varietal deterioration due to introgression to genes from unrelated stocks which can only be solved by prevention

Natural crossing occurs due to following three reasons

i. Natural crossing with undesirable types.
ii. Natural crossing with diseased plants.
iii. Natural crossing with off- type plants.

Natural crossing occurs due to following factors

i. The breeding system of species
ii. Isolation systems
iii. Varietal mass
iv. Pollinating agent

a. Minor genetic variations: Minor genetic variations may exist even in the

Varieties appearing phenotypically uniform and homogeneous at the time of their release. During later production cycle some of this variation may be lost because of selective elimination by the environment. To overcome these yields trials are suggested.

Selective influence of diseases: The selective influence of diseases in varietal deterioration is also of considerable importance. New crop varieties often become susceptible to new races of diseases often caused by obligate parasites and are out of seed programmes. Similarly the vegetatively propagated stocks deteriorate fast if infected by viral, fungal and bacterial diseases. During seed production it is, therefore, very important to produce disease free seeds/stocks.

b. Techniques of plant breeders: In certain instances, serious instabilities may occur in varieties due to cytogenetically irregularities not properly assessed in the new varieties prior to their release. Other factors, such as break down in male sterility, certain environmental conditions, and other heritable variations may considerably lower the genetic purity.

Maintenance of Genetic Purity During seed Production:

The various steps suggested), to maintain varietal purity, are as follows.

a. Use of approved seed only in seed multiplication.
b. Inspection and approval of fields prior to planting.
c. Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, weeds, and for freedom from noxious weeds and seed borne diseases etc.
d. Sampling and sealing of cleaned lots
e. Growing of samples of potentially approved stocks for comparison with authentic stocks.

The various steps suggested for maintaining genetic purity are as follows:

a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures
b. Rouging of seed fields prior to the stage at which they could contaminate the seed crop.
c. Periodic testing of varieties for genetic purity.
d. Avoiding genetic shifts by growing crops in areas in their adaptation only.
e. Certification of seed crops to maintain genetic purity and quality of seed.
f. Adopting the generation system.
g. Grow out tests.

Agronomic principles

1. Selection of a Agro-climatic Region A crop variety to be grown for seed production in an area must be adapted to the photoperiod and temperature conditions prevailing in that area.
2. Selection of seed plot the plot selected for seed crop must be free from volunteer plants, weed plants and have good soil texture and fertility the soil of the seed plot should be comparatively free from soil borne diseases and insects pests.
3. Isolation of Seed crops the seed crop must be isolated from other nearby fields of the same crops and the other contaminating crops as per requirement of the certification standards.
4. Preparation of Land Good land preparation helps in improved germination, good stand establishment and destruction of potential weeds. It also aids in water management and good uniform irrigation.
5. Selection of variety The variety of seed production must be carefully selected, should possess disease resistance, earliness, grain quality, a higher yielder, and adapted to the agro climatic conditions of the region.
6. Seed treatment: Depending upon the requirement the following seed treatment may be given

a. Chemical seed treatment.
b. Bacterial inoculation for the legumes.
c. Seed treatment for breaking dormancy.

1. Time of planting The seed crops should invariably be sown at their normal planting time. Depending upon the incidence of diseases and pests, some adjustments, could be made, if necessary.
2. Seed Rate Lower seed rates than usual for raising commercial crop are desirable because they facilitate rouging operations and inspection of seed crops.
3. Method of sowing The most efficient and ideal method of sowing is by mechanical drilling.
4. Depth of sowing Depth of sowing is extremely important in ensuring good plant stand. Small seeds should usually be planted shallow, but large seeds could be planted a little deeper.
5. Rouging: Adequate and timely rouging is extremely important in seed production. Rouging in most of the field crops may be done at many of the following stages as per needs of the seed crop.

SEED PROCESSING

After harvest the seeds need to be processed by various methods in order to maintain the physical purity and also to increase the shelf life. This should be done before seeds are taken for storage.

Cleaning Stem bits and chaff collected along with the seeds will harbour insects which would damage stored seeds. In order to prevent such damage, cleaning either by wet method or dry method should be followed.

i. Wet cleaning - Plants which carry seeds in their moist flesh can be cleaned by this method. Seeds scooped from the flesh of a ripened fruit should be collected in a vessel and rubbed vigorously with coarse sand to remove flesh around the seeds. Then seeds are taken in a sieve and washed repeatedly under running water to remove the bits and pieces of flesh and mucilage. After such cleaning seeds should be dried for 10 days before storage. E.g. Cucumber, Tomato etc.

ii. Dry cleaning - This method is used for the matured seeds in a dry capsule / pod. Either the dry pods can be harvested individually or the whole plant with the pod is pulled out and shade dried, threshed for the collection of seeds. After threshing seeds are gently crushed or rolled and winnowed before storing. E.g. Paddy, Millets, Pulses, Oilseeds etc.

Winnowing It is an ancient method to remove the chaff from the seeds by tossing them in the air. Elongated flat baskets are used for winnowing. It helps to remove stem bits, old petals, husks and other parts of the flower and debris mixed with the seeds. There are also mechanical winnowers available.

Sieving Sieves with different gauge sizes are used for sieving in order to remove the debris and chaff from the seeds. Large debris retains in the larger sieve, whereas the dust materials smaller than the seeds is removed in the small size sieve.

Drying of Seeds Seed drying is the process of lowering the moisture content of the seed in order to improve the vigour and viability of the seed and thereby increasing the storage life. It helps to keep the seeds free from pest and disease incidence. Drying should be done at a lower temperature. During drying, first the moisture from the seed surface will be evaporated and the moisture from inner layers of the seed is transferred to the surface for further drying. Various drying methods involved are:

a. Natural drying / Sun drying it is a common method of drying followed in the field or threshing yard by using the radiant energy of the sun. Seeds should be spread in a thin layer to enhance the uniform drying of the seeds. Seeds with high moisture content should be shade dried and later exposed to sun drying. Sun dried seeds should not be kept open in the threshing yard during night times, since it absorbs moisture from the air. The main advantage of natural drying is that it is an easy and cheap method. But there are many disadvantages like slow drying, requirement of a large floor area, loss due to pest and disease attack and high weather risks. Sun drying is advisable only in the morning and evening hours. Drying in mid noon causes damage to seed quality.

b. Artificial / Mechanical drying by using forced natural / heated air This type of drying can be carried out inside the storage godown itself. Godowns should be provided with ventilators for circulation of outside dry air with the help of blowers and thereby the seeds are dried. It is possible only during the dry seasons. In some cases, drying is done by passing the heated outside air with the use of burner heater. This principle is followed in most of the present day dryers. Main advantage of this method is that drying is uniform and done within a short span of time. But the cost of the equipment and fuel requirement is very expensive.

Tests to ascertain the dryness of seeds Simple traditional methods are involved in order to ascertain whether the seeds are properly dried or not. Thin seeds are twisted between the fingers, thick seeds can be bitten by the front tooth and the small seeds can be squeezed between the finger nails. If they break with a cracking sound, it shows that the seeds are dried well.

SEED VILLAGE

What is seed village?
A village, wherein trained group of fanners are involved in production 'of seeds of various crops and cater to the needs of themselves, fellow fanners of the village and fanners of neighbouring villages in appropriate time and at affordable cost is called "a seed village".

Concept

- Organizing seed production in cluster (or) compact area
- Replacing existing local varieties with new high yielding varieties.
- Increasing the seed production
- To meet the local demand, timely supply and reasonable cost
- Self-sufficiency and self-reliance of the village
- Increasing the seed replacement rate

Features

- Seed is available at the door steps of farms at an appropriate time
- Seed availability at affordable cost even lesser than market price
- Increased confidence among the farmers about the quality because of known source of production

- Producer and consumer are mutually benefited
- Facilitates fast spread of new cultivars of different kinds

Establishment of seed villages

The present programme of seed village scheme is having two phases

I. Seed production of different crops

Seed village concept is to promote the quality seed production of foundation and certified seed classes. The area which is suitable for raising a particular crop will be selected, and raised with single variety of a kind.

Selection of are

The area with the following facilities will be selected.
1. Irrigation facilities
2. Suitability of climatic conditions to raise the crop for more than one season
3.Labour availability and Knowledge of local farmers on that particular crop
4. Occurrence or outbreak of pest and diseases
5. Past history of the area for suitability to raise seed crop
6. Average rainfall and distribution
7. Closeness to a urban area for easy movement of seed and other inputs

Seed Supply

- Suitable area for seed production will be identified by the Scientists. The foundation/ certified seeds or University labeled seeds will be supplied by the University through Krishi Vigyan Kendras (KVKs) and Research Stations at 50% subsidy cost to the identified farmers in the area. The farmers will use these quality seeds and take up their own seed production in a small area (1 acre) for their own use. The crops are Rice, Pulses and Oilseeds.

Capacity building

In order to harness the synergy between technologies and the community participation, special emphasis is being given to build farmer's capacity to produce quality seeds. A training on seed production and seed technology to the identified farmers for the seed crops grown in the seed villages will be given for technology empowerment of farmers.

- Duration of the training: 3 days
  First one day training: At the time of sowing
  Training on : Isolation distance, sowing practices, seed treatment, and other agronomic practices.
  Second one day training : During flowering
  Training on: Identifying off types and removal, maintenance of seed plots, plant protection

measures, maturity status and harvesting methods.
Third one day training: After harvest
Training on: Seed cleaning, grading, seed treating, bagging and storage aspects, seed sampling and sending to seed testing laboratory for analysis.

- A seed grower forum will be organized for further empowerment of technology and marketing.
.

II. Establishing seed processing unit

Post-harvest seed handling is a vital component of the total technology in marketing available good quality seeds of improved varieties. If the seeds are not processed and handled properly, all the past efforts in production may be lost. Thus seed processing and packaging is very important aspect in seed production..! The location of seed processing centres is based on the available infrastructure and convenience. Such a place will be well connected with roads and transportation facilities. Each seed processing centre will have the following infrastructure.

- Seed garden cum clearer
- Bag closer, trolleys, scales and furniture
- Building to house equipment
- Seed storage structure
- Seed threshing and drying yard
- Information centre

The information centre will have internet facility to provide access to information on seed demand and market trends, agriculture market index, weather forecast, plant protection measures etc.,

Advantages of Seed Village Concept or Compact Area Approach

1. Solve the problem of isolation. Mainly in cross pollinated crops like maize, sunflower where it required more Isolation distance the problem will be solved by raising a single variety in a large area.
2. Mechanization is possible from sowing to harvesting
3. Post-harvest handling of seed is easy .
4. Because of a single variety, the problem of varietal admixture during processing, drying will be avoided
5. Seed certification official will cover large area per unit time
6. Totally it reduces the cost of cultivation
7. Seed will be with high genetic, physical purity

SOIL & WATER CONSERVATION

Types of Soils in India

Soil is a valuable resource of India. Much of the Indian agriculture depends upon the extent and qualities of soil. Weathering prepares loose materials on the surface of the Earth and mixed with decayed organic matters it forms soil.

India is a large country and witness's diverse range of climatic and other natural conditions. The nature of soil in a place is largely influenced by such factors as climate, natural vegetation and rocks.

The various types of soil found in India includes alluvial soil, Laterite soil, Red soil, Black soil, Desert soil, and Mountain soil. They are each discussed below.

Major types and characteristics of soils in India:

Indian soils may be divided into six major types based on their character and origin:

1. Alluvial soil: Materials deposited by rivers, winds, glaciers and sea waves are called alluvium and soils made up of alluvium are alluvial soils. In India alluvial soils are mainly found on the Indo-Ganga Brahmaputra Plains, Coastal Plains and the broad river valleys of South India. They are also found along the river basins of some plateau and mountain regions.

In the Indo-Ganga plain two other types of alluvium are found. The old alluviums are clayey and sticky, have a darker colour, contain nodules of lime concretions and are found to lie on slightly elevated lands. The new alluviums are lighter in colour and occur in the deltas and the flood plains.

In comparison to old alluvial soil, the new alluvial soils are very fertile. The alluvial soil is regarded as the best soil of India for its high fertility and the rich harvest, it gives rice, wheat, sugarcane, jute oil-seeds and pulses are the main crops grown on this soil.

Influence on Agriculture: Alluvial soil is very productive. Abundant of wheat, sugarcane, oilseeds, pulses, rice and jute is grown on this soil.

2. Laterite and Lateritic soils: Laterite is a kind of clayey rock or soil formed under high temperature and high rainfall. By further modification laterite is converted into red colored lateritic soils charged with iron nodules. Laterite and lateritic soils are found in South Maharashtra, the Western Ghats in Kerala and Karnataka, at places on the Eastern Ghat, in some parts of Assam, Tamil Nadu, Karnataka, and in western West Bengal (particularly in Birbhum district). These soils are generally infertile. Some plants like tea, coffee, coconut, areca nut, etc. are grown in this soil.

Influence on Agriculture: They are unsuitable for agriculture. Some plants like the cashew can thrive on lateritic soils. Root crops like tapioca also do reasonably well on these soils.

3. Red Soils: Red soils develop on granite and geneses rocks under low rainfall condition. The dissemination of red oxides of iron gives the characteristic red colour of the soil. These soils are friable and medium fertile and found mainly in almost whole of Tamil Nadu, South-eastern Karnataka, North-eastern and South-eastern Madhya Pradesh, Jharkhand the major parts of Orissa, and the Hills and

Plateaus of North-east India. But these have capacity to grow good crops after taking help of irrigation and fertilizers. Wheat, rice, millets, gram, pulses, oil-seeds and cotton are cultivated here.

4. Black Soils or Regur soils: The regur or black soils have developed extensively upon the Lava Plateaus of Maharashtra, Gujarat, Madhya Pradesh mainly Malwa. Black soils have also developed on gneisses of north Karnataka and north and west of Andhra Pradesh. The regur is clayey, becomes very sticky when wet. Its special merit lies in its water holding capacity. These soils are very fertile and contain a high percentage of lime and a moderate amount of potash. The type of soil is especially suited to the cultivation of cotton and hence sometimes called 'black cotton soil.' Sugarcane, wheat, and groundnut are also cultivated.

Influence of Agriculture: They are able to retain water. Crops grow without much irrigation. These soils are fertile and suitable for the production of cotton, jowar, sugarcane, wheat and groundnut. Green skinned bananas grow here in abundance.

5. Desert soil: The soils of Rajasthan, Haryana and the South Punjab are sandy. In the absence of sufficient wash by rain water soils have become saline and rather unfit for cultivation. In spite of that cultivation can be carried on with the help of modern irrigation. Wheat, bajra, groundnut, etc. can be grown in this soil.

Influence on Agriculture: These soils are not suitable for agriculture due to scanty rainfall; however, agriculture can be carried on with the help of irrigation. Bajra, wheat, groundnut can be grown on these soils.

6. Mountain soil: Soils are varied in mountains. Alluvium is found at the valley floor, brown soil, rich in organic matter, in an altitudinal zone lying between about 700-1800 m. Further up podzol soils, grey in color and acidic in reaction, are found associated with coniferous vegetation. In the Alpine forest belts the soils are thin and darker in colour. This type of soil is suitable for the cultivation of potatoes, fruits, tea coffee and spices and wheat.

Influence on Agriculture: They are fertile and suitable for cultivation of potatoes, rice, wheat, fruits and tea. Oak trees are good for the growth of Oak trees. Potato and barley grows in Podzolic soil.

Major Types of Soil found in India

In the higher regions of the Himalayas, Glaciated rocky soils are found just below the snow line. Below this boulder clay is found. Further south, Podsol type of soil is found.

The great plain of North India has been built up of alluvium brought down by the great rivers. Here the soil is of two kinds:

- Old alluvium and
- New alluvium.

In the northern parts of Punjab, U. P., and Bihar, the soil is old alluvium.

New alluvium is found in those parts where fresh silt is deposited every year. Alluvium soils in India is of three types:

- Sandy soil,
- Clayey soil and
- Loamy soil.

The sandy soil has the highest percentage of large grained sand. As water can easily sink through it, it is not suitable for the cultivation of rice. Clayey soil is fine grained, impermeable and can retain water. The deltaic regions have this type of soil. It is good for the cultivation of rice and jute. The grain of loamy soil is intermediate between sand and clay and most suitable for a wider range of crops. In Punjab, Haryana, U. P., and Bihar this type of soil is found. It is suitable for the production of rabi as well as kharif crops.

In South India river valleys and coastal plains are made up of alluvial soil. Lava soil is found in the north-western part of Deccan. As this soil can retain moisture, it is very suitable for the production of cotton even in a rain shadow area. So it is known as 'Black Cotton Soil'. Maharashtra, Gujrat and certain parts of Madhya Pradesh have this of soil.

The Red soil which is found in Kerala, Karnataka and Andhra Pradesh is light red in colour. Laterite soil is found in Tamil Nadu, Karnataka and Chhota Nagpur. It is not suitable for cultivation of crops other than millets.

SOIL FERTILITY

Soil fertility: Soil fertility is defined as the quality that enables the soil to provide proper nutrient compounds in proper amounts and in proper balance for the growth of specified plants. Soil fertility is also defined as the ability of soil to supply adequately the nutrients normally taken from the soil by plants.

This refers to the ability of the soil to supply essential plant nutrients and soil water in adequate amounts and proportions for plant growth and reproduction in the absence of toxic substances which may inhibit plant growth. Soils are composed of five main components:

- mineral particles derived from rocks by weathering;
- organic materials - humus from dead and decaying plant material;
- soil water - in which nutrient elements are dissolved;
- soil air - both carbon dioxide and oxygen;
- Living organisms including bacteria that help plant decomposition.

Soils differ because they have different proportions of these components and because the mineral particles have been affected to different degrees by weathering. Age of soil minerals, prevailing temperatures, rainfall, and leaching and soil chemistry are the main factors which determine how much a particular soil will weather. Vanuatu soils, because they are geologically young, are often less weathered than soils of neighbouring Pacific countries.

The major and micro or trace elements are made available to plants by breakdown of the mineral and organic matter in the soil. Availability of these nutrients depends on how much is present, the form in which it is present in the soil, the rate at which it is released from organic matter or mineral particles and the soil pH i.e. its acidity or alkalinity.

The proportion of nutrients held on the clay and humus particles influence deficiencies e.g. potassium(K), calcium(Ca) and magnesium(Mg) are held on the surface of clay particles and are directly taken up by plant roots or from the soil solution. An excess of K can create a deficiency of Ca or the reverse can occur. Acid soils high in Manganese (Mn) often cannot supply enough Cobalt (Co) for rhizobium bacteria with a consequent effect on nitrogen (N) fixation by legumes. Also on very acid soils Manganese and Iron (Fe) make phosphorus (P) unavailable to plants by 'fixing' it in insoluble complexes. The chemical relationships influencing soil fertility are complex and affected by the parent material from which soil develops, the type of clay present, the proportions of different sized particles, e.g. sand, silt, clay, which also have important effects on soil structure. Detailed discussion of this topic is outside the scope of this Bulletin.

Soil Chemistry:

It deals with the chemical constitution of the soil - the chemical properties and the chemical reactions in soils. It is the study of chemical composition of soil in relation to crop needs. Traditional soil chemistry focuses on chemical and biochemical reactions in soils that influence nutrient availability for plant growth, and potential environmental consequences associated with inorganic and organic fertilization. Soil chemistry has increasingly focused on the environment over the past few decades, especially as related to ground and surface water quality. Understanding the reactions and biogeochemical processes of potential pollutants and contaminants in soils will enable a more accurate prediction of fate and toxicity of contaminants, and development of remediation strategies.

The overall goal of soil chemistry/fertility research is a more fundamental understanding of chemical and biochemical reactions in soils related to plant growth, sustainability while maintaining soil and environmental quality. Soils are the medium in which crops grow to provide food and cloth to the world. Soil is the major factor that limits the type of vegetation and crops. Under similar climatic conditions, a loose and porous soil that retains little water will support sparse vegetation when compared to deep, fertile loam or clay. The basic need of crop production is to maintain soil fertility and soil productivity

SOIL FERTILITY AND SOIL PRODUCTIVITY

SNO	SOIL FERTILITY	SOIL PRODUCTIVITY
1	It is the inherent capacity of the soil to provide essential chemical elements for plant growth	Soil productivity emphasizes the capacity of soil to produce crops and is expressed in terms of yield.
2	A combination of soil properties and an aspect of soil – plant relationships.	An economic concept and not a property of soil
3	Soil fertility is vital to a productive soil. But a fertile soil is not necessarily be a productive soil. Many factors can limit production, even when fertility is adequate. For eg., soils in arid region may Be fertile but not productive.	Soil fertility is one factor among all the external factors that control plant growth like air heat (temp.), light, mechanical support, soil fertility and water. Plant depends on soil for all these factors except for light.
4	Organic matter in the soil improves soil fertility by mineralization of nutrients.	Organic matter also improves soil productivity by improving soil porosity, aggregation and physical condition of soil thus modifying the soil environment for crop growth.

Concepts of soil fertility and soil productivity

- It is evident from the early writing of Theophrastus (372 – 287 BC) even before the advent of Christian era, Greek and Romans realised the impact of soil on the growth of plants and made a mention about the application of organic wastes and saltpeter for the plants.
- The first experiment aimed at elucidating the increase in the weight of plant during its growth was reported by Nicholas (1401 - 1446).
- Jan Baptiste van Helmont (1577-1644) attributed the increase in weight of willow shoot to water. But a German chemist, Glauber (1604-1668), who attributed the growth of plants to the absorption of saltpeter ($KNO3$) from the soil.
- John Woodward (during the year about 1700) first conducted water culture experiments on spearmint and emphasised that the growth factor is some terrestrial matter but not the water.
- Jean Baptiste Boussingault (1802-1882) carried out field plot experiments. He was called as 'father of field plot technique'.
- Justus von Liebig (1803-1873) put forth the 'law of minimum' which states that the yield is governed by the limiting nutrient and is directly proportional to the factor which is minimum in the soil.

Soil as a source of plant nutrients

Soils are complex natural formations on the surface of the earth and consist of five main components: Mineral matter, organic matter, water, air and living organisms. The rocks and minerals on weathering release nutrients into the soil. The most important part of the soil with respect to plant nutrition is the colloidal fraction which consists of inorganic colloids (clay) and organic colloids (humic substances).

Most of soil colloids possess electronegative adsorption sites available for attracting cautions including calcium, magnesium, potassium, ammonium etc. as well as $H+$ arising from the biological activity. Organic matter on decomposition releases nutrients. The cautions adsorbed on the surface of the colloids are capable of exchanging rapidly and reversibly with those in soil solution. The principal immediate source of mineral nutrients to plant roots is ions in the soil solution.

This nutrient supply is gradually depleted by absorption of nutrient ions by plant roots and continuously replenished by desorption of exchangeable ions on the clay-humus complex and break down of readily decomposable organic debris. The microbes in the soil also help in supplementing nutrients by the way of nutrient transformations. These sources represent the reserves that serve to replace but only at a relatively slow rate. For intensive cultivation of crop plants, however, application of mineral salts to soil is required.

Methods of Soil Fertility Evaluation

Different Methods of Soil Fertility Evaluation are:

1. Biological Method:

a. Field trials

b. Pot culture

c. Neubauer seedling method

d. Aspergillus niger method.

2. Use of visual symptoms of nutrient deficiency or toxicity method.

3. Plant Analysis Method:

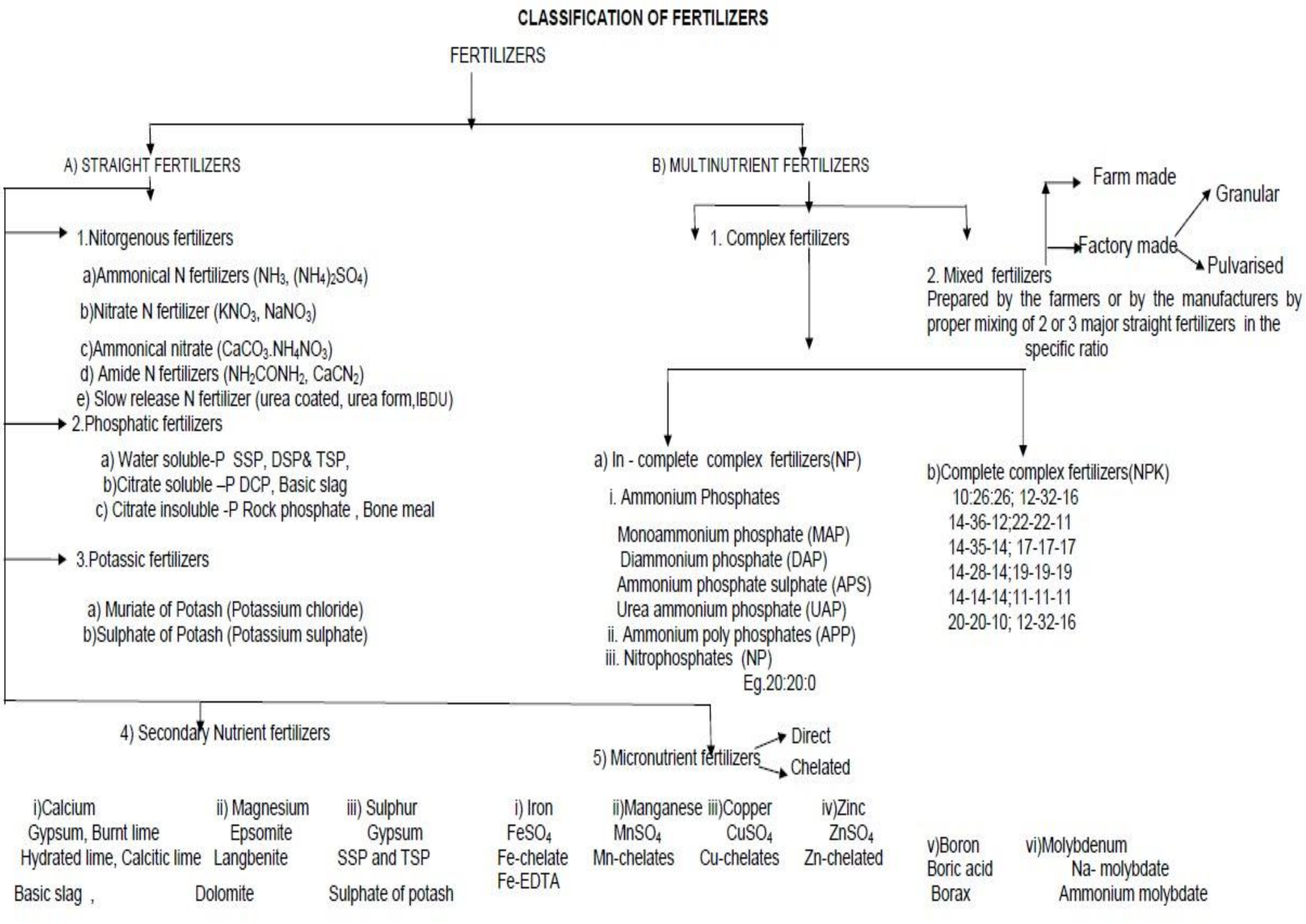
a. Total elemental analysis
b. Plant tissue tests

4. Soil Analysis Method: Soil testing has been used by soil scientist as an aid in determining soil fertility level.

FERTILIZERS

Fertilizer:

A fertilizer can be defined as a mined or manufactured material containing one or more essential plant nutrients in potentially available forms in commercially valuable amounts. A **fertilizer** or **fertiliser** (in British English) is any material of natural or synthetic origin (other than liming materials) that is applied to soils or to plant tissues (usually leaves) to supply one or more plant nutrients essential to the growth of plants. This also depends on its soil fertility as well as organic things such as humic acid, seaweed and worm castings



Mechanism

Fertilizers enhance the growth of plants. This goal is met in two ways, the traditional one being additives that provide nutrients. The second mode by which some fertilisers act is to enhance the effectiveness of the soil by modifying its water retention and aeration. This article, like most on fertilizers, emphasises the nutritional aspect. Fertilizers typically provide, in varying proportions:

- three main macronutrients:
  - Nitrogen (N): leaf growth;
  - Phosphorus (P): Development of roots, flowers, seeds, fruit;
  - Potassium (K): Strong stem growth, movement of water in plants, promotion of flowering and fruiting;
- three secondary macronutrients: calcium (Ca), magnesium (Mg), and sulphur (S);
- micronutrients: copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), boron (B), and of occasional significance there are silicon (Si), cobalt (Co), and vanadium (V) plus rare mineral catalysts.

The nutrients required for healthy plant life are classified according to the elements, but the elements are not used as fertilizers. Instead compounds containing these elements are the basis of fertilisers. The macronutrients are consumed in larger quantities and are present in plant tissue in quantities from 0.15% to 6.0% on a dry matter (DM) (0% moisture) basis. Plants are made up of four main elements: hydrogen, oxygen, carbon, and nitrogen. Carbon, hydrogen and oxygen are widely available as water and carbon dioxide. Although nitrogen makes up most of the atmosphere, it is in a form that is unavailable to plants. Nitrogen is the most important fertilizer since nitrogen is present in proteins, DNA and other components (e.g., chlorophyll). To be nutritious to plants, nitrogen must be made available in a "fixed" form. Only some bacteria and their host plants (notably legumes) can fix atmospheric nitrogen (N_2) by converting it to ammonia. Phosphate is required for the production of DNA and ATP, the main energy carrier in cells, as well as certain lipids.

Micronutrients are consumed in smaller quantities and are present in plant tissue on the order of parts-per-million (ppm), ranging from 0.15 to 400 ppm DM, or less than 0.04% DM. These elements are often present at the active sites of enzymes that carry out the plant's metabolism. Because these elements enable catalysts (enzymes) their impact far exceeds their weight percentage.

Classification:

Fertilizers are classified in many ways. They are classified according to whether they provide a single nutrient (say, N, P, or K), in which case they are classified as "straight fertilizers." "Multinutrient fertilizers" (or "complex fertilizers") provide two or more nutrients, for example N and P. Fertilizers are also sometimes classified as inorganic (the topic of most of this article) vs organic. Inorganic fertilizers exclude carbon-containing materials except ureas. Organic fertilizers are usually (recycled) plant- or animal-derived matter. Inorganic are sometimes called synthetic fertilizers since various chemical treatments are required for their manufacture.

Single nutrient ("straight") fertilizers

The main nitrogen-based straight fertilizer is ammonia or its solutions. Ammonium nitrate (NH_4NO_3) is also widely used. About 15M tons were produced in 1981. Urea is another popular source of nitrogen, having the advantage that it is a solid and non-explosive, unlike ammonia and ammonium nitrate, respectively. A few percent of the nitrogen fertilizer market (4% in 2007is met by calcium ammonium nitrate ($Ca(NO_3)_2 \bullet NH_4NO_3 \bullet 10H_2O$).

The main straight phosphate fertilizers are the superphosphates. "Single superphosphate" (SSP) consists of 14–18% P_2O_5, again in the form of $Ca(H_2PO_4)_2$, but alsophosphogypsum ($CaSO_4 \cdot 2 H_2O$). Triple superphosphate (TSP) typically consists of 44-48% of P_2O_5 and no gypsum. A mixture of single superphosphate and triple superphosphate is called double superphosphate. More than 90% of a typical superphosphate fertilizer is water-soluble.

Multinutrient fertilizers

These fertilizers are the most common. They consist of two or more nutrient components.

Binary (NP, NK, PK) fertilizers

Major two-component fertilizers provide both nitrogen and phosphorus to the plants. These are called NP fertilizers. The main NP fertilizers are monoammonium phosphate (MAP) and diammonium phosphate (DAP). The active ingredient in MAP is $NH_4H_2PO_4$. The active ingredient in DAP is $(NH_4)_2HPO_4$. About 85% of MAP and DAP fertilizers are soluble in water.

NPK fertilizers

NPK fertilizers are three-component fertilizers providing nitrogen, phosphorus, and potassium.

NPK rating is a rating system describing the amount of nitrogen, phosphorus, and potassium in a fertilizer. NPK ratings consist of three numbers separated by dashes (e.g., 10-10-10 or 16-4-8) describing the chemical content of fertilizers. The first number represents the percentage of nitrogen in the product; the second number, P_2O_5; the third, K_2O. Fertilizers do not actually contain P_2O_5 or K_2O, but the system is a conventional shorthand for the amount of the phosphorus (P) or potassium (K) in a fertilizer. A 50-pound bag of fertilizer labeled 16-4-8 contains 8 pounds of nitrogen (16% of the 50 pounds) an amount of phosphorus and potassium equivalent to that in 2 pounds of P_2O_5 (4% of 50 pounds) and 4 pounds of K_2O (8% of 50 pounds). Most fertilizers are labeled according to this N-P-K convention, though Australian convention, following an N-P-K-S system, adds a fourth number for sulfur.

Micronutrients

The main micronutrients include sources of iron, manganese, molybdenum, zinc, and copper. As for the macronutrients, these elements are provided as water-soluble salts. Iron presents special problems because it converts to insoluble (bio-unavailable) compounds at moderate soil pH and phosphate concentrations. For this reason, iron is often administered as a chelate complex, e.g., the EDTA derivative. The micronutrient needs depend on the plant. For example, sugar beets appear to require boron, and legumes require cobalt.

Organic Fertilizer

Organic fertilizers are fertilizers derived from animal matter, human excreta or vegetable matter. (E.g. compost, manure). Naturally occurring organic fertilizers include animal wastes from meat processing, peat, manure, slurry, and guano.

Organic chemicals have Carbon integral to their structure. In the process of composting, the balance of Carbon (browns) and Nitrogen (greens) is essential. Compost is the usual amendment to achieve healthy soil. Healthy soil grows healthy plants.

In contrast, the majority of fertilizers used in commercial farming are extracted from minerals (e.g., phosphate rock) or produced industrially (e.g., ammonia).

Sources

The main organic fertilizers are, peat, animal wastes (often from slaughter houses), plant wastes from agriculture, and treated sewage sludge.

Mineral

The main source of organic fertilizer is compost. Peat is a substrate. As a substrate, Peat itself offers no nutritional value to the plants, but improves the soil by aeration and absorbing water.

Mined powdered limestone rock phosphate, and Chilean salt peter are inorganic (not of biologic origins) compounds, which can be energetically intensive to harvest

Animal sources

These materials include the products of the slaughter of animals. Blood meal, bone meal, hides, hoofs, and horns are typical precursors. Fish meal, and feather meal are other sources.

Plant

Processed organic fertilizers include compost, humic acid, amino acids, and seaweed extracts. Other examples are natural enzyme-digested proteins. Decomposing crop residue (green manure) from prior years is another source of fertility.

Other ARS studies have found that algae used to capture nitrogen and phosphorus runoff from agricultural fields can not only prevent water contamination of these nutrients, but also can be used as an organic fertilizer. ARS scientists originally developed the "algal turf scrubber" to reduce nutrient runoff and increase quality of water flowing into streams, rivers, and lakes. They found that this nutrient-rich algae, once dried, can be applied to cucumber and corn seedlings and result in growth comparable to that seen using synthetic fertilizers.

Treated sewage sludge

Although night soil (from human excreta) was a traditional organic fertilizer, the main source of this type is nowadays treated sewage sludge, also known as bio solids.

Bio solids as soil amendment is only available to less than 1% of US agricultural land. Industrial pollutants in sewage sludge prevents recycling it as fertilizer. The USDA prohibits use of sewage sludge in organic agricultural operations in the U.S. due to industrial pollution, pharmaceuticals, hormones, heavy metals, and other factors. The USDA now requires 3rd-party certification of high-nitrogen liquid organic fertilizers sold in the U.S.

Sewage sludge use in organic agricultural operations in the U.S. has been extremely limited and rare due to USDA prohibition of the practice (due to toxic metal accumulation, among other factors).

Urine

Animal sourced urea and urea-formaldehyde from urine are suitable for organic agriculture; however, synthetically produced urea is not.[14] The common thread that can be seen through these examples is that *organic* agriculture attempts to define itself through minimal processing (e.g., via chemical energy such as petroleum — see Haber process), as well as being naturally occurring or via natural biological processes such as composting.

SOIL EROSION

Introduction to Soil Erosion

Definition: – soil erosion is the detachment, transport & deposition soil erosion is the detachment, transport & deposition of soil particle on land surface - termed as loss of soil.

– Measured as mass /unit area - tonne/ha or Kg/sq.m

Soil loss is of interest primarily on Soil loss is of interest primarily on -site effect of erosion such as loss of crop productivity v Off site effect of erosion are siltation in ditches, streams , reservoirs

Sediment generated by erosion processes are prime carrier of agricultural chemicals that pollutes stream or lakes.

Soil Erosion Problem

- Soil is the most precious gift of nature -Prime resource -for food, fodder etc. -Soil mismanaged - less productivity.
- In India, more than 100 million hectares soil degraded eroded unproductive
- About 17 tones/ha soil detached annually->20% of this is transported by river to sea →10% deposited in reservoir results 1 to 2% loss off storage capacity.

The Flash's

Articles

For

NABARD Gr. A & B

By:- Gaurav(The Flash)

#3

SOIL AND WATER CONSERVATION (Part-II)

&

WATER RESOURCES

SOIL EROSION

Introduction to Soil Erosion

Definition: –soil erosion is the detachment, transport & deposition of soil particle on land surface - termed as loss of soil.

Soil erosion is one form of soil degradation. Soil erosion is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur at an alarming rate causing serious loss of topsoil. The loss of soil from farmland may be reflected in reduced crop production potential, lower surface water quality and damaged drainage networks.

While erosion is a natural process, human activities have increased by 10-40 times the rate at which erosion is occurring globally. Excessive (or accelerated) erosion causes both "on-site" and "off-site" problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual end result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems world-wide

- Measured as mass /unit area - tonne/ha or Kg/sq.m
- Soil loss is of interest primarily on-site effect of erosion such as loss of crop productivity
- Offsite effect of erosion are siltation in ditches streams , reservoirs
- Sediment generated by erosion process are prime carrier of agricultural chemical that pollutes stream or lakes.

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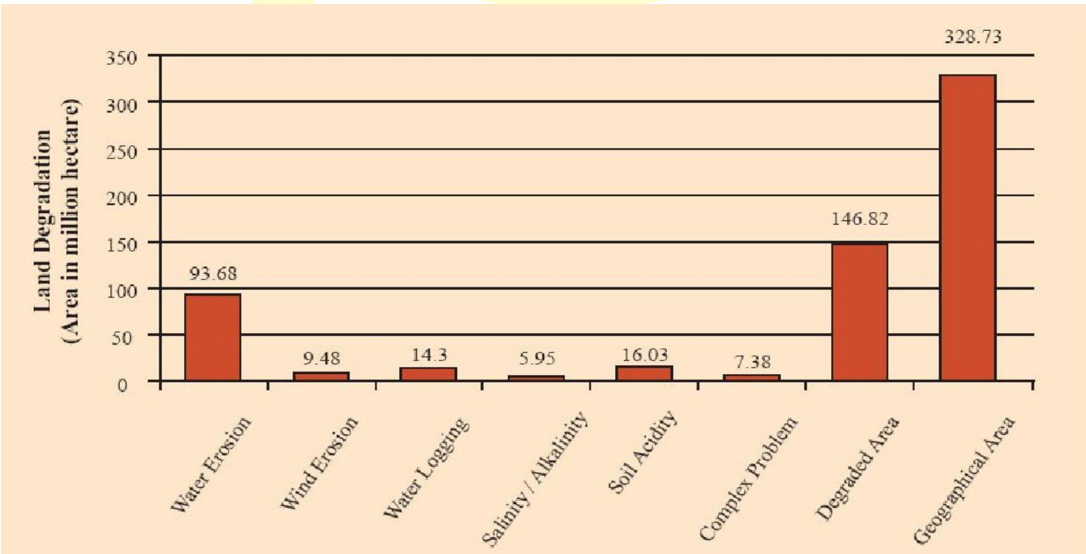


- When a raindrop hits soil that is not protected by a cover of vegetation and where there are no roots to bind the soil, it has the impact of a bullet.
- Soil particles are loosened, washed down the slope of the land and either end up in the valley or are washed away out to sea by streams and rivers.
- Erosion removes the topsoil first. Once this nutrient-rich layer is gone, few plants will grow in the soil again
- Without soil and plants the land becomes desert like and unable to support life.
- Soil erosion deteriorates soil quality & reduces pr**oductivit**y of natural , agricultural & forest ecosystem
- Soil erosion deteriorates quality of water
- Increased sedimentation causes reduction of capacity of water bodies.

Causes of soil erosion

Erosion occurs when farming practices are not compatible with the fact that soil can be washed away or blown away. These practices are:

- Inappropriate farming techniques such as deep ploughing land 2 or 3 times a year to produce annual crops
- Lack of crop rotation
- Planting crops down the contour instead of along it.
- **Human Induced & Natural Causes**
- Land use - Over grazing by cattle, Deforestation arable land use, faulty farming, construction mining etc.
- Climatic conditions: precipitation & wind velocity
- Soil: soil characteristics - texture, structure water retention and transmission properties.
- Hydrology: Infiltration, surface detention**,** overland flow velocity, and subsurface water flow.
- Land forms: Slope gradient, slope length and shape of slope

Types of Soil Erosion

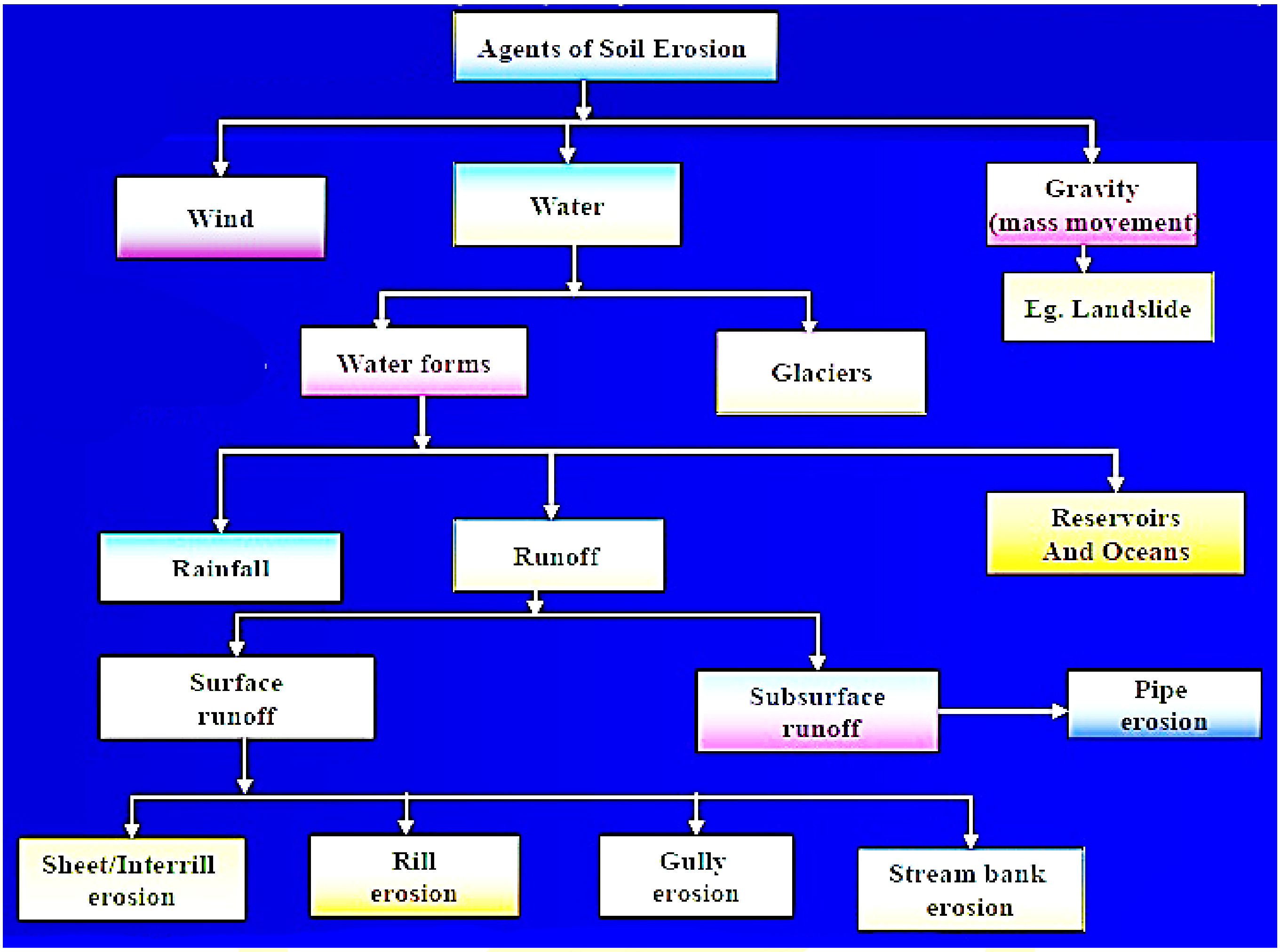
- Geological erosion, Natural erosion & Erosion from activities of human & animals
  - Geological erosion:-Soil forming and distribution
    - Long-time process
  - Human and animal:-Tillage, removal of plants and other vegetarian → Accelerated erosion
  - Stream bank erosion
  - Landslide, Volcanic eruption, flooding
  - Water and wind: major factors of soil erosion

Soil Erosion Parameters

Soil erosion – function of:

- Erosivity – depends on rainfall
- Erodibility – property of soil
- Topography – property of land
- Management – contributed by man
- Erodibility: Detachability & transportability
- Topography: Slope, length, relation to other land
- Management: Land use & crop management

Soil Erosion Processes



Water Erosion

- Detachment & transport of soil particles from land mass by water including rain, runoff, melted snow
- Depends on: soil nature & capacity of water to transport
- More on sloppy land
- More velocity→ more transport
- Water erosion → accelerated by agriculture, grazing and construction activities

Factors affecting Erosion water

- Climate→Precipitation, temperature, wind, humidity and solar radiation
- Soil→size, type of soil, soil texture, structure, organic matter
- Vegetation→interception of rainfall-reduce surface sealing & runoff, decrease surface velocity improvement of aggregation, increased biological activity and aeration, transpiration, physical holding
- Topography→degree of slope, shape and length of slope and size and shape of watershed.

Types of Water Erosion

- **Water Erosion Types:** Interrill (raindrop and sheet), rill, gully & stream channel erosion
- **Raindrop erosion** (splash erosion)→Soil detachment & transport - from impact of raindrops directly on soil particles or on thin water surfaces
- On bare soil : about 200 t/ha soil is splashed into air by heavy rains
- Relationship - erosion, rainfall momentum & Energy-by raindrop mass, size, shape, velocity & direction
- Relationship: Rainfall intensity & energy
- $E = 0.119 + 0.0873 \log_{10} i$;E-kinetic energy in MJ/ha-mm ; i=intensity of rainfall in mm/h

Water erosion causes two sets of problems:

- An on-site loss of agricultural potential
- An off-site effect of downstream movement of sediment, causing flooding and the silting up of reservoirs.

Sheet Erosion/ Interrill Erosion

- **Sheet erosion:** Uniform removal of soil in thin layers from sloping land resulting from overland flow-idealized form of sheet erosion rarely occurs
- Splash & sheet erosion sometimes combined and known as Interill Erosion
- Soil erosion is characterised by the downslope removal of soil particles within a thin sheet of water.
- Sheet erosion occurs when the entire surface of a field is gradually eroded in more or less uniform way.
- It is a gradual process and it is not immediately obvious that soil is being lost

Rill Erosion (channel erosion)

Channel erosion can occur on steep land or on land that slopes more gently. Because there are always irregularities in a field, water finds hollows in which to settle and low-lying channels through which to run. As the soil from these channels is washed away, channels or miniature dongas are formed in the field.

Detachment and transport of soil particle by concentrated flow of water; Predominant form of erosion; Depends on hydraulic shear of water flowing in the rill, rill erodibility and critical shear

- Critical shear: shear below which soil detachment is negligible
- Rill detachment rate -erosion rate occurring beneath submerged area of the rill

Gully erosion (dongas)

Dongas usually occur near the bottom of slopes and are caused by the removal of soil and soft rock as a result of concentrated runoff that forms a deep channel or gully. On steep land, there is often the danger of gullies forming. Water running downhill cuts a channel deep into the soil and where there is a sudden fall, a gully head forms at the lower end of the channel and gradually works its way back uphill. As it does so, it deepens and widens the scar that the gully makes in the hillside. Gully erosion is related to stream bank erosion, in which fast-flowing rivers and streams increasingly cut down their own banks

Wind erosion

Wind erosion occurs when the land surface is left bare in regions that are arid enough, as a result of low rainfall, to allow the soil to dry out, and flat enough to allow the wind to carry the soil away over several consecutive days. Land may become susceptible to wind erosion through grazing animals, which remove the protective plant cover, and whose hooves break up the soil, especially round watering points. Arable land that has been left bare is also a major problem.

- Process of detachment transportation & deposition of soil by action of wind
- Depends on wind speed, soil, topographic features and vegetative cover
- More problems in arid or semi-arid region
- Change in texture of soil
- In India: Mainly occur in Rajasthan Gujrat and parts of Punjab

Mechanism of Wind Erosion

- Initiation of movement –due to turbulence velocity and wind velocity
- Transportation –depends on particle size, gradation, wind velocity and distance
- Deposition—occurs when gravitational force is greater than forces holding soil particles in air
- Types of soil movement by wind
    - Saltation- Fine particles lifted from surface and following specific path w.r.t wind and gravity
    - Suspension-floating of small particles
    - Surface creep -rolling or sliding of large soil particles along soil surface.

Factors determining soil erosion

There are various factors determining soil erodibility of which the following are the most important:

Slope

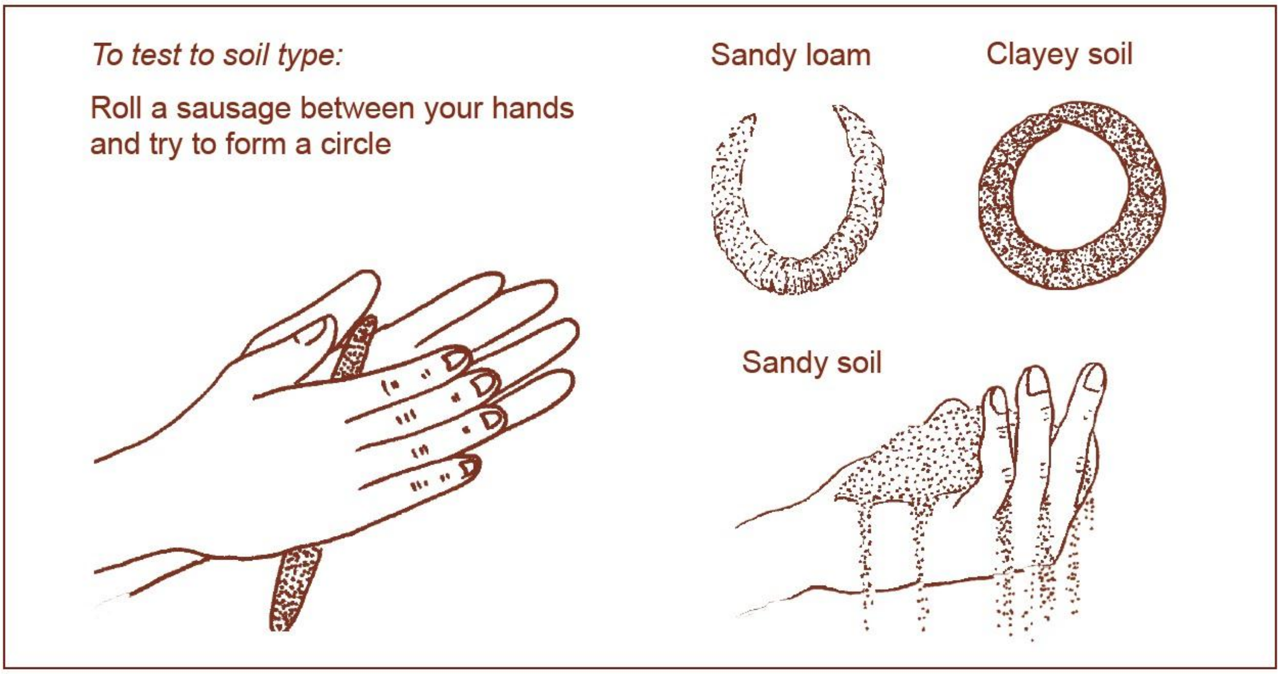
The steeper the slope, the greater the erosion, as a result of the increased velocity (swiftness) of water-flow. The length of the slope is very important, because the greater the size of the sloping area, the greater the concentration of the flooding water.

Soil texture

Soil texture is the size distribution of soil particles. The size of particles never changes. A sandy soil, therefore, remains sandy and a clayey soil remains clayey. The three main particles are sand, silt and clay. The more sandy a soil the easier it will erode.

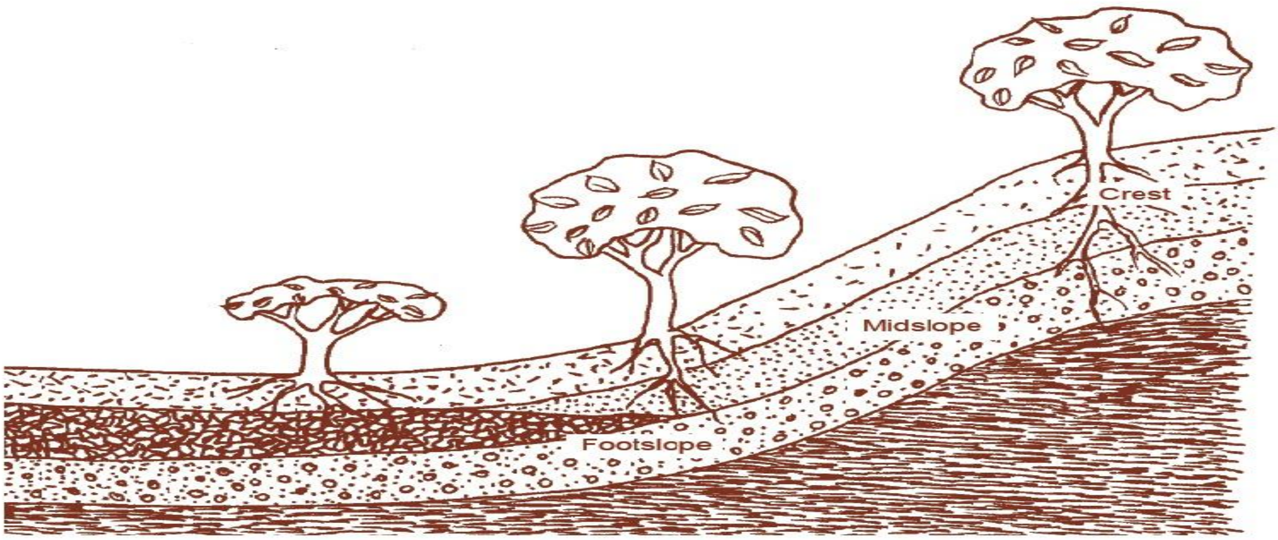
Soil structure

The term soil structure means the grouping or arrangement of soil particles. Over cultivation and compaction cause the soil to lose its structure and cohesion (ability to stick together) and it erodes more easily.



Terrain unit

The *crest* (top of slope) is usually well drained as soil moisture moves downhill, leaving air in the pore spaces most of the time. Over time, the fine (clay) particles are carried downslope leaving the soil sandy. Plant roots can penetrate easily to deep levels and withdraw enough soil water from there. These soils have a lower erosion potential and are normally more stable. In the *mid slope* soil moisture moving from the crest starts to dam up as a result of the clay-rich soil just downhill. The soils are moderately well drained with a higher erosion potential.



In the *foot slope* the soil has been waterlogged (saturated with water) as a result of the long-term accumulation of clay which does not allow water to infiltrate. Plants that grow on these soils are limited to those that can adapt their root systems to grow laterally above the hard clayey layer. These imperfectly drained soils have a high erosion potential.

Organic material

Organic material is the "glue" that binds the soil particles together and plays an important part in preventing soil erosion. Organic matter is the main source of energy for soil organisms, both plant and animal. It also influences the infiltration capacity of the soil, therefore reducing runoff.

Vegetation cover

The loss of protective vegetation through overgrazing, ploughing and fire makes soil vulnerable to being swept away by wind and water. Plants provide protective cover on the land and prevent soil erosion for the following reasons:

- Plants slow down water as it flows over the land and this allows much of the rain to soak into the ground.
- Plant roots hold the soil in position and prevent it from being blown or washed away.
- Plants break the impact of a raindrop before it hits the soil, reducing the soil's ability to erode.
- Plants in wetlands and on the banks of rivers are important as they slow down the flow of the water and their roots bind the soil, preventing erosion.

Land use

Grass is the best natural soil protector against soil erosion because of its relatively dense cover. Small grains, such as wheat, offer considerable obstruction to surface wash. Row crops such as maize and potatoes offer little cover during the early growth stages and thereby encourage erosion. Fallowed areas, where no crop is grown and all the residue has been incorporated into the soil, are most subject to erosion.

SOIL CONSERVATION

There are a number of other conservation practices which can be used by farmers. Any single conservation practice can significantly decrease soil erosion rates. Combining a number of soil conservation practices is often more effective. The ideal goal would be to achieve a soil loss rate of 6.7 tonnes/ha/year. This is roughly the rate at which soil can rejuvenate itself. Making sure there are always plants growing on the soil and that the soil is rich in organic matter are two key methods in prevention. Organic matter binds soil particles together which reduces erosion. Organic matter in soil can be increased with crop rotation or by incorporating organic fertilizers. Crop rotation is also effective at enhancing soil structure. There are also many other methods used by farmers to reduce soil erosion. Mulching is one example. It involves spreading hay or straw over a field as a substitute for a cover crop.

Some of the following measures can be implemented to prevent soil erosion:

- The use of contour ploughing and windbreaks
- Leave unploughed grass strips between ploughed lands (strip cropping)
- Make sure that there are always plants growing on the soil, and that the soil is rich in humus
- Avoid overgrazing
- Allow indigenous plants to grow along riverbanks
- Conserve wetlands
- Cultivate land, using a crop rotation system
- Minimum or no tillage
- Encourage water infiltration and reduce water runoff.

Practical methods of soil conservation are broadly grouped as follows:

(A) Biological measures (B) Mechanical or Engineering methods.

A. Biological Measures:

The following are the biological methods which are helpful in checking the soil erosion:

1. Agronomic practices:

The important agricultural practices which contribute to the conservation and productivity of cultivated lands are referred to as conservation farming's or advanced agronomical methods. These are listed as under:

I. Contour farming
II. Tillage and keeping the land fallow
III. Crop rotation, sowing of leguminous crops and mixed cropping
IV. Mulching
V. Strip cropping

(i) Contour farming:

It is practiced in the hilly regions or on the slopes. In such areas the ram water is absorbed in very little amount because of its quick downward movement on the slopes. If these sloppy areas are ploughed up and down the slope, the heavy rainfall may cause gully development. Taking into consideration this defect, the sloppy areas are ploughed and seeded against the slope, i.e., in circular furrows around the slopes. This process is termed as contour farming.

(ii) Tillage operation and keeping the land fallow:

There are several diverse opinions as to whether deep ploughing gives good result or shallow ploughing. A number of researches support the view that in dry areas, shallow ploughing gives comparatively good crop yields Shallow ploughing removes the weeds and enables the soil to absorb water. Deep ploughing of en leads to soil erosion but in the areas where rainfall is sufficiently high, deep ploughing (upto 15-30 cm deep) is effective in removing weeds and increasing crops yields.

If the land is left uncultivated and sheep, goats and other cattle are allowed to graze and sit over it for some time, the soil becomes fertile. Though this practice is useful yet it is not possible in the countries like India where exists severe problem of cereals because of thick human population.

(iii) Crop rotation, sowing of legumes and mixed cropping:

When the same crop 's grown in the field every year, the soil becomes depleted in certain minerals. The soil loses its fertility even after the use of fertilizers and ultimately erosion sets in. Rotation of crops is an important method for checking erosion and maintaining productivity of soil. After 2 years crop should be changed in the fields.

A good rotation should include a cultivated row crop, densely plan e small grasses and a spreading legume or a legume and grass mixture. Selection of crops for rotation should be made taking into consideration the climate, economic condition soil types, soil texture, slopes, nature of erosion, etc. Deep-rooted crops should be rotated by shallow-rooted crops.

The rotation of crop serves the following purposes:

1. Enriches the soil,
2. Improves the soil texture,
3. Improves water holding capacity of the soil,
4. Improves crop production,
5. Controls the recurrence of weeds and diseases.

(iv) Mulching:

It means covering the soil surface by straw, leaves or grasses. Mulches of different kinds check soil erosion, increase soil fertility and also minimize moisture evaporation from the top soils. Various types of surface tillers and crop residues are helpful in obstructing the movement of soil particles.

(v) Strip cropping:

It is an important method which employs all the advanced cultivation practices such as contour farming, proper tillage, crop rotation, mulching, cover cropping, etc. Strip cropping is very effective and practical means for controlling soil erosion.

It is of the following types:
(a) Contour strip cropping,
(b) Field strip cropping,
(c) Wind strip cropping, and
(d) Permanent or temporary buffer strip cropping

2. Agrostological methods:

The following are the important agrostological practices that check soil erosion:

(i) Cultivation of grasses (ley farming).
(ii) Retiring the land.
(iii) Afforestation and Reforestation.
(iv) Checking of overgrazing.

(i) Cultivation of grasses (Ley farming):

This method consists in growing grasses in rotation with agricultural crops. This practice improves the fertility of soil and helps in binding of the soil, thus preventing the soil erosion. This practice is recommended for Nilgiris and similar places which are subjected to very severe soil erosion.

(ii) Retiring the land:

Areas subjected to heavy soil erosion should necessarily be put under thick cover of grasses. Under favourable climatic conditions grazing should also be allowed for short periods. Researchers conducted at Solapur in Maharashtra have shown that grasses have good soil binding capacity. In Nilgiri hills, Tamil Nadu doobgrass (Cynodon dactylon), Dectylis glomerata, Eragrostis amabitis and E. cerbula are proved to be most effective in soil binding and in stabilizing the reserves of the bench terrace and sodding water channels.

(iii) Afforestation and reforestation:

Afforestation means growing forests at places where there were no forests before due to lack of trees or due to adverse factors such as unstable soil, aridity, or swampiness. Reforestation means replanting of forests at places where they have been destroyed by uncontrolled forest fires, excessive felling and lopping. Plantation of trees in short blocks is known as a wind break and extensive plantation of trees is called shelter belts.

B. Mechanical Methods:

It is only in recent years that soil erosion problems have received attention of engineers. The mechanical practices of soil conservation include various engineering techniques and structures which are adopted to supplement the biological methods when the latter alone are not sufficiently effective.

These practices aim at the following objectives:

- To reduce the velocity of run-off water and to retain it for long period so as to allow maximum water to be absorbed and held in the soil.
- To divide a long slope into several small parts so as to reduce the velocity of run-off water to the minimum, and
- Protection against erosion by wind and water.

Mechanical methods for soil conservation are:

1. Basin leaching,
2. Pan breaking,
3. Sub soiling,
4. Contour terracing,
5. Contour trenching,
6. Terrace outlets,
7. Gully control,
8. Digging of ponds and reservoirs, and
9. Stream bank protection.

(i) Basin leaching:

In this method, a number of small basins (water reservoirs) are made along the contour by means of an implement called basin blister. Basins collect and retain rain water for long period and also catch and stabilize downwardly moving soils of the slopes.

(ii) Pan breaking:

In some areas, soils become impervious to water and are less productive because of formation of hard sheet of clay a few feet below the surface. Such areas can be made productive and water permeable by breaking hard clay pans by means of pan breaker on contour at a distance of about 5 feet. By pan breaking, drainage and percolation of rain water is improved and soil is saved from residual run-off and erosion.

(iii) Sub-soiling:

In this method hard subsoil is broken deeply by means of an implement called subs oiler. This process promotes absorption of rain water in the soil and makes the soil more loose and fit to allow luxuriant growth of vegetation.

(iv) Contour terracing:

Sometimes drainage channels or properly spaced ridges or soil mounds are formed along the contour (at right angles to the slope) to retain water in the soil and check the soil erosion. These are called terraces. Terraces are levelled areas constructed at right angles to the slope to reduce soil erosion

(vii) Gully and ravine control:

Gully formation can be checked by the following methods:

- By making perimeter bunds around gullies to check flow of water through it.
- By growing suitable soil-binding vegetation on the gullies to check soil erosion.
- Diversion trenches should be made around gullies.

(viii) Ponds and reservoirs:

Small ponds and water reservoirs or dams should also be made at suitable places for irrigation and some other purposes. Various types of dams have been devised to arrest and plug gullies and thus to check soil erosion. These dams may be (a) brush dams (b) earth dams, (c) concrete dams or (d) woven wire dams.

(ix) Stream bank protection:
Banks of ravines and rivers with high vertical drops are subjected to heavy soil erosion. The bank erosions can be checked by making the drop sloppy and by growing vegetation on the slopes or by constructing stone or concrete pitch.

WATERSHED MANAGEMENT

Watershed:

A ***watershed*** is simply the geographic area through which water flows across the land and drains into a common body of water, whether a stream, river, lake, or ocean. The watershed boundary will more or less follow the highest ridgeline around the stream channels and meet at the bottom or lowest point of the land where water flows out of the watershed, the mouth of the waterway.

Much of the water comes from rainfall and storm water runoff. The quality and quantity of storm water is affected by all the alterations to the land--mining, agriculture, roadways, urban development, and the activities of people within a watershed. Watersheds are usually separated from other watersheds by naturally elevated areas.

Watershed Management

Management of the environment has been primarily focussed on specific issues such as air, land, and water. Most efforts have resulted in decreasing pollutant emissions to air and water, improved landfills, remediation of waste sites and contaminated groundwater, protection of rare and endangered species, design of best management practices to control water and contaminant runoff, and much more.

Watershed management is the study of the relevant characteristics of a watershed aimed at the sustainable distribution of its resources and the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal, and human communities within a watershed boundary. Features of a watershed that agencies seek to manage include water supply, water quality, drainage, storm water runoff, water rights, and the overall planning and utilization of watersheds. Landowners, land use agencies, storm water management experts, environmental specialists, water use surveyors and communities all play an integral part in watershed management.

Objective Of watershed Management

The different objectives of watershed management programs are:

- To protect, conserve and improve the land of watershed for more efficient and sustained production.
- To protect and enhance the water resource originating in the watershed.
- To check soil erosion and to reduce the effect of sediment yield on the watershed.
- To rehabilitate the deteriorating lands.
- To moderate the floods peaks at downstream areas.
- To increase infiltration of rainwater.
- To improve and increase the production of timbers, fodder and wild life resource.

- To enhance the ground water recharge, wherever applicable.
- To reduce the occurrence of floods and the resultant damage by adopting strategies for flood management.
- To provide standard quality of water by encouraging vegetation and waste disposal facilities.

Need of Watershed Management

Watersheds are important because the surface water features and storm water runoff within a watershed ultimately drain to other bodies of water. It is essential to consider these downstream impacts when developing and implementing water quality protection and restoration actions. Everything upstream ends up downstream. We need to remember that we all live downstream and that our everyday activities can affect downstream waters.

Watershed management practices in terms of purpose

- To increase infiltration
- To increase water holding capacity
- To prevent soil erosion
- Method and accomplishment

In brief various control measures are:

- Vegetative measures (Agronomical measures)
- Strip cropping
- Pasture cropping
- Grass land farming
- Wood lands
- Engineering measures (Structural practices)
- Contour bonding
- contour trenching
- Terracing
- Construction of earthen embankment
- Construction of check dams
- Construction of farm ponds
- Construction of diversion
- Gully controlling structure
- Rock dam
- Establishment of permanent grass and vegetation
- Providing vegetative and stone barriers
- Construction of silt tanks den tension

WATER RESOURCE

IRRIGATION:

Irrigation is the artificial application of water to the soil to supplement the rainfall and groundwater contribution to assist the crop production.

Sustainable development and efficient management of water is an increasingly complex challenge in India. Increasing population, growing urbanization, and rapid industrialization combined with the need for raising agricultural production generates competing claims for water. There is a growing perception of a sense of an impending water crisis in the country. Some manifestations of this crisis are:

a) There is hardly any city which receives a 24-hour supply of drinking water. Besides in many rural habitations there are pockets where arsenic, nitrate, and fluoride concentration in drinking water are posing a serious health hazard.

b) Increasing costs of developing new water resource – Many major and medium irrigation projects seem to remain under execution forever as they slip from one plan to the other with escalating cost and time overruns.

c) Siltation of reservoirs and owing to lack of maintenance, the capacity of the older irrigation systems seems to be going down.

d) Declining groundwater table due to over-exploitation imposing an increasing financial burden on farmers who need to deepen their wells and replace their pump sets and on State Governments whose subsidy burden for electricity supplies rises.

e) Water pollution and degradation of water-related ecosystems - Water in most parts of rivers is not fit for bathing, let alone drinking. Untreated or partially treated sewage from towns and cities is being dumped into the rivers. Untreated or inadequately treated industrial effluents pollute water bodies and also contaminate groundwater,

f) Wasteful use of already developed water supplies, often encouraged by the subsidies and distorted incentives that influence water use,

g) Rise in water-logging and salinity resulting in degradation of soils in irrigated areas,

h) Increasing water conflicts about water rights between upper and lower riparian states in a river, conflicts about quality of water, people's right for rainwater harvesting in a watershed against downstream users, industrial use of groundwater and its impact on water tables and conflicts between urban and rural users etc.

i) The gross irrigated area does not seem to be rising in a manner that it should be, given the investment in irrigation. The difference between potential created and area actually irrigated remains large. Unless we bridge the gap, significant increase in agricultural production will be difficult to realize.

a) Floods are a recurring problem in many parts of the country. Degradation of catchment areas and loss of flood plains to urban development and agriculture have accentuated the intensity of floods.

India with 2.4% of the world's total area has 16% of the world's population; but has only 4% of the total available fresh water. This clearly indicates the need for water resource development, conservation, and optimum use.

Objectives /Importance of Irrigation

The importance of irrigation in the world is well stated by N.D. Gulhati of India:

"Irrigation in many countries including India is an age-old art – as old as civilization – but for the whole world it is a modern science – science of survival".

The broad objectives of irrigation are as follows:

a) To increase crop production on sustainable basis where water is a limitation

- To increase national income/national cash-flow
- To increase labour employment
- To increase standard of living

b) Modification of soil & climatic environment

- For leaching of salts
- For reclamation of sodic soils
- For frost protection

c) To mitigate i.e., lessen the risk of catastrophes caused by drought

- To overcome food shortages
- To protect high value crops/trees

d) To increase population of arid and sparsely populated areas

- For national defence
- For population re-distribution

e) National security i.e., self-sufficiency in food grain production

1) To supply the moisture essential for plant growth.
2) For better utilization of production factors. (Nutrients)
3) To provide crop insurance against short spells of drought.
4) To dilute/washout soluble salts
5) To soften tillage pans
6) Intensive cropping is made possible
7) Timely seedbed preparation and timely sowing.
8) To create favourable microclimate for crop growth.
9) Higher yields as well as stability in production

Method of irrigation

Depending on soil type slope source of irrigation water, nature of crop methods differs.

1. Surface methods of irrigation
   a) Flooding
   b) Boarder strip
   c) Corrugations
   d) Check basin
   e) Ridge and furrow
   f) Ring or basin
2. Sub- surface methods
3. Sprinkler – system.
4. Drip/trickle irrigation.
5. Quantity of irrigation water depends on rooting depth and water holding capacity of soil.

6. Irrigation water can be quantified through weirs, flumes, orifices, water meters etc.

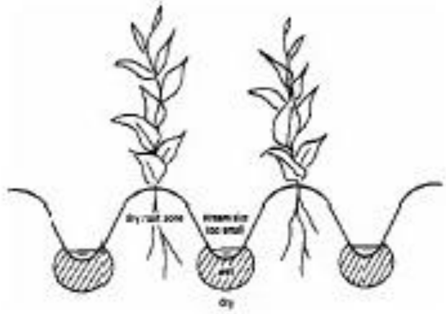


Fig 13.1 Ridge and Furrow method

Fig:13.2 Sprinkler Nozzle

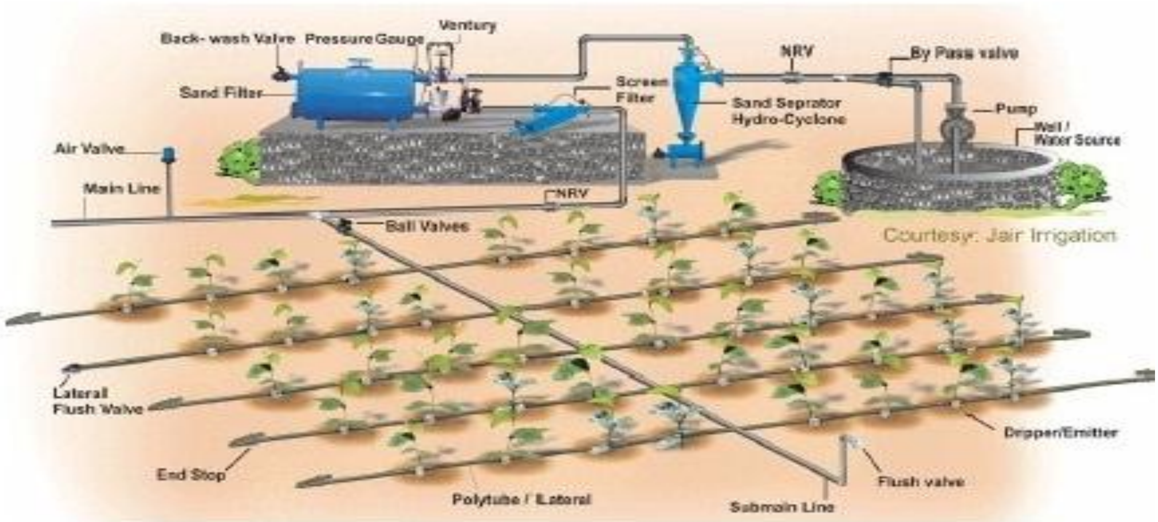


Fig:13.3 Drip Irrigation System

Types of irrigation – (classification)

1. Flood
2. Surface
3. Sub surface
4. Sprinkle
5. Drip irrigation.

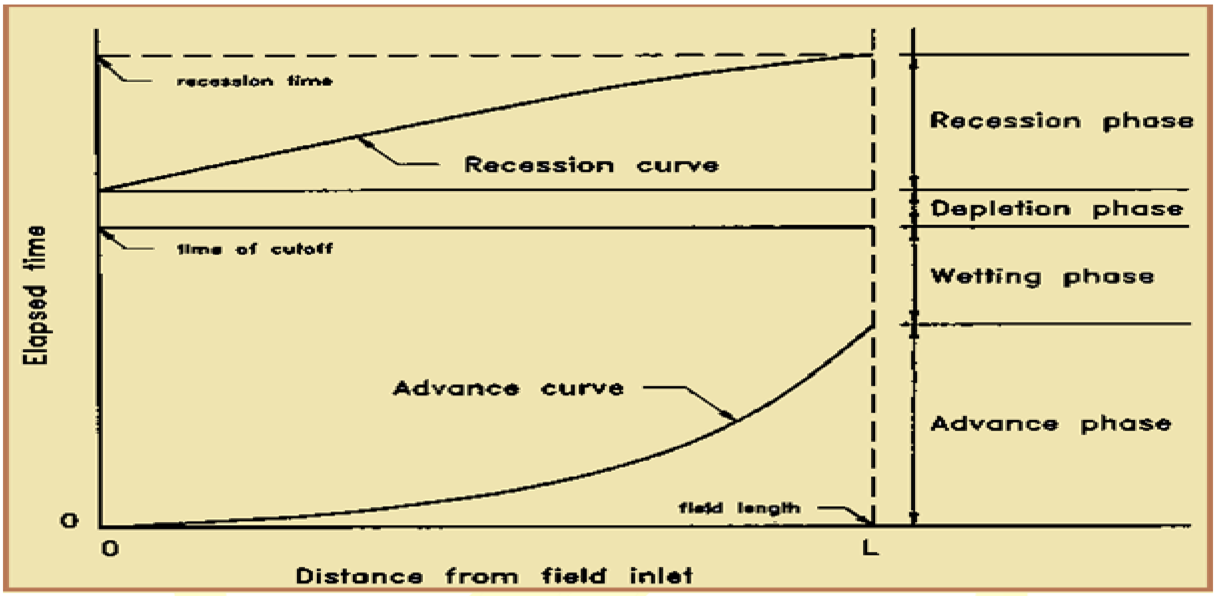
Surface irrigation: Water is applied directly to the soil from channel located at upper ridge of the field proper land preparation adequate control of water is necessary for uniform distribution of water border. The entire field is divided into strips separated by low ridge of the strip to lower in form of sheet guided by the low ridges. Border should have uniform gentle slope in direction of irrigation. Each strip is independently by turning stream of water at upper ridge. Suitability-suitable for close growing crops some row crop & orchards under favourable soil & topographic condition. Not recommended for extremely low or extremely high infiltration rate soils.

Advantage:

1. Easy construct & operate
2. Person can irrigation more compares to check basin.
3. If properly designed use uniform distribution & high water use efficiency.
4. Large streams can be effectively used.
5. If can provide excellent drainage (surface) if have proper outlet facility at the lower end.

Disadvantages:

1. Required precise land levelling
2. Required large irrigation streams.

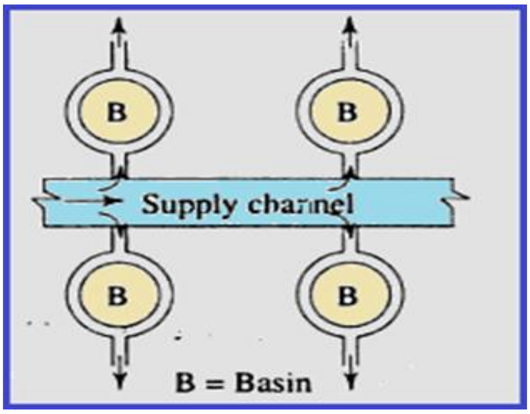


Check basin:

It is used in extreme condition of soil. It is well known method generally used for heavy soils with low infiltration rate or high permeable soil like deep sand. Used for orchards grain & folder production.

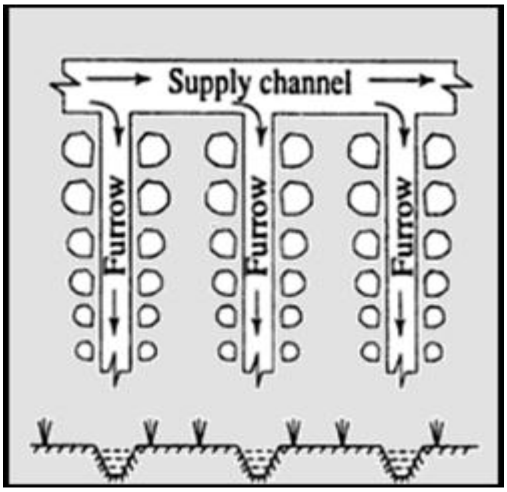
Disadvantages:

1. Labour requirement for land preparation is high.
2. Operation cost is more.
3. The ridges cause hindrances to implements by field operations.



Furrow method:

Furrow is preferably used for row crops like maize, sugarcane, potato, groundnut & other vegetable crops. Water is applied in small furrows beture oil the row crops. Water infiltrated into soil & spread within the root zone. Large as well as small sized stream can be effectively used for irrigation. It also acids for safe disposal of excess water i.e. facilitates drainage. Only 1/5 to ½ of land surface is in contact with water (wet). There by reducing the evaporation losses. Method is specially situated to crops like maize which are sensitive to water in contact with their strength. The cost of land preparation is reduced & there is no wastage of land under field channels. In clay or deep clay soils shadow furrow are made along with guiding ridge to take care of soil cracking behaviour such furrow are called corrugated furrow.



Subsurface irrigation: Water is applied below the ground surface by maintaining artificial water table at some depth depends upon the soil characteristic & root zone of crop. Water moves through capillaries within soil to meet plant requirement deep trenches & underground piper are the two ways for sub-surface irrigation.

Adaptability: Soils having low W.H.C. soil having very high-high infiltration rate. Soils surface method is not possible where sprinkle method of irrigation proves to be expensive.

Advantage:

1) Evaporative losses are minimum.

Disadvantage:

1) Salty water cannot be used.

Sprinkler Irrigation: In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed.

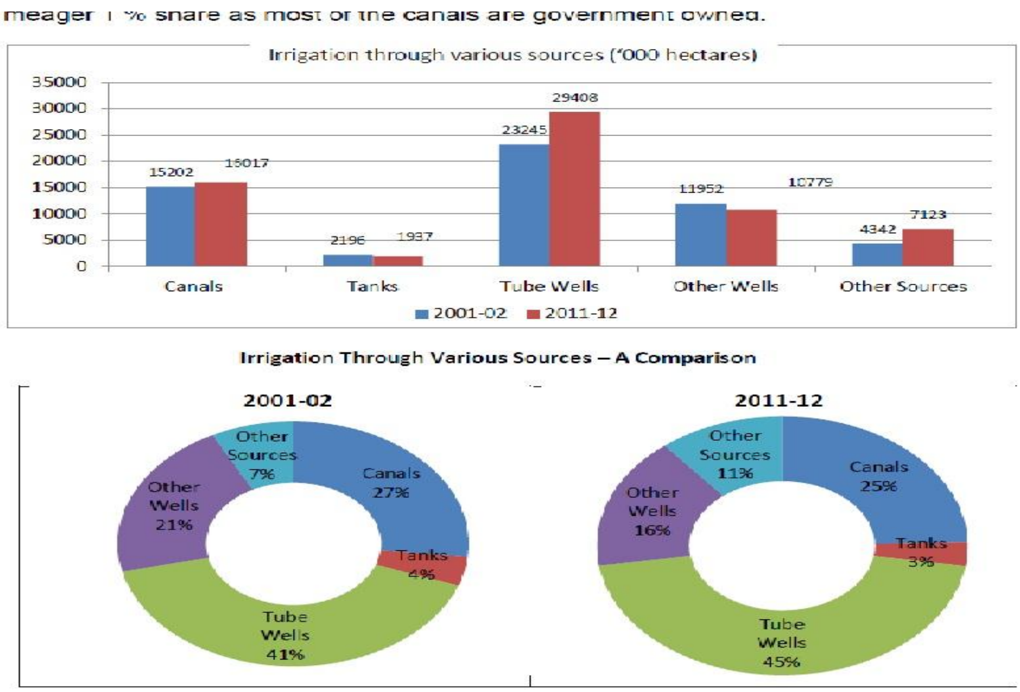
Risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.

Sub-irrigation:

Sub-irrigation also sometimes called seepage irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table. Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling

Sources of Irrigation:

Various sources of irrigation in India are canals, tanks, tube wells and other wells with tube wells and canals accounting for about 70 % of total irrigation. Compared to 2001-02, irrigation through both canals and tube wells has shown an increasing trend whereas that through tanks and other wells has shown a decline. Even in the case of irrigation through canals and tube wells, while irrigation through tube wells has increased by about 27 % since 2001-02 that through canals has increased only marginally (about 5%). Private canals comprise a meagre 1 % share as most of the canals are government owned.



Water Requirement of Crop:

Water requirement of crop is the quantity of water regardless of source, needed for normal crop growth and yield in a period of time at a place and may be supplied by precipitation or by irrigation or by both.

Water is needed mainly to meet the demands of evaporation (E), transpiration (T) and metabolic needs of the plants, all together is known as consumptive use (CU). Since water used in the metabolic activities of plant is negligible, being only less than one percent of quantity of water passing through the plant, evaporation (E) and transpiration (T), i.e. ET is directly considered as equal to consumptive use (CU). In addition to ET, water requirement (WR) includes losses during the application of irrigation water to field (percolation, seepage, and run off) and water required for special operation such as land preparation, transplanting, leaching etc.

WR = CU + application losses + water needed for special operations.

Water requirement (WR) is therefore, demand and the supply would consist of contribution from irrigation, effective rainfall and soil profile contribution including that from shallow water tables (S)

WR = IR + ER + S

Under field conditions, it is difficult to determine evaporation and transpiration separately. They are estimated together as evapotranspiration (ET). IR is the irrigation requirement.

Factors influencing Evapotranspiration (ET): ET is influenced by atmospheric, soil, plant and water factors.

A) Atmospheric factors:

1) Precipitation
2) Sunshine
3) Wind velocity
4) Temperature
5) Relative humidity

B) Soil factors:

1) Depth of water table
2) Available soil moisture
3) Amount of vegetative cover on soil surface.

C) Plant factors:

1) Plant morphology
2) Crop geometry
3) Plant cover
4) Stomatal destiny
5) Root depth

D) Water factors: 1) Frequency of irrigation 2) Quality of water ET.

Water requirement of any crop depends on crop factors such as variety, growth stage, and duration of plant, plant population and growing season. Soil factors such as temperature, relative humidity, wind velocity and crop management practices such as tillage, fertilization, weeding, etc. Water requirement of crops vary from area to area and even field to field in a farm depending on the above-mentioned factors.

Estimation of Evapotranspiration (ET):

Climate is the most important decides the rate of ET. Several empirical formulas are available to estimate ET from climate date. FAO expert group of scientists has recommended four methods for adoption of different regions of world.

1) Blaney and Criddle method
2) Radiation method
3) Pan evaporation method
4) Modified penman method

Estimation of ET Involves Three Important Steps:

a) Estimation of PET or evapotranspiration (ET) by any four above methods.
b) Estimation of crop co-efficient (KC) and
c) Making suitable adjustments to local growing conditions.

a) Reference Evapotranspiration (ETO): ETO can be defined as the rate of evapotranspiration of an extended surface of an 8 to 15 cm tall, green cover, actively growing completely shading the ground and not short of water.

Selection of a method for estimation of ETO depends on availability of metrological data and amount of accuracy needed. Among four methods for estimation of ETO, modified Blaney-Criddle method is simple, easy to calculate and requires data on sunshine (S.S.) hours, wind velocity (WV), relative humidity (RH) in addition to temperature (T).

Among these methods, modified penman method is more reliable with a possible error of 10% only. The possible errors for other methods are 15, 20 and 25% of pan evaporation, radiation and modified Blaney-Criddle methods respectively.

Modified Blaney method:

ETO = C [P (0.46 T + 8)] mm/day
Where ETO = Reference crop ET in mm/day for the month considered
T = Mean daily temperature in oC over the month considered
P = Mean daily percentage of total annual day time hours of a given month and latitude (from standard table)
C = Adjustment factor depends on minimum R.H., Sunshine hours and day time wind estimates.

Pan evaporation method:

ETO = Kp | Epan Where Kp = Crop factor
Epan = mean pan evaporation (Epan pan evaporation)

Modified penman method:

ETO = C [W.Rn + (1-w). f (U). (ea – ed)]
Where Rn = Net radiation in equivalent evaporation expressed as mm/day
W = temperature of altitude related factor
F (U) = Wind related function
Ea – ed= Vapour pressure deficit (mili bar)
C = the adjustment factor (ratio of U day to U night)
Rn (0.75-Rns)

Ea =Saturated vapour pressure (m.bar)
Ed = Mean actual vapour pressure of the air (m. bar)

Crop Coefficient:

Crop co-efficient is the ratio between evapotranspiration of crop (Etc) and potential evapotranspiration and expressed as T (crop) = Kc X ETo

Irrigation requirement:

Irrigation requirement is the total quantity of water applied to the land surface in supplement to the water supplied through rainfall and soil profile to meet the water needs of crops for optimum growth.

IR = WR – (ER + S)

Net irrigation requirement:

The net irrigation requirement is the amount of irrigation water just required to bring the soil moisture content in the root zone depth of the crops to field capacity. Thus, net irrigation requirement is the difference between the field capacity and soil moisture content in the root zone before application of irrigation water.

Gross irrigation requirement: The total amount of water inclusive of water in the field applied through irrigation is termed as gross irrigation requirement, which in other words is net irrigation requirement plus application and other losses.

Consumptive use of water:

Sr. No	Crop	Consumptive Use (cm)	Place
1	Jawar (Rabi)	450	Pune
2	Wheat	550	Pune
3	Sugarcane (Suru)	2500	Padegoan
4	Sugarcane (Adsali)	3300	Padegoan
5	Groundnut	560	Pune
6	Gram	250	Rahuri
7	Sunflower	350	Rahuri

Irrigation requirement of some common crops grown in India:

Crop	Growing Period (No. of days)	Total Water Requirement		Daily Water Requirement	
		in cm	in inches	in cm	in inches
Jawar	114	64.25	25.70	0.575	0.23
Maize	100	44.50	17.80	0.450	0.18
Rice	93	104.50	41.80	1.075	0.43
Wheat	88	37.00	14.80	0.425	0.17
Groundnut	124	65.25	26.10	0.525	0.21
Linseed	88	31.71	12.68	0.350	0.14
Cotton	202	105.50	42.20	0.525	0.21
Sugarcane	365	237.50	95.00	0.650	0.26
Tobacco	132	98.00	39.20	0.750	0.30
Onion	120	75.00	30.00	0.625	0.25
Potato	88	30.00	12.00	0.750	0.30
Pea	88	30.00	12.00	0.350	0.14

Mustard	88	25.20	10.08	0.300	0.12
Barley	88	25.20	10.08	0.400	0.16
Oat	88	36.00	14.40	0.400	0.16
Ragi	127	74.50	29.80	0.575	0.23

COMMAND AREA DEVELOPMENT

The Command Area Development (CAD) programme was initiated in 1974-75 with a view to bridge the gap between the potential created and its utilisation and optimising agricultural productivity through better management of land and water use in the command areas served by selected major and medium irrigation projects. The programme presently covers 226 projects with a total culture able command area of 21.95 million hectares spread over 23 States and 2 Union Territories and administered through 55 CAD authorities. From the inception of the programme in 1974-75, up to March, 1998 an amount of Rs.1807 crore has been released to the States as Central assistance under the CAD programme. On the basis of shortcomings, as found during the implementation of this programme over last two decades, it is being reoriented, based on Evaluation Studies, so as to make it more effective instrument for ensuring speedy transit to irrigated agriculture along with optimising the water use efficiency.

Plan Outlays and Expenditure The Table 6.2.3 given below indicates the Plan outlays and expenditure in the Central and State Sectors for Command Area Development Programme during the Ninth Plan.

TABLE 6.2.3
Plan Outlays And Expenditure

(Rs. crore)

Year	Central Sector		State Sector	
	Approved Outlay	Actual/Anticipated Expenditure	Approved Outlay	Actual/Anticipated Expenditure
Ninth Plan	860.00		2027.19	
1997-98	141.00	129.96	371.35	360.19
1998-99	188.00	175.32	348.48	303.60
1999-2000	177.00	160.07	315.31	312.13
2000-01	160.88	--	NA	

The physical position of this programme is given in the following Table 6.2.4:

TABLE 6.2.4
Achievement On CAD Activities (Mill. Ha.)

Items	Achiv. Till March 1992	Achiv. 1992-93 to 1996-97	Achiv. 1997-98	Antcpt. Achiv. 1998-99	Target 1999-2000	Antcd. Achiv 1999-2000	Cummu-lative achiv. Upto March 2000
Field Channels	12.19	1.76	0.32	0.32	0.32	0.15	14.74
Warabandi	6.12	2.52	0.42	0.33	0.29	0.11	9.50
Land Levelling	1.99	0.10	0.01	0.02	0.03	0.02	2.14
Field Drains	0.58	0.19	0.03	0.06	0.09	0.02	0.88

Greater stress is being laid on better and efficient management of the water distribution system, more efficient and timely on farm water delivery, training of field staff and farmers and involvement of farmers under the command area in the management of water distribution system below the outlet level. Reclamation of waterlogged areas is another item now included under the programme

Programme for 2000-01

- The programme will be continued during 2000-01. Greater thrust needs to be given for Land Consolidation as a pre-requisite for optimal water use efficiency. Close monitoring and evaluation of the projects is being emphasised both at the Centre and State level by suitably strengthening the concerned organisations wherever necessary. An amount of Rs.160.88 crore has been provided in the Central Sector for Annual Plan 2000-01.

- In order to assess the implementation and impact of ongoing centrally sponsored Command Area Development Programme in terms of the objectives and its quantification, the Planning Commission has emphasised the need for comprehensive evaluation of the CAD programme. Accordingly, evaluation of 18 CAD projects had been awarded by MOWR. Most of the reports have been submitted to the MOWR. The major findings are as under :
    - Enforcement of Warabandi has helped in equitable distribution of water among farmers and in improving utilisation of irrigation potential as well as agricultural productivity.
    - The extension service support has been considered very important to help the farmers in their decision making in switching over from dry land crops to irrigated crops.
    - Suitable cropping pattern and improved variety of crops having better water efficiency have been introduced in many irrigation projects replacing no remunerative crops.
    - The major constraints for ground water development includes small and fragmented holdings, poor economic status of farmers, cumbersome institutional financial support and poor supply of electricity and diesel to operate pump sets, availability of inadequate subsidy to farmers.
    - For achieving efficiency in irrigation, emphasis have to be given to the maintenance of the system.

Water conservation Techniques

Primary source of water in India is south-west and north-east monsoons. Monsoon, however, is erratic and as you have already studied the duration and the amount of rain fall is highly variable in different parts of our country. Hence, surface runoff needs be conserved. The techniques for conservation of surface water are:

(a) Conservation by surface water storage

Storage of water by construction of various water reservoirs have been one of the oldest measures of water conservation. The scope of storage varies from region to region depending on water availability and topographic condition. The environmental impact of such storage also needs to be examined for developing environment friendly strategies.

(b) Conservation of rain water

Rain water has been conserved and used for agriculture in several parts of our country since ancient times. The infrequent rain if harvested over a large area can yield considerable amount of water. Contour farming is an example of such harvesting technique involving water and moisture control at a very simple level. It often consists of rows of rocks placed along the contour of steps. Runoff captured by these barriers also allows for retention of soil, thereby serving as erosion control measure on gentle slopes. This technique is especially suitable for areas having rainfall of considerable intensity, spread over large part i.e. in Himalayan area, north east states and Andaman and Nicobar Islands. In areas where rainfall is scanty and for a short duration, it is worth attempting these techniques, which will induce surface runoff, which can then be stored.

(c) Ground water conservation

Attributes of groundwater

- There is more groundwater than surface water.
- Groundwater is less expensive and economic resource and available almost everywhere
- Groundwater is sustainable and reliable source of water supply.
- Groundwater is relatively less vulnerable to pollution.
- Groundwater is a free of pathogenic organisms.
- Groundwater needs little treatment before use.
- There is no **conveyance losses** in underground based water supplies.
- Groundwater has low vulnerability to drought.
- Groundwater is the key to life in arid and semi-arid regions.
- Groundwater is source of dry weather flow in some rivers and streams.

As highlighted earlier, out of total 4000 BCM (billion cubic meters) precipitation that occurs in India, about 45 mhan (million hectares meters) percolates as ground water flow. It may not be possible to tap the entire ground water resources. The ground water potential is only 490 BCM. As we have limited ground water available, it is very important that we use it economically and judiciously and conserve it to the maximum. Some of the techniques of ground water management and conservation are described below.

(i) Artificial recharge

In water scarce areas, there is an increased dependence on ground water. The water table declines quickly due to low and erratic rainfall. The only alternative is to replenish the ground water by artificial means. As you have studied in the previous lesson, there are various techniques to develop and manage ground water artificially. In one of the methods, water is spread over ground to increase area and length of time for water to remain in contact with soil. So as to allow maximum possible opportunity for water to enter into the ground. Try to recollect the other methods of recharging ground water.

(ii) Percolation tank method

Percolation tanks are constructed across the water course for artificial recharge. The studies conducted in a Maharastra indicates that on an average, area of influence of percolation of 1.2 km2, the average ground water rise was of the order of 2.5 m and the annual artificial recharge to ground water from each tanks was 1.5 hec m.

(d) Catchment area protection (CAP)

Catchment protection plans are usually called **watershed protection** or management plans. These form are an important measure to conserve and protect the quality of water in a watershed. It helps in withholding runoff water albeit temporarily by a **check bund**

Constructed across the streams in hilly terrains to delay the run off so that greater time is available for water to seep underground. Such methods are in use in north-east states, in hilly areas of tribal belts. This technique also helps in soil conservation. Afforestation in the catchment area is also adopted for water and soil conservation.

e) Inter-basin transfer of water

A broad analysis of water and land resources and population statistics of various river basins in our country reveals that areas in western and peninsular regions have comparatively low water resources/cultivable land ratio. Northern and eastern region which are drained by Ganga and Brahmaputra have substantial water resources. Hence, the scheme of diverting water from region with surplus water to water deficit region can be adopted Ganga- Cauveri link would enable to transfer of vast quantities of Ganga basin flood water running out to sea, to west and south west India. The transfer of the surplus Ganga water would make up for the periodical shortage in Sone, Narmada, Godaveri, Krishna and Cauveri. The National Grid Commission envisages diversion of part of the surplus discharge in the Ganga near Patna during the high flood period.

(f) **Adoption of drip sprinkler irrigation**

Surface irrigation methods, which are traditionally used in our country, are unsuitable for water scarce areas, as large amount of water is lost through evaporation and percolation. Drip irrigation is an efficient method of irrigation in which a limited area near the plant is irrigated by dripping water. It is suitable method for any area and especially for water scarce areas. This method is particularly useful in row crop. Similarly sprinkler method is also suitable for such water scarce areas. About 80% water consumption can be reduced by this method, whereas the drip irrigation can reduce water consumption by 50 to 70 %.

(g) **Management of growing pattern of crops**

In water scarce areas, the crop selection should be based on efficiency of the crop to utilize the water. Some of the plants suitable for water scarce areas are
(i) Plants with shorter growth period;
(ii) High yielding plants that require no increase in water supply;
(iii) Plants with deep and well trenched roots and
(IV) Plants which cannot tolerate surface irrigation.

(h) **Reducing evapotranspiration**

Evapotranspiration losses can be reduced by reducing the evaporation from soil surface and transpiration from the plants, in arid zones, considerable amount of water is lost in evaporation from soil surface. This can be prevented by placing water tight moisture barriers or water tight mulches on the soil surface. Non-porous materials like papers, asphalt, plastic foils or metal foils can also be used for preventing evaporation losses. Transpiration losses can be reduced by reducing air movement over a crop by putting wind breaks and evolving such types of crops which possess xerophytic adaptations.

(i) **Reducing evaporation from various water bodies**

The quantity of water lost through evaporation is very high in many areas in our country. It is estimated that 10000 hectares of land loses about 160mm3 of water each year. The water losses through evaporation from storage tanks, reservoirs, irrigation tanks, rivers and canals reduce the water available for various uses. The methods that reduce evaporation from water bodies are- installing wind breaks, reducing energy available for evaporation, constructing artificial aquifers, minimizing exposed surface through reservoir regulation, reducing ratio of area/volume of water bodies, locating reservoirs at higher altitudes and applying monomolecular firms.

(j) **Recycling of water**

The wastewater from industrial or domestic sources can be used after proper treatment, for irrigation, recharging ground water, and even for industrial or municipal use. If agricultural lands are available close to cities, municipal waste water can be easily used for irrigation.

Micro Irrigation

Drip irrigation, also known as trickle irrigation or micro irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer.

Major, Medium, Minor Irrigation

Irrigation works have been classified as major, medium and minor, depending on their culturable command area.

1. Major Irrigation:
Culturable command area (CCA) more than 10,000 hectares.

2. Medium Irrigation:
Culturable command area more than 2,000 hectares but less than 10,000 hectares.

3. Minor Irrigation:
Culturable command area up to 2,000 hectares.

All groundwater and surface water schemes having culturable command area upto 2000 ha individually are classified as minor irrigation schemes. Minor surface water flow irrigation projects comprising storage, diversion works and surface lift irrigation schemes occupy a prominent place in the scheme of irrigated agriculture particularly in the undulating areas south of the Vindhyas and the hilly regions. Minor Irrigation Schemes are labour intensive, provide employment to rural population and check their migration to urban areas. They also help in raising the standards of living of rural population and bring them above the poverty line. Such schemes are quick maturing and the benefit from the schemes starts flowing with a very small gestation period. Generally, the schemes are installed in a maximum of two to three years.

The minor irrigation schemes are funded from plan funds, institutional finance and private investments by the farmers. It is generally considered as a people's programme as the plan funds form only a small portion of the total investment for its development.

Institutional investment for minor irrigation

Institutional finance plays an important role in the implementation of Minor Irrigation schemes. The Land Development Banks, State Cooperative Banks, Commercial Banks and NABARD provide credit facilities to the farmer and institutions for development of Minor Irrigation facilities. Institutional finance by NABARD for minor irrigation schemes has been decreasing over the last 3 years. The total credit refinanced by NABARD for minor irrigation has decreased from Rs.795.32 crore in 1995-96 to Rs.477.91 crore in 1997-98. In addition, the institutional investment being provided under the normal programme by the Land Development banks/cooperative banks has decreased from Rs.37.29 crore in

1995-96 to Rs.10.72 crore during the year 1997-98. In order to find out the reasons for decline in credit disbursement, a meeting was held on 12th July, 1999 in the Ministry of Water Resources. During the meeting it was pointed out by several cooperative banks that the meetings of the Unit Cost Committee set up by NABARD are not held on regular basis. Since the unit cost has not been revised, the lending for minor irrigation sector has reduced. It was also pointed out that in many cases the ground water availability report, as given by State Ground Water Board, is not updated but in several cases found to be inaccurate. It was decided that as the Central Ground Water Board is operating more that 13000 observation wells in the country and the Board regularly conduct a studies regarding water availability as well as its behaviour in different parts of the country. The same may be used for the purpose of providing financial assistance for the minor irrigation sector. It was also noted that late approvals by NABARD contribute towards delaying grants of credit for minor irrigation sector. There was a general consensus that the eligibility conditions for institutional finance for minor irrigation should be less restricted. There has been a decline in institutional finance due to persisting default by some States as the recovery level, is very low in these States. The Ministry of Water Resources is taking steps to remove the above problems and ensuring that the credit disbursement provided by NABARD and State cooperative banks for minor irrigation sector does not decline.

The salient features of Minor Irrigation Programme are:

- To ensure adequate provision of funds for the externally aided projects according to the schedule of disbursement;
- To ensure prioritisation for on-going schemes;
- Stepping up the institutional investment to the extent possible including subsidy to small & marginal farmers and other weaker sections;
- Stepping up ground water development, especially in the Eastern and North- Eastern States;
- Encouraging minor irrigation programme for tribal, backward, drought-prone areas and areas having pre-dominantly scheduled caste and scheduled tribe farmers by establishing effective coordination as well as by dovetailing if possible all ongoing programmes/schemes like employment generation schemes etc. under various Ministries.
- Encouraging schemes utilising non-conventional sources of energy like hydrums etc.,
- In water scarce and drought prone areas, the use of sprinkler/drip irrigation system as a water saving device as well as for efficient use of water for productivity should be encouraged.
- To improve the utilisation of public tube wells and their rehabilitation along with turning over to beneficiary farmers for O&M.

Whereas major and medium irrigation works are meant for tapping surface water (e.g., rivers), minor irrigation mainly involves ground water development, e.g., tube-wells, boring works, etc.

Drainage: Removal of excess water from the surface or below the surface of the soil so as to create favourable conditions for plant growth.

Causes of Water Logging

a. Intensive rains
b. Floods
c. Soil slope
d. Bunds
e. Defective irrigation
f. Seepage from unlined canals.

Effects of ill drained conditions

a. Lack of accretion of soil.
b. Restricted root growth and lodging problems
c. Difficulty in tillage.

1. Increase in salinity in top layers of soil.
   All crops including rice require well drained conditions.
   Crops like maize mustard are very sensitive to water logging or ill drainage even for a short Period. Mid-season drainage is important in rice.

2. Drainage can be surface drainage (or) Sub surface drainage.

Benefits of drainage

1. Helps in soil ventilation/accretion
2. Facilitates timely tillage operations.
3. Better and healthy root growth.
4. Favours growth of soil microorganism (better mineralization)
5. Warming up for optimum soil temperature maintenance.
6. Promotes leaching and reduce logging.
7. Improves anchorage and reduce lodging.
8. Improves soil structure and decrease soil erosion.
9. Improves sanitary and health conditions and makes rural life happy.

Definitions & Terms used in Irrigation

- **Hydroscopic Water:** That water is adsorbed from an atmosphere of water vapour because of attractive forces in the surface of particles.
- **Hysteresis:** It is the log of in one of the two associated process or phenomena during reversion.
- **Indicator Plant:** It is the plant, which reflects specific growing condition by its presence or character of growth.
- **Infiltration Rate:** It is the maximum rate at which a soil under given condition and at given time can absorb water when there is no divergent flow at borders
- **Intake Rate or Infiltration Velocity:** It is the rate of water entry into the soil expressed as a depth of water per unit area applicable or divergence of flow in the soil.
- **Irrigation Requirement:** It refers to the quantity of water, exclusive of precipitation, required for crop production. This amounts to net irrigation requirement plus other economically avoidable losses. It is usually expressed in depth for given time.
- **Leaching:** It is removal of soluble material by the passage of water through the soil.
- **Leaching Requirement:** It is the fraction of water entering the soil that must pass through the root zone in order to prevent soil salinity from exceeding a specific value.
- **Oasis effect:** It is the exchange of heat whereby air over crop is cooled to supply heat for evaporation.
- **Percolation:** It is the down word movement of water through the soil.
- **Permanent Wilting Point (PWP):** Permanent wilting point is the moisture content in percentage of soil at which nearly all plants wilt and do not recover in a humid dark chamber unless water is added from an outside source. This is lower limit of available moisture range for

plant growth ceases completely. The force with which moisture is held by dry soil this point corresponds to 15 atmospheres.

- **Permeability:** Permeability is the property of a porous medium to transmit fluids It is a broad term and can be further specified as hydraulic conductivity and intrinsic permeability.
- **PF:** It is the logarithm of height in cm of column of water which represents the total stress with which water is held by soil.
- **PH:** It is the negative logarithm of hydrogen ion concentration.
- **Potential Evaporation:** It represents evaporation from a large body of free water surface. It is assumed that, there is no effect of addictive energy .It is primarily a function of evaporative demand of climate.
- **Potential Evapo-transpiration:** It is the amount of water evaporated in a unit time from short uniform green crop growing actively and covering an extended surface and never short of water. Penman prefers the term potential transpiration.
- **Seepage:** It is the water escaped through the soil under gravitational forces.
- **Agricultural Drainage:** It is removal of excess water known as free or ravitational water from the surface or below the surface of farm land to create favorable condition for proper growth and development of the plot.
- **Surface Drainage:** when the excess water saturates the pores spaces removal of water of water by downward flow through the soil is called subsurface drainage.

The Flash's

Articles

For

NABARD Gr. A & B

By:- Gaurav(The Flash)

#4

Farm and Agriculture Engineering

Farm and Agriculture Engineering

Farm power

Various types of agricultural operations performed on a farm can be broadly classified as: 1. Tractive work – such as seed bed preparation, cultivation, harvesting and transportation. 2. Stationary work- such as silage cutting, feed grinding, threshing, winnowing and lifting of irrigation water.

These operations are done by different sources of power, namely human, animal, mechanical power (oil engines and tractors), electrical power and renewable energy (solar energy, biogas, biomass and wind energy).

Human power

Human beings are the main sources of power for operating small tools and implements at the farm. They are also employed for doing stationary work like threshing, winnowing, chaff cutting and lifting irrigation water. Of the total rural population in India, only 30% is available for doing farm work. The indications are that the decline in number of labourers employed for agriculture. On an average, a man develops nearly 0.1 horse power (hp).

Advantages: Easily available and used for all types of work.

Disadvantages: Costliest power compared to all other farms of power, very low efficiency, requires full maintenance when not in use and affected by weather condition and seasons.

Animal power

The most important source of power on the farm all over the world and particularly in India is animal. It is estimated that, nearly 80% of the total draft power used in agriculture throughout the World is still provided by animals. India is having 22.68 crore cattle, which is the highest in the World. Mainly, bullocks and buffaloes happen to be the principle sources of animal power on Indian farms. However, camels, horses, donkeys and elephants are also used for the farm work. The average force a bullock can exert is nearly equal to one tenth of its body weight. Power developed by an average pair of bullocks is about 1 hp for usual farm work.

Advantages:

1. Easily available.
2. Used for all types of work.
3. Low initial investment.
4. Supplies manure to the field and fuels to farmers.
5. Live on farm produce.

Disadvantages:

1. Not very efficient.
2. Seasons and weather affect the efficiency.
3. Cannot work at a stretch.
4. Require full maintenance when there is no farm work.
5. Creates unhealthy and dirty atmosphere near the residence.
6. Very slow in doing work.

Mechanical power

It is available through tractors, power tillers and oil engines. The oil engine is a highly efficient device for converting fuel into useful work. The efficiency of diesel engine varies between 32 and 38%, whereas that of the carburettor engine (Petrol engine) is in the range of 25 and 32%. In recent years, diesel engines, tractors and power tillers have gained considerable popularity in agricultural operations. It is estimated that, about one million tractors of 25 hp range are in use for various agricultural operations in India. Similarly, total number of oil engines of 5 hp for stationery work is 60 lakhs. Normally, stationery diesel engines are used for pumping water, flour mills, oil ghanis, cotton gins, chaff cutter, sugarcane crusher, threshers and winnowers etc.,

Advantages: Efficiency is high; not affected by weather; cannot run at a stretch; requires less space and cheaper form of power

.

Disadvantages: **I**nitial capital investment is high; fuel is costly and repairs and maintenance needs technical knowledge.

Electrical power

Now-a- day's electricity has become a very important source of power on farms in various states of the country. Electrical power is used mostly for running electrical motors for pumping water, dairy industry, cold storage, farm product processing, and cattle feed grinding. It is clean source of power and smooth running. The operating cost remains almost constant throughout its life. Its maintenance and operation need less attention and care. On an average, about 1/10th of the total electrical power generated in India, is consumed for the farm work, approximately it is 4600 megawatt.

Advantages: Very cheap form of power; high efficiency; can work at a stretch; maintenance and operating cost is very low and not affected by weather conditions.

Disadvantages: Initial capital investment is high; require good amount of technical knowledge and it causes great danger, if handled without care,

Renewable energy

It is the energy mainly obtained from biomass; biogas, solar and wind are mainly used in agriculture for power generation and various agricultural processing operations. It can be used for lighting, power generation, water heating, drying, greenhouse heating, water distillation, refrigeration and diesel engine operation. This type of energy is inexhaustible in nature. The availability of wind energy for farm work is quite limited. Where the wind velocity is more than 32 kmph, wind mills can be used for lifting water. Main limitation for this source is uncertainty. Average capacity of a wind mill would be about 0.5 hp. There are about 2540 windmills in India. It is the cheapest sources of farm power available in India.

Renewable sources of energy: Energy sources which are continuously and freely produced in the nature and are not exhaustible are known as the renewable sources of energy. Eg: solar energy, biomass and wood energy, geo thermal energy, wind energy, tidal energy and ocean energy. But main attention has to be directed to the following sources of renewable namely,

a) solar photovoltaic,
b) wind, and
c) hydrogen fuel cell.

Advantages of renewable energy

a) These sources of energy are renewable and there is no danger of depletion. These recur in nature and are in-exhaustible.

b) The power plants based on renewable sources of energy don‟t have any fuel cost and hence negligible running cost.

c) Renewable are more site specific and are used for local processing and application. There is no need for transmission and distribution of power.

d) Renewables have low energy density and more or less there is no pollution or ecological balance problem.

e) Most of the devices and plants used with the renewables are simple in design and construction which are made from local materials, local skills and by local people. The use of renewable energy can help to save foreign exchange and generate local employment.

f) The rural areas and remote villages can be better served with locally available renewable sources of energy. There will be huge savings from transporting fuels or transmitting electricity from long distances.

Disadvantages of renewable energy

a) Low energy density of renewable sources of energy need large sizes of plant resulting in increased cost of delivered energy.

b) Intermittency and lack of dependability are the main disadvantages of renewable energy sources.

c) Low energy density also results in lower operating temperatures and hence low efficiencies.

d) Although renewables are essentially free, there is definite cost effectiveness associated with its conversion and utilization.

e) Much of the construction materials used for renewable energy devices are themselves very energy intensive.

f) The low efficiency of these plants can result in large heat rejections and hence thermal pollution.

g) The renewable energy plants use larger land masses.

New sources of energy:

The new sources of energy is available for local exploitation. In many cases, autonomous and small power plants can be built to avoid transmission losses. Most prominent new sources of energy are tidal energy, ocean waves, OTEC, peat, tar sand, oil shales, coal tar, geo thermal energy, draught animals, agricultural residues etc., The total energy production in India is 14559×1015 joules. 93% of India‟s requirement of commercial energy is being met by fossil fuels, with coal contributing 56%, and oil and natural gas contributing 37%. Water power and nuclear power contributing only 7% of total energy production. Comparing the total energy production in India from commercial sources with that of world, it is only 3.5% of total world production.

Biomass

Plant matter created by the process of photosynthesis is called biomass (or) all organic materials such as plants, trees and crops are potential sources of energy and are collectively called biomass. Photosynthesis is a naturally occurring process which derives its energy requirement from solar radiation. The plants may be grown on land (terrestrial plants) or grown on water (aquatic plants). Biomass also includes forest crops and residues after processing. The residues include crop residues (such as straw, stalks, leaves, roots etc.,) and agro-processing residues (such as oilseed shells, groundnut shells, husk, bagasse, molasses, coconut shells, saw dust, wood chips etc.,). The term biomass is also generally understood to include human waste, and organic fractions of sewage sludge, industrial effluents and household wastes. The biomass sources are highly dispersed and bulky and contain large amounts of water (50 to 90%). Thus, it is not economical to transport them over long distances, and conversion into usable energy must takes place close to source, which is limited to particular regions.

Availability of biomass

The total terrestrial crop alone is about 2 × 1012 metric tones. These include sugar crops, herbaceous crops and silviculture plants. The terrestrial crops have an energy potential of 3 × 1022 joules. At present only 1% of world biomass is used for energy conversion. The estimated

Production of agricultural residue in India is 200 million tonnes per year and that of wood is 130 million tonnes. At an average heating value of 18 MJ / kg db, a total potential of energy from agricultural residue is 6× 1012 MJ/ Year. At a power conversion rate of 35%, total useful potential is about 75,000 MW. This can supply all our villages with power at a rate of 30,000 kWh per day per village against the present meagre consumption of only 150 kWh per day per village. The cattle production in India is nearly 237 million. Assuming the average wet dung obtained per animal per day to be 10 kg and a collection rate of 66%, the total availability of wet dung in the country would be 575 million tonnes per annum. This it would enable to produce 22,425 million m3 of biogas, which can replace kerosene oil to an extent of 13, 904 million litres per year. In a biogas plant, apart from the gas that is produced, enriched manure is also obtained as a by-product. It is estimated that, 206 million tons of organic manure per annum would be produced in biogas plants, which would replace 1.4 million tons of nitrogen, 1.3 million tons of phosphate and 0.9 million tons of potash.

Biomass Conversion

Biomass can either be utilized directly as a fuel, or can be converted into liquid or gaseous fuels, which can also be as feedstock for industries. Most biomass in dry state can be burned directly to produce heat, steam or electricity. On the other hand biological conversion technologies utilize natural anaerobic decay processes to produce high quality fuels from biomass. Various possible conversion technologies for getting different products from biomass is broadly classified into three groups, viz.

(i) thermo-chemical conversion,
(ii) bio-chemical conversion and
(iii) oil extraction.

These alternative technologies for biomass conversion offer sound and alternative options for meeting the future fuels, chemicals, food and feed requirements. Three main approaches can be adopted for generation and utilization of biomass:

(i) Collection of urban and industrial wastes as supplementary fuel in boilers and as a feed stock for producing methane and some liquid fuels.

(ii)Collection of agricultural and forest residues to produce fuels, organic manures and chemical feed stock.

(iii) Growth of some specific energy plants for use as energy feedstock and cultivation of commercial forestry, aquatic and marine plants for different products.

Thermo-chemical conversion includes processes like combustion, gasification and pyrolysis.
Combustion refers to the conversion of biomass to heat and power by directly burning it, as occurs in boilers.
Gasification is the process of converting solid biomass with a limited quantity of air into producer gas, while
Pyrolysis is the thermal decomposition of biomass in the absence of oxygen. The products of pyrolysis are charcoal, condensable liquid and gaseous products.

Biochemical conversion includes anaerobic digestion to produce biogas and fermentation to obtain alcohol fuels, the third approach is oil extraction. Edible and non-edible oils can be extracted from a variety of grains and seeds. They can be directly used as fuels by transesterification process to produce bio-diesel, which is a good substitute for conventional diesel oil. Thermal conversion processes for biomass involve some or all of the following processes:

Pyrolysis: Biomass +heat charcoal, gas and oil
Gasification: Biomass +limited oxygen fuel gas
Combustion: Biomass +stoichiometric O2 hot combustion products

Principles of combustion In general, the term combustion refers to the process of release of heat by the exothermic heat of reaction for the oxidation of the combustible constituents of the fuel. Practically the combustion process is an interaction amongst fuel, energy and the environment. Fuel may be defined as a combustible substance available in bulk, which on burning in presence of atmospheric air generates heat that can be economically utilized for domestic and industrial purposes. The common fuels are compounds of carbon and hydrogen; in addition variable percentages of oxygen and small percentages of sulphur and nitrogen are also present. Biomass fuels are normally thermally degradable solids. Combustion of organic materials not only generates natural components of air such as carbon dioxide and water but also produces carbonaceous residues, smoke and tar and gases of carbonyl derivatives, and carbon monoxide. The important parameters affecting combustion are moisture, organic compounds and minerals (ash).

Biogas Most organic materials undergo a natural anaerobic digestion in the presence of moisture and absence of oxygen and produce biogas. The biogas so obtained is a mixture of methane (CH_4): 55-65% and Carbon dioxide (CO_2) : 30-40%. The biogas contains traces of H_2, H_2S and N_2. The calorific value of biogas ranges from 5000 to 5500 Kcal/Kg (18.8 to 26.4 MJ /m^3). The biogas can be upgraded to synthetic natural gas (SNG) by removing CO_2 and H_2S. The production of biogas is of particular significance in India because of its large scale cattle production. The biogas is used for cooking, domestic lighting and heating, run I.C. Engines and generation of electricity for use in agriculture and rural industry. Family biogas plants usually of 2-3 m^3 capacity.

Advantages

a) The initial investment is low for the construction of biogas plant.

b) The technology is very suitable for rural areas.

c) Biogas is locally generated and can be easily distributed for domestic use.

d) Biogas reduces the rural poor from dependence on traditional fuel sources, which lead to deforestation.

e) The use of biogas in village helps in improving the sanitary condition and checks environmental pollution.

f) The by-products like nitrogen rich manure can be used with advantage.
g) Biogas reduces the drudgery of women and lowers incidence of eye and lung diseases.

Raw materials for biogas generation Biogas is produced mainly from

a. Cow dung,
b. Sewage,
c. Crop residues,
d. Vegetable wastes
e. Water hyacinth
f. Poultry droppings and
g. Pig manure.

Anaerobic digestion

The treatment of any slurry or sludge containing a large amount of organic matter utilizing bacteria and other organisms under anaerobic condition is commonly referred as anaerobic digestion or digestion. Anaerobic digestion consists of the following three stages.

The three stages are (i) the enzymatic hydrolysis, (ii) acid formation and (iii) methane formation.

Enzymatic hydrolysis

In this stage, a group of facultative micro-organisms acts upon the organic matter and convert insoluble, complex, high molecular compounds of biomass into simple, soluble, low molecular compounds. The organic substances such as polysaccharide, protein and lipid are converted into mono-saccharide, peptide, amino acids, and fatty acids. Then they are further converted into acetate, propionate and butyrate

.

Acid formation

The microorganisms of facultative and anaerobic group collectively called as acid formers, hydrolyse and ferment the productions of first phase i.e., water soluble substances into volatile acid. The major component of the volatile acid is the acetic acid. In addition to acetate or hydrogen and carbon dioxide, some other acids like butyric acid and propionic acid are also produced.

Methane formation

Finally, acetate or hydrogen plus carbon dioxide are converted into gas mixture of methane (CH_4) and CO_2 by the bacteria which are strictly anaerobes. These bacteria are called methane fermentations. For efficient digestion, these acid formers and methane fermentations must remain in a state of dynamic equilibrium. The remaining indigestible matter is referred as „slurry". The following are some approximate rules used for sizing biogas plants or for estimating their performance:

1. One kg of dry cattle dung produces approximately 1 m^3 of biogas.

2. One kg of fresh cattle dung contains 8% dry bio-degradable mass.

3. One kg of fresh cattle dung has a volume of about 0.9 litres.

4. One kg of fresh cattle dung requires an equal volume of water for preparing slurry.

5. Typical rent ion time of slurry in a biogas plant is 40 days.

The efficiency of biogas generation depends upon the following factors:

a) Acid formers and methane fermenters must remain in a state of dynamic equilibrium which can be achieved by proper design of digester.

b) Anaerobic fermentation of raw cow dung can takes place at any temperature between 8 and 55°C. The value of 35°C is taken as optimum. The rate of biogas formation is very slow at 8°C. For anaerobic digestion, temperature variation should not be more than 2 to 3°C. Methane bacteria work best in the temperature range of 35 and 38°C

c) A pH value between 6.8 and 7.8 must be maintained for best fermentation and normal gas production. The pH above 8.5 should not be used as it is difficult for the bacteria to survive above this pH.

d) A specific ratio of carbon to nitrogen (C/N ration) must be maintained between 25:1 and 30:1 depending upon the raw material used. The ratio of 30:1 is taken as optimum.

e) The water content should be around 90% of the weight of the total contents. Anaerobic fermentation of cow dung proceeds well if the slurry contains 8 to 9% solid organic matter.

f) The slurry should be agitated to improve the gas yield.

g) Loading rate should be optimum. If digester is loaded with too much raw material, acids will accumulate and fermentation will be affected

Types of biogas plants: Biogas plants basically are two types.

i) Floating dome type Eg. KVIC-type (KVIC- Khadi Village Industries Commission)

ii) Fixed dome type nEg. Janata type (Chinese model)

Comparison between KVIC type and Janata type biogas plants

S.No	KVIC- type	Janata type
1.	Capital investment is high	Capital investment is Less
2.	Cost of maintenance is high	Cost of maintenance is minimum
3.	Life span of the plant is expected to be 30 years and that of gas holder is 5-8 years.	Life span of the plant is comparatively more.
4.	Steel gas holder is essential, which require maintenance such as painting, repairing, and replacements of damaged parts due to corrosion.	Steel gas holder is not required.
5.	Locally available materials can't be used for construction of digester. Fabricated gas holder is to be transported from nearby towns.	The entire plant can be constructed with locally available materials.
6.	The space above the movable drum can't be used for other purposes.	The space above the plant can be used.
7.	Effect of temperature during winter is more.	Effect of temperature during winter is less.
8.	The gas is released at a pressure of 8-12 cm of water column.	The gas is released at a pressure of 90 cm of water column.
9.	It is suitable for processing animal dung.	It is suitable for processing other materials along with animal dung.

Solar energy

The fossil fuels in the world are depleting very fast by the turn of this century, man will have to depend upon renewable resources of energy which are free from pollution, low in cost of transmission and distribution. Sun is the primary source of energy and all forms of energy on the earth are derived from it. Our solar system consists of the sun, 9 planets orbiting around the sun. Satellites (or moons) orbiting around the planets, asteroids, comets and meteors. The sun is at the centre of solar system and all these bodies revolve around it, and are held by its great gravitational pull, which governs their motion. Sun is heaviest body of the solar system around which all the planets revolve. The mass of the sun is 1.98×1030kg and its diameter is 1.392×109m. It is about 109 times the diameter of the earth. The average distance of the sun from the earth is about 1.496*1011m.,which is called one astronomical unit (AU).The sun rotates around its axis and completes one rotation in 25 days. The temperature and pressure in the interior of the sun are extremely high, and the temperature on the surface is 6000K.The sun continuously emits radiations in visible region and in the radio wave region in all the directions and the small fraction of it reaches the earth. The light emitted from the sun reaches the earth in 8.3 minutes, and it is the main source of heat and light energy for all the members of solar system including the earth.

Energy in the form of heat is one of the main energy requirements in the domestic, agricultural, industrial and economic sectors of our economy. Pyrometer: It is used to measure total radiation (direct and diffuse) in terms of energy per unit time per unit area on a horizontal surface. Pyrheliometer: It is used for measuring beam radiation. Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the earth is approximtely1.8×1011 MW which is many thousand times larger than the present consumption rate on the earth of all commercial energy sources. Thus, in principle, solar energy could supply all the present and future energy needs of the world on a continuing basis. This makes it one of the most promising of the unconventional energy sources.

The advantages of solar energy are

(i) Environmentally clean source of energy and

(ii) Freely available in adequate quantities in almost all parts of the world where people live.

The main problems associated with solar energy are:

(i) Dilute source of energy and

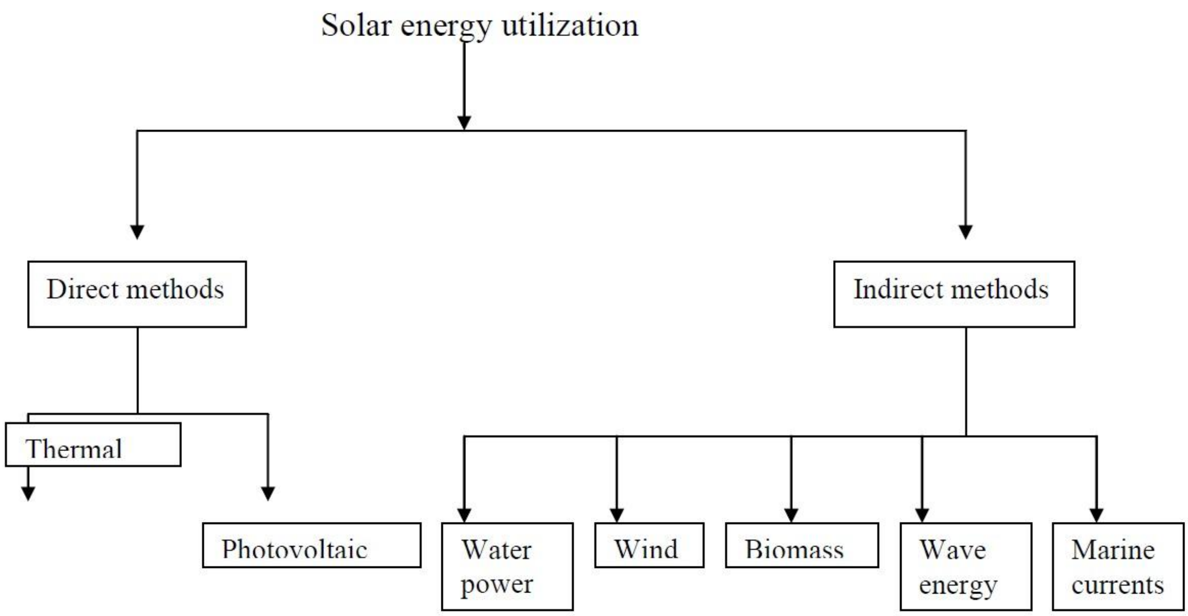
(ii) Availability varies widely with time. India,

Being tropical country receives solar insolation in the order of 1650-2100 kwh/m2/year for nearly 250-300 days. Solar energy can be used directly or indirectly.

Applications of solar energy

1. Heating and Cooling of buildings
2. Solar water and air heating
3. Salt production by evaporation of seawater
4. Solar distillation
5. Solar drying of agricultural products
6. Solar cookers
7. Solar water pumping
8. Solar refrigeration
9. Electricity generation through Photo voltaic cells
10. Solar furnaces
11. Industrial process heat
12. Solar thermal power generation

7.1 Classification of methods for solar energy utilization



Heat transfer for solar energy utilization

Heat transfer occurs mainly by 3 mechanisms. The first is by conduction through solid materials in the presence of a temperature difference. The second mechanism is by radiation in which energy moves in space by electromagnetic waves in a moving fluid. The moving molecules gain heat or lose it by conduction or radiation and carry it by their movement from one place to another. In this process, the third mechanism is convection.

Wind energy

Wind is the world's fastest growing energy source today and it has been retaining this position consecutively for the last five years. The global wind power capacity has increased by a factor of 4.2 during the last five years. The total global installed capacity is 39434 MW in 2004. Installed capacity in different regions is shown in Table 1:

Country	Installed capacity, MW
Germany	14609
United states of America	6352
Spain	6202
Denmark	3115
India	212

Air in motion is called wind. The winds on the earth surface are caused primarily by the unequal heating of the land and water by the sun. The differences in temperature gradients induce the circulation of air from one zone to another. Winds are caused on earth due to:

1. The absorption of solar energy on earth surface and its atmosphere. The pressure and temperature gradients causes winds or wind flow.

2. Also the rotation of earth about its axis and its movement around the sun causes the flow of wind.

Energy derived from wind velocity is wind energy. It is a non-conventional type of energy, which is renewable with suitable devices. This energy can be used as a perennial source of energy. Wind energy is obtained with the help of wind mill. The minimum wind speed of 10kmph is considered to be useful for working wind mills for agricultural purpose. Along the sea coast and hilly areas, wind mills are likely to be most successful in Karnataka, Maharashtra and Gujarat.

The wind energy over earth is estimated to be 1.6×107 M.W, which is equivalent to the energy consumed. But, the wind energy is available in dilute form. The conversion machines are large. The wind energy varies from time to time and place to place. Due to this reason some storage facility is required. The kinetic energy of wind is converted into useful shaft power by wind mills. General applications of wind mills are pumping water, fodder cutting, grain grinding, generation of power etc. In India, wind speed lies between 5 kmph-20 kmph. The high wind velocity is seasonal. The wind energy, if used for power generation, it will be uncertain to generate power. In India, wind power can be used for lifting water in rural areas for drinking and for irrigation purpose.

Factors affecting the wind

1. Latitude of the place

2. Altitude of the place.

3. Topography of the place 4. Scale of the hour, month or year.

Suitable places for the erection of wind mills

1. off-shore and on the sea coast: An average value on the coast is 2400 kWH/m2/year.
2. Mountains: An average value is 1600 KWH/m2/year.
3. Plains: An average value is 750 KWH/m2/year.

Places unsuitable for wind mills

1. Humid equatorial region- there is virtually no wind energy.
2. Warm, windy countries, wind energy may not be usual because of the frequency of cyclones.

Advantages of wind energy

1. It is a renewable source of energy.
2. It is non-polluting and no adverse influence on the environment.
3. No fuel and transportation is required.
4. The cost of electricity under low production is comparatively low.

Disadvantages

1. The available wind energy is dilute and fluctuating in nature.
2. Unlike water energy, wind energy requires storage capacity because of its irregularity.
3. Wind energy operating machines are noisy in operation.
4. Wind power systems have a relatively high overall weight. For large systems, a weight of 110 kg/kW has been estimated.
5. Large areas are required for wind mill.
6. The present wind mills are neither maintenance free nor practically reliable.

Biofuels

"Biofuels" are transportation fuels like ethanol and biodiesel that are made from biomass materials. These fuels are usually blended with petroleum fuels namely with gasoline and diesel fuel, but they can also be used on their own. Ethanol and biodiesel are also cleaner burning fuels, producing fewer air pollutants. It has drawn significant attention due to increasing environmental concern and diminishing petroleum reserves. Bio-diesel fuel can be made from renewable vegetable oils, animal fats or recycled cooking oils by transesterification process. Biodiesel is the fastest growing alternative fuel in the world. Ethanol is an alcohol fuel made from the sugars found in grains such as corn, sorghum, and wheat, as well as potato skins, rice, sugarcane, sugar beets and yard clippings by fermentation.

Characteristics of bio-fuels

The following are some of the characters for the efficient bio-diesel:

1. Kinematic viscosity
2. Density
3. Calorific value
4. Melt or pour point
5. Cloud point
6. Flash point
7. Acid value
8. Iodine value
9. Cetane number
10. Stability – oxidative, storage and thermal
11. Carbon residue
12. Ash percentage
13. Sulphur percentage

Water harvesting Structure

There are many ways of harvesting water. All these methods basically fall under three main categories viz.:

- surface water collection
- ground water collection
- augmentation of ground water recharge

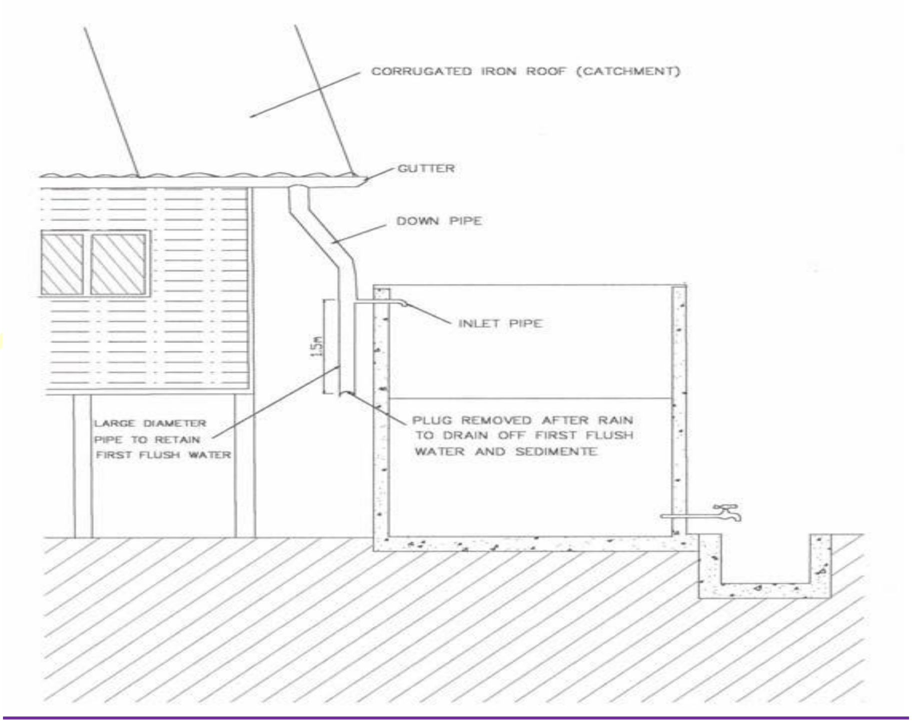
The methods which are particularly useful in augmenting drinking water availability especially in the rural areas and which can be easily adopted at a moderate cost with the Involvement of the local people are discussed in the following paras.

Roof top harvesting

Rain water may be harvested in areas, having rainfall of considerable intensity, spread over The larger part of the year e.g. The himalayan areas, northeastern states, andaman nicobar, Lakshadweep islands and southern parts of kerela and tamil nadu. This is an ideal solution Of water problem where there is inadequate groundwater supply and surface sources are Either lacking or insignificant. Rain water is bacteriologically pure, free from organic matter And soft in nature. In this system, only roof top is the catchment The roofing Should be of galvanized iron sheets (g.i.), aluminium, clay tiles, asbestos or concrete. In case Of thatch-roof, it may be covered with waterproof ldpe sheeting. For collection of water, a Drain is provided (gutter) along the edge of the roof. It is fixed with a gentle slope towards down pipe, which is meant for free flow of water to the storage tank. This may be made up of G.i. sheet, wood, bamboo or any other locally available material. The down pipe should be at Least 100 mm diameter and be provided with a 20 mesh wire screen at the inlet to prevent dry Leaves and other debris from entering it.

During the period of no rain, dust, bird droppings etc. Accumulate on the roof. These are washed off with the first rains and enter the storage tank to contaminate the water. This can be prevented by two methods:

(a) simple diversion of foul water
(b) installation of foul flush system



Under method (a), the down pipe is moved away from the inlet of the storage tank initially during the rains, until clean water flows. Under method (b), storage provision for initial rain is kept in a pipe. These are cleaned off after each heavy rain. These are provided between down pipe and the storage tank. Filter materials such as sand, gravel or coconut/ palm/ betalnut fibre etc. are used as filter media.

Storage tank can be constructed underground or above ground. The underground tank may be masonry or R.C.C. structure suitably lined with water proofing materials. The surface tank may be of G.I. sheet, R.C.C., Plastic/ HDP or Ferro cement Tank placed at a little higher elevation on a raised platform. To facilitate cleaning of the tank, an outlet pipe may be fitted and fixed in the tank at bottom level. The size of the tank will depend upon the factors such as daily demand, duration of dry spell, catchment area and rainfall. The tank is provided with:

i. a manhole of 0.50 m × 0.50 m size with cover
ii. Vent pipe/ over flow pipe (with screen) of 100 mm dia.
iii. drain pipe (100 mm dia.) at bottom

Choice of the tank depends on locally available materials and space available. When the tank is constructed underground, at least 30 cm of the tank should remain above ground. The withdrawal of water from the underground tank is made by installing hand pump on it. In case of surface tank, tap can be provided. Before the tank is put into use it should be thoroughly cleaned and disinfected with high Dosage of chlorine. Since the water shall remain stored for quite a long time, periodical disinfection of stored water is essential to prevent growth of pathogenic bacteria. Typical drawings of roof water harvesting structures are shown in Figure 6.1, 6.2 and 6.3.

Fig 6.2 Roof Water Harvesting

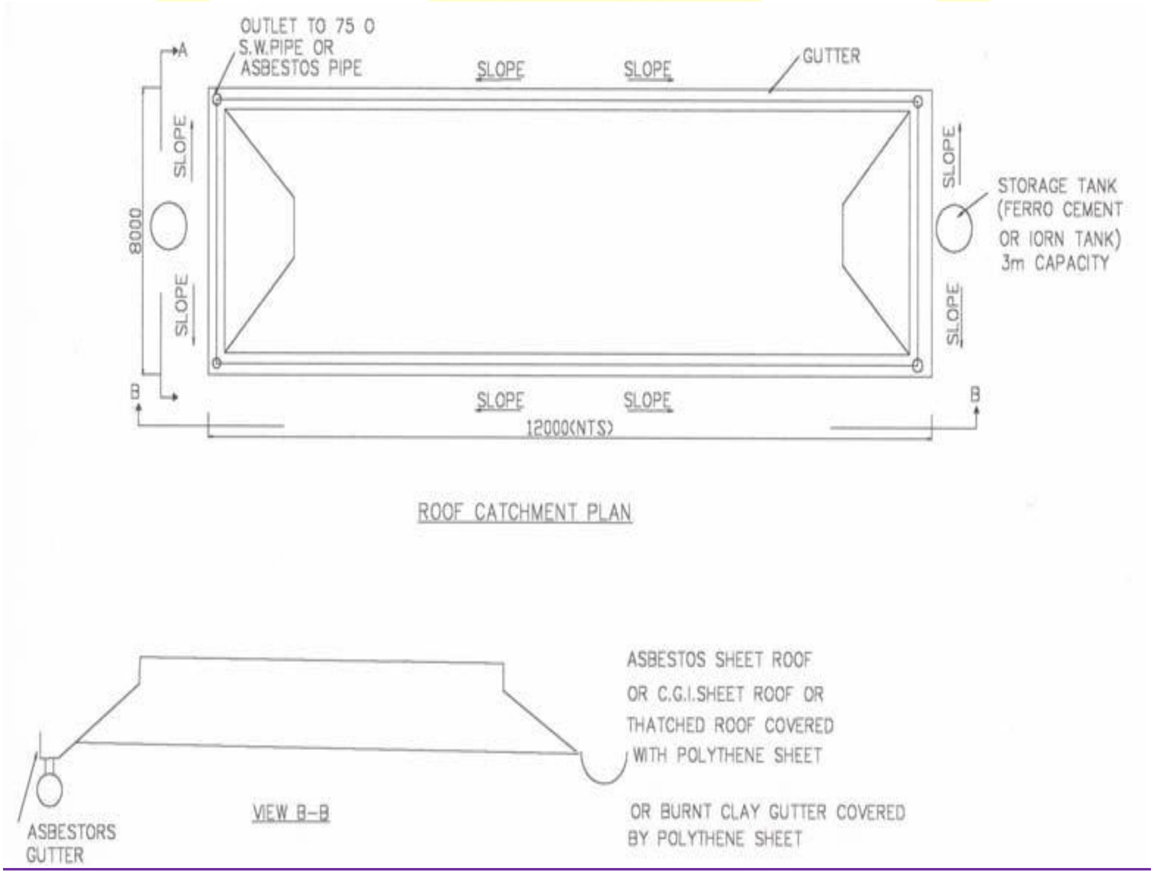
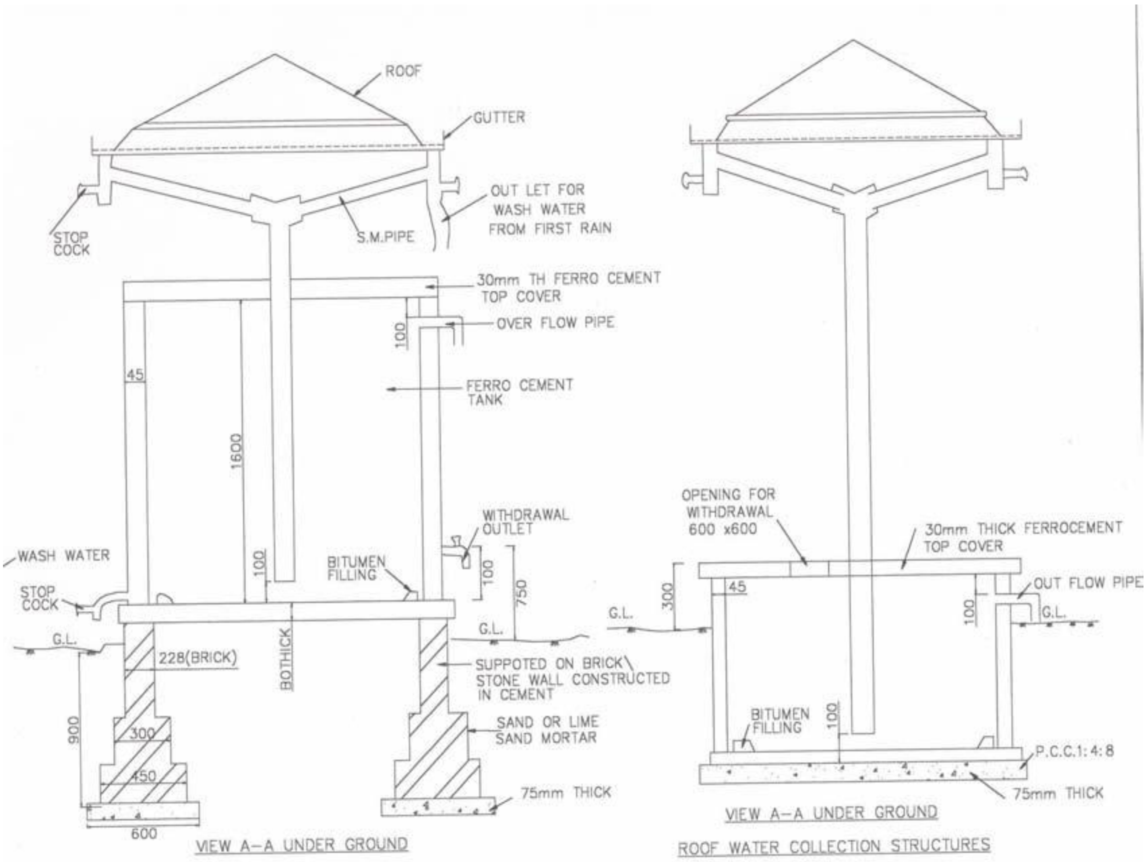


Fig 6.3 roof water collection



TANKA/ KUND/ KUNDI

Tanka is generally circular in shape and is constructed in stone masonry in 1:3 cement-sand mortar. While small Tankas of 3 to 4.22 m diameter and about 21-59 cum capacity are built by individual households, larger ones of 6 m diameter and 200 cum capacity are built for the village communities. In both these cases the depth is kept equal to the diameter. The catchment of the Tanka is treated in a variety of ways to increase the rain water collection. The commonly used materials are murrum, coal ash, gravel, pond silt, Bentonite, soil-cement mix, lime concrete, sodium carbonate etc. Because of the constraints of availability of large open areas around the Tanka and the unit cost of treatment, a circular strip of land of 12 m width around the Tanka is usually treated, the slope of which is kept as 3% i.e. a fall of 3 cm in a length of 1 m. This provides bulk of the requisite amount of water to fill the Tanka. Remaining water is received from the natural catchment outside the treated area

PERCOLATION TANK

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation of impounded surface runoff to recharge the ground water. These have come to be recognized as a dependable mode for ground water recharge in the hard rock terrain covering two-third of the country. The hard rock areas with limited to moderate water holding and water yielding capabilities often experience water scarce situations due to inadequate recharge, indiscriminate withdrawal of ground water and mismanagement. These are quite popular in the states of Maharashtra, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Karnataka and Gujarat. The percolation tank is more or less similar to check dams or nala bund with a fairly large storage reservoir. A tank can be located either across small streams by creating low elevation check dams or in

CHECK DAMS/ CEMENT PLUG/ NALA BUNDS

Check dams are constructed across small streams having gentle slope and are feasible both in hard rock as well as alluvial formations. The site selected for check dam should have sufficient thickness of permeable bed or weathered formation to facilitate recharge of stored water within short span of time. The water stored in these structures is mostly confined to stream course and the height is normally less than 2 m. These are designed based on stream width and excess water is allowed to flow over the wall. In order to avoid scouring from excess run off, water cushions are provided at downstream side. To harness the maximum run off in the stream, series of such check dams can be constructed to have recharge on regional scale.

Farm pond

Farm Pond is a dug out structure with definite shape and size having proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. It is one of the most important rain water harvesting structures constructed at the lowest portion of the farm area. The stored water must be used for irrigation only. Inadvertently, some people use the farm ponds as ground water recharge structures which is not correct as per the definition. For recharging the ground water, the structures require high capacity and are generally located in the soils having high infiltration rates and are called percolation tanks. Percolation tank is meant for only recharge purpose and not for irrigation. Such structures conceptually differ in their hydrology and physical location. A farm pond must be located within a farm drawing the maximum runoff possible in a given rainfall event.

A percolation pond can be dug out in any area where the land is not utilized for agriculture Farm ponds have a significant role in rain fed regions where annual rainfall is more than or equal to 500 mm. If average annual rainfall (AAR) varies between 500 to 750 mm, the farm ponds with capacity of 250 to 500 m3 can be constructed. If AAR is more than 750 mm, the farm ponds with capacity more than 500 m3 can be planned particularly in black soil regions without lining. It was observed from the field experience and if present rainfall pattern changes; at least two to three rainfall events producing considerable runoff are possible in a season making farm ponds an attractive proposition. In high rainfall semi-arid regions, these structures can be made as multiple use enterprises like protective/supplemental irrigation, fish culture or duck farming integrated with poultry. These structures provide localised water and food security by enhancing the crop productivity and climate resilience.

Moreover, farm ponds conserve the natural resources like soil and nutrients apart from water and acts as flood control structure by reducing peak flows in the watersheds or given area of catchment. Depending on the source of water and their location, farm ponds are grouped into four types:

1) Excavated or Dug out ponds

2) Surface ponds

3) Spring or creek fed ponds and

4) Off stream storage ponds.

Watershed Management

Definition: "Watershed management is a concept which recognizes the judicious management of three basic resources of soil water and vegetation, on watershed basis, for achieving particular objective for the wellbeing of the people". It includes treatment of land most suitable biological as well as engineering measures.

Objective of watershed management:

1. Production of food, fodder, fuel.
2. Pollution control
3. Over exploitation of resources should be minimized
4. Water storage, flood control, checking sedimentation.
5. Wild life preservation
6. Erosion control and prevention of soil, degradation and conservation of soil and water.
7. Employment generation through industrial development dairy fishery production.
8. Recharging of ground water to provide regular water supply for consumption and industry as well as irrigation.
9. Recreational facility.

Steps in watershed management: Watershed management involves determination of alternative land treatment measures for, which information about problems of land, soil, water and vegetation in the watershed is essential.

In order to have a practical solution to above problem it is necessary to go through four phases for a full scale watershed management.

Programme:

1. Recognition phase.
2. Restoration phase.
3. Protection phase.
4. Improvement phase.

1. Recognition Phase: It involves following steps

1. Recognition of the problem
2. Analysis of the cause of the problem and its effect.
3. Development of alternative solutions of problem.

Necessary information is obtained from different surveys like soil survey, land capability survey, agronomic survey, forest, engineering and socio economic survey, etc. This information serves as a basis for fixing and determining the watershed problems, priorities in land treatment measures, and causes and effects of problems on land and people.

2. Restoration Phase: It includes two main steps.

a. Selection of best solution to problems identified
b. Application of the solution to the problems of the land

As per the priorities, treatment applied initially to critical areas. After this proper measures like biological and engineering measures are applied to all types of lands.

3. Protection Phase: This phase takes care of the general health of the watershed and ensures normal functioning. The protection is against all factors which may cause determined in watershed condition.

4. Improvement phase: This phase deals with overall improvement in the watershed and all land is covered. Attention is paid to agriculture and forest management and production, forage production and pasture management, socio economic conditions to achieve the objectives of watershed management. Health, family planning, improving cattle, poultry, etc. are taken depending upon intensity.

Agro processing

Agro processing could be defined as set of techno economic activities carried out for conservation and handling of agricultural produce and to make it usable as food, feed, fibre, fuel or industrial raw material. Hence, the scope of the agro-processing industry encompasses all operations from the stage of harvest till the material reaches the end users in the desired form, packaging, quantity, quality and price. Ancient Indian scriptures contain vivid account of the post-harvest and processing practices for preservation and processing of agricultural produce for food and medicinal uses. Inadequate attention to the agro-processing sector in the past put both the producer and the consumer at a disadvantage and it also hurt the economy of the Country. Agro-processing is now regarded as the sunrise sector of the Indian economy in view of its large potential for growth and likely socio economic impact specifically on employment and income generation. Some estimates suggest that in developed countries, up to 14 per cent of the total work force is engaged in agro-processing sector directly or indirectly. However, in India, only about 3 per cent of the work force finds employment in this sector revealing its underdeveloped state and vast untapped potential for employment. Properly developed, agro-processing sector can make India a major player at the global level for marketing and supply of processed food, feed and a wide range of other plant and animal products.

Modified and Controlled Atmospheres for the Storage

Modified atmosphere (MA) and controlled atmosphere (CA) technologies have great potential in a wide range of applications. The increasingly global nature of food production and the increased emphasis on reducing chemical preservatives and pesticides have put the spotlight on these centuries-old technologies. Yet until now, there have been very few current resources available, and none have covered all aspects.

Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities explores the science and application of the modified atmosphere (MA) and the controlled atmosphere (CA). It covers all technological applications, including storage, transport, and packaging for all fruits, vegetables, and ornamentals of temperate, subtropical, and tropical origin. Tracing the historical developments of these technologies, it provides information on the ideal conditions to be used for many horticultural commodities. It also outlines the effects of MA and CA on the physiology and biochemistry of these commodities as well as on their flavour and quality.

Providing the most comprehensive resource on all basic and applied aspects of these technologies, the text also reviews the vast amount of literature already written on this topic. This extensive work captures, for the first time, the entire subject of MA and CA, presenting a complete review of the technological aspects of this important development in food safety and preservation.

The controlled atmospheric storage in higher CO_2 and lesser O_2 are maintained is most significant contribution in storage technology. If storage done with refrigeration, it gives growth to respiratory activity and delay softening, yellowish, quality change, etc. The important factor of storage is tolerance susceptibility to injured vegetables increasing CO_2 and decreasing O_2.

The work on controlled atmosphere storage started in England in 1927 by kid and West. Modified atmosphere does not differ in principle from controlled atmosphere. In this the produce is held under the atmospheric condition by package, over wrap, box liner or Pallet cover. The two produce and the concentration of CO_2 and O_2 more benefit can be obtained by controlled atmosphere storage in apple. Among tropical fruits, the best storage of mangoes is 5% CO_2 and 5% O_2 at 13 0C.

Improved appearance can get by controlled atmosphere storage the O_2 level was 2 % and bellows this level it is harmful slight benefit with papaya were stored in 5% CO_2 and 1% O_2 for 2 days at 13% C. Ripening can be delayed for months by holding banana in 1-10 % O_2 and 5-10 % CO_2 commercial controlled atmosphere recommendation cannot be given in case of citrus fruits.

Advantages of Controlled Atmosphere Storage:

i) Control all types of micro-organisms.
ii) Chilling injury and other physiological disorders.
iii) Black heart in potato
iv) Cost of equipment and operation
v) This is less popular in India.

Perishable food storage

Cold storages are meant to preserve the perishable commodities of food items for a longer period with retention of the original colour, flavour and taste. However, each commodity or item has certain life and they cannot be stored even in a cold storage for indefinite period. Storage beyond certain period may not be economical as well since payment of rent of cold storage increases the cost of the item. Hence, cold storages are used for high value items or when prices crash down due to bumper crop or for such items which are grown during the season but there is a demand round the year or for products like meat, fish or milk products which are quickly perishable.

PRODUCT

Cold storages are being used for preservation of many food products since long. Their location has to be strategic and they should have easy access. Cold storages have demand all over the country. This note primarily looks into the prospects in Assam. Assam grows many varieties of fruits and vegetables. Consumption of meat, fish, chicken etc. is also on the higher side. Hence, a cold storage unit seems to have good scope.

MARKET POTENTIAL

Demand and Supply Location is a very critical aspect for the success of cold storage. It should be in close proximity of growing area as well as market and at the same time should be easily accessible for heavy vehicles round the year. Uninterrupted power supply is yet another pre-requisite.

Marketing Strategy Many fruits and vegetables like pineapples, apples, plums, oranges, potatoes, brinjals, cauliflowers etc. are grown in Assam. Likewise, consumption of meat, chicken, fish etc. is also Substantial. Hence, there is a good scope for a cold storage unit. A possibility of storing some milk products may also be explored. Different items are stored during different times requiring different temperatures. Hence, there is a need to divide total storage space in different temperature zones depending upon local needs.

MANUFACTURING PROCESS

A proper market analysis would throw light on storage needs and accordingly tentative plan for the whole year has to be drawn. Compressors suitable for using ammonia have to be selected as ammonia is cheap, easily available and is of high latent heat of evaporation, but it is highly toxic in nature if mixed with oil containing high carbon percentage. Hence, handling and maintenance has to be very careful. Rooms with different temperature requirements must be properly insulated and protected from moisture. On outside walls, one coating of foam with vapour proof material is advisable. Temperature and humidity is maintained according to the items stored. Use of skewed door arrangements, proper insulation and required circulation of cool air inside the storage area would make operations economical and improve profitability.

Silos

A **silo** ("pit for holding grain") is a structure for storing bulk materials. Silos are used in agriculture to store grain (see grain elevators) or fermented feed known as silage. Silos are more commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust. Three types of silos are in widespread use today: tower silos, bunker silos, and bag silos.

Tower Silos

Storage silos are cylindrical structures, typically 10 to 90 ft (3 to 27 m) in diameter and 30 to 275 ft (10 to 90 m) in height with the slip form and Jump from concrete silos being the larger diameter and taller silos. They can be made of many materials. Wood staves, concrete staves, cast concrete, and steel panels have all been used, and have varying cost, durability, and airtightness trade-offs. Silos storing grain, cement and woodchips are typically unloaded with air slides or augers. Silos can be unloaded into rail cars, trucks or conveyors.

Tower silos containing silage are usually unloaded from the top of the pile, originally by hand using a silage fork, which has many more times than the common pitchfork, 12 vs 4, in modern times using mechanical unloaders. Bottom silo unloaders are utilized at times but have problems with difficulty of repair.

Bunker Silos

Bunker silos are trenches, usually with concrete walls, that are filled and packed with tractors and loaders. The filled trench is covered with a plastic tarp to make it airtight. These silos are usually unloaded with a tractor and loader. They are inexpensive and especially well-suited to very large operations.

Bag Silos

Bag silos are heavy plastic tubes, usually around 8 to 12 ft (2.4 to 3.6 m) in diameter, and of variable length as required for the amount of material to be stored. They are packed using a machine made for the purpose, and sealed on both ends. They are unloaded using a tractor and loader or skid-steer loader. The bag is discarded in sections as it is torn off. Bag silos require little capital investment. They can be used as a temporary measure when growth or harvest conditions require more space, though some farms use them every year.

Bins

A bin is typically much shorter than a silo, and is typically used for holding dry matter such as concrete or grain. Grain is often dried in a grain dryer before being stored in the bin. Bins may be round or square, but round bins tend to empty more easily due to a lack of corners for the stored material to become wedged and encrusted.

The stored material may be powdered, as seed kernels, or as cob corn. Due to the dry nature of the stored material, it tends to be lighter than silage and can be more easily handled by under-floor grain unloaders. To facilitate drying after harvesting, some grain bins contain a hollow perforated or screened central shaft to permit easier air infiltration into the stored grain.

The Flash's

Articles

For

NABARD Gr. A & B

By:- Gaurav(The Flash)

#5

Plantation & Horticulture

HORTICULTURE

What is horticulture?

- India is the seventh largest country in the world with a total geographical area of 328.73 m ha and has second largest population 121crores (2011), after China.
- The total arable land available is 144 million hectare of which 70% is under rain fed cultivation.
- Around 55-60 % of the total population depends on agriculture and allied activities.
- Horticulture crops constitute a significant portion of total agricultural production in the country.
- The term **HORTICULTURE** is derived from two **Latin words** - ―***HORTUS***‖ meaning "**GARDEN**" and ―***CULTURA***‖ meaning "**CULTIVATION**".
- In ancient days the gardens had protected enclosures with high walls or similar structures surrounding the houses.
- The enclosed places were used to grow fruit, vegetables, flowers and ornamental plants. Therefore, in original sense *"Horticulture refers to cultivation of garden plants within protected enclosures".*

Definition: Horticulture is a science and technique of production, processing and merchandizing of fruits, vegetables, flowers, spices, plantations, medicinal and aromatic plants.

Branches of horticulture

Horticulture is a wide field which includes a great variety and diversity of crops. The science of horticulture can be divided into several branches depending upon the crops it deals with. Following are the branches of horticulture.

- **Pomology:** study of fruit crops.
- **Olericulture**: cultivation of vegetables.
- **Floriculture:** cultivation of flower crops.
- **Plantation crops:** cultivation of coconut, arecanut, rubber, coffee, tea, etc.
- **Spices crops:** cultivation of cardamom, pepper, nutmeg etc.
- **Medicinal and aromatic crops**: cultivation of medicinal and aromatic crops.
- **Post harvest technology**: deals with post-harvest handling, grading, packaging, storage processing, value addition, marketing etc., of horticulture crops.
- **Plant propagation** : deals with propagation of plants

FRUIT CROPS:

- India is the second largest producer of fruits after Brazil.
- A large variety of fruit crops are grown in India. Of these, mango, banana, citrus, papaya, guava, pineapple, sapota, jackfruit, litchi, grapes, apple, pear, peach, plum, walnut etc. are the important ones.
- India accounts for 10 per cent of the total world production of fruits.
- It leads the world in the production of mango, banana, sapota and acid lime besides recording highest productivity in grape.
- The leading fruit growing states are Maharashtra, Karnataka, Andhra Pradesh, Bihar and Uttar Pradesh.

VEGETABLE CROPS:

- More than 40 vegetables belonging to Solanaceaeous, cucurbitaceous, leguminous, cruciferous, root crops and leafy vegetables are grown in Indian tropical, sub-tropical and temperate regions.
- Important vegetables grown in India are onion, tomato, potato, brinjal, peas, beans, okra, chilli, cabbage, cauliflower, bottle gourd, cucumber, watermelon, carrot, radish etc.
- India ranks second in vegetable production next to China *w.r.t.* area and production contributing 13.38 % to the total world production.
- India occupies first position in cauliflower, second in Onion, third in cabbage in the world.
- West Bengal, Orissa, Uttar Pradesh, Bihar, Maharashtra, Karnataka are the important states for horticultural crop production

Differences between fruits and vegetables

Sl No.	Vegetables	X	Fruits
1.	Most of the vegetables are annuals	:	Fruit plants are perennial in nature
2.	Mostly majority of them are sexually propagated	:	Fruit plant are sexually and asexually propagated
3.	Cultivation of vegetable is seasonal and special techniques like pruning and training are generally not required	:	Fruit plants require special practices like training and pruning and are required seasonally.
4.	Vegetable plants are generally non-woody	:	Fruit plants are generally woody in nature
5.	All parts of the plant are edible	:	Only fruit is edible but sometimes false fruit also edible (eg. Fleshy thalamus of apple)
6.	Generally consumed after cooking	:	Mostly consumed raw after ripening

FLORICULTURE:

- In India, flower cultivation is being practiced since ages.
- It is an important/integral part of socio-cultural and religious life of Indian people.
- It has taken a shape of industry in recent years.
- India is known for growing traditional flowers such as jasmine, marigold, chrysanthemum, tuberose, crossandra, aster, etc.
- Commercial cultivation of cut flowers like, rose, orchids, gladiolus, carnation, anthurium, gerbera is also being done.
- The important flower growing states are Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, West Bengal, Sikkim, Jammu & Kashmir, Meghalaya, etc.

PLANTATION CROPS:

- This is one of the important sectors contributing about Rs.7,500 crores of export earnings.
- The major plantation crops include coconut, arecanut, oil palm, cashew, tea coffee, rubber cocoa, betel vine, vanilla etc.
- The leading states are Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, Goa, Assam etc.

SPICES:

- They constitute an important group of horticulture crops and are defined as vegetable products or mixture thereof,
- Free from extraneous matter used for flavouring, seasoning and imparting aroma in foods.
- India is known as **home of spices** producing a wide variety of spices like black pepper, cardamom, ginger, turmeric, chilli, Coriander etc.
- Major spice producing states are Kerala, Andhra Pradesh, Gujarat, Rajasthan, Maharashtra, Karnataka, Orissa, Tamil Nadu etc.

MEDICINAL AND AROMATIC PLANTS:

- India has diverse collection of medicinal and aromatic plants species distributed throughout the country.
- It has more than 9,500 species with medicinal properties.
- Demand for these crops is increasing progressively in both domestic and export markets.
- Important medicinal plants are Isabgol, Senna, Opium poppy, Periwinkle, Coleus, Ashwagandha, etc. and aromatic plants are Japanese mint, Lemon grass, Citronella, Davana, Patchouli etc

FEATURES OF HORTICULTURE IN GENERAL

• Horticultural produces are mostly utilized in the fresh state and are highly perishable nature.

• Horticultural crops need intensive cultivation, requires large input of capital, labour and technology per unit area.

• Cultural operations like propagation, training, pruning and harvesting are skilled and specific to horticultural crops.

• Horticultural produce are rich sources of vitamins and minerals and alkaloids.

• Aesthetic satisfaction is an exclusive phenomenon to horticultural science.

IMPORTANCE OF HORTICULTURE

- Fruit crops cover an area of 4.96 m ha and vegetable crops 6.75 m ha. Accordingly, 49.29 m.ton of fruits and 101.43 m ton of vegetables are produced in the country annually (Indian Horticulture Database, 2005).
- To meet out the projected demand of population by 2020 AD about 50 mt of fruits and 143 m tons of vegetables would be required. Therefore by 2020 A.D. the production of fruits needs to be increased.
- Requirements of export and processing industry further add to the requirements of horticultural produce.
- In view of these, there is lot of scope of increasing production and potentiality of horticulture crops.
- Apart from fruits and vegetables, floriculture industry in India comprising of florist trade, nursery plants, potted plants, seed and bulb products is being observed as sunrise industry.
- There is roaring business of flowers in almost all metropolitan cities of the different states.
- The developed flower market in the country during 2005 is with area of 2.24 lakh ha with a production of 6.54 lakh MT loose flowers and 19,515 lakh cut flowers.
- The traditional flowers are grown on a large area on a commercial scale. These flowers are mostly grown for loose flower purpose.
- Area under cut flowers like rose, chrysanthemum, gladiolus, carnation and orchids is increasing day by day.

- Plantation crops are another potential sector with lot of opportunities for employment generation, foreign exchange earnings and overall supporting livelihood sustenance of mankind at large.
- These plantaion crops form the mainstay of lively hood in coastal areas of the country where predominating stands of plantation crops are found.
- Coconut has so much importance in the country that the state Kerala receives its very name on the basis of coconut, the Malayalam name of which is *Kera*. These cover an area of 31.02 lakh ha with a production of 131.60 lakh MT.

Horticulture is important due to the following considerations:

1. as a source of variability in produce.

2. as a source of nutrients, vitamins, minerals, flavour, aroma, alkaloids, oleoresins, fibre, etc.

3. as a source of medicine.

4. as an economic proposition as they give higher returns per unit area in terms of energy, money, job, etc.

5. Employment generation - fruit crops requires 860 man days/annum as against 143 man days/annum for cereal crops whereas the crops like grapes, banana and pineapple needs 1000- 2500 man days per annum.

6. Effective utilization of waste land through cultivation of hardy fruits and medicinal plants.

7. As a substitute for family income being the component of home garden/ kitchen garden.

8. As a foreign exchange earner, has higher share compare to agriculture crops

9. As an input for industry being amenable to processing, especially fruit and vegetable preservation industry.

10. Aesthetic consideration and protection of the environment.

11. Religious significance in the country.

- In short and sweet horticulture supplies quality food for health and mind, more calories per unit area, develops better resources and yields higher returns per unit area.
- It also enhances land value and creates better purchasing power for those who are engaged in this industry. Therefore, ***horticulture is important for health, wealth, hygiene and happiness.***

SCOPE OF HORTICULTURE

Like any other things, scope of horticulture depends on incentive it has for the farmers, adaptability of the crops, necessity and facilities for future growth through inputs availability and infrastructure for the distribution of produce/marketing etc.

1. Incentive for the farmer:

- The biggest incentive for the farmer is money.
- Horticultural crops provide more returns in terms of per unit area of production, export value, value addition compared to agricultural crops.

2. **Adaptability:**

- India is bestowed with a great variety of climatic and edaphic conditions as we have climates varying from tropical, subtropical, temperate and within these humid, semi-arid, arid, frost free temperate etc.
- Likewise we have soils from loam, alluvial, laterite, medium black, rocky shallow, heavy black, sandy etc., and thus a large number of crops can be accommodated with very high level of adaptability. Thus, there is lot of scope for horticultural crops.

3. **Necessity:**

- After having achieved the self-sufficiency in food, nutritional security for the people of the country has become the point of consideration/priority.
- To meet the nutritional requirement in terms of vitamins and minerals horticulture crops are to be grown in sufficient quantities to provide a bare **minimum of 85 g of fruits** and **200 g of vegetables per head per day** with a population of above 120 crores.
- Good land is under pressure for stable food, industry, housing, roads and infrastructure due to population explosion and only wasteland had to be efficiently utilized where cultivation of annuals is a gamble due to restricted root zone and their susceptibility of abiotic stress. These lands can be best utilized to cultivate hardy horticultural crops like fruits and medicinal plants.
- At present *our share in international trade of horticultural commodities is less than one per cent of total trade*. Moreover, these commodities (spices, coffee, tea etc.,) fetch 10-20 times more foreign exchange per unit weight than cereals and therefore, taking advantage of globalization of trade, nearness of big market and the size of production, our country should greatly involve in international trade which would provide scope for growth.

4. **Export value:**

- Among fresh fruits-mangoes and grapes; in vegetables- onion and potato; among flowers, roses; among plantation - cashewnut, tea , coffee, coconut, arecanut, and spice crops like black pepper, cardamom, ginger, turmeric, chillies, etc., constitute the bulk of the export basket.
- *European* and *gulf* countries are major importer of horticultural produce.

Reasons for scope of Horticulture in India are:

1. To exploit the great variability of agro climatic conditions in the country.
2. To meet the need for fruits, vegetables, flowers, spices, beverages in relation to population growth based on minimum nutritional security and for other needs.
3. To meet the requirement of processing industry.
4. To substitute import and increase export.
5. To improve the economic conditions of the farmers and to engage more labourers to avoid the problem of unemployment.
6. To protect environment.

Other importance:

1. Similar to forest trees these horticultural trees will maintain the ecosphere.
2. They help in transforming the micro climate.
3. Provides shelter to birds, reptiles and other microorganisms and add to the geo-ecological diversity on the land.
4. Provides thrust to the writers, poets, thinkers and analysts there by keeps their cultural impulse alive.

5. Adds to the survival of life-spheres of living entity.

Horticultural crops and Human Nutrition:

- Fruits and vegetables play an important role in balanced diet.
- These provide not only energy rich food but also provide vital protective nutrients/elements and vitamins.
- Comparatively fruits and vegetables are the cheapest source of natural nutritive foods.
- Since most of Indians are vegetarians, the incorporation of horticulture produce in daily diet is essential for good health.
- Realizing the worth of fruits and vegetables in human health, Indian Council of Medical Research (ICMR) recommended the use of **120g fruits** and **280 g vegetables per capita per day**.
- With the growing awareness and inclination towards vegetarianism worldwide the horticulture crops are gaining tremendous importance.

Functions of fruits and vegetables in human body:

1. Fruits and vegetables provide palatability/ taste,
2. Improves appetite and provides fibre to overcome constipation.
3. They neutralize the acids produced during digestion of proteins and fatty acids.
4. They improve the general immunity of human body against diseases, deficiencies etc.
5. They are the important source of vitamins and minerals for used in several bio-chemical reactions occur in body.
6. Fruits and vegetables provide higher energy value per unit area compared to cereals.

Some of the essential nutrients provided by different fruits are:

- Fruits are also a good source of energy. Eg. Avocado, Olive etc.,
- Fruits are also a good source of enzymes which are helpful in metabolic activities leading to proper digestion of food. Eg. Jamun and Papaya.
- All fruits have one or the other medicinal value.
- They should be eaten in adequate quantity.
- Regular consumption of fruits reduces obesity, maintain health and increase the longevity of life.
- Fruits are attractive in appearance, delicious in taste and easily digestible. Therefore, they are liked by young and old alike.

Vitamins/ Minerals	Role in human body	Source
Vitamin-A	1. Essential for growth and reproduction. 2. Helps in resistance to infections, increases longevity and decreases senility. 3. Deficiency causes, night blindness, xeropthalmia, retardation in growth, roughness in skin, formation of stones in kidney.	*Mango, Papaya, Persimon, Dates, Jack fruit, Walnut, Oranges, Passion fruit, Loquât etc.* *Coriander leaves, Drumstic leaves, Fenugreek leaves etc.*
Vitamin – B_1	1. For maintaining good appetite and normal digestion. 2. Necessary for growth, fertility, lactation and for normal functioning of nervous system. 3. Deficiency causes beri-beri, paralysis, loss the sensitivity of skin, enlargement of heart, loss of appetite and fall in body temperature.	*Walnut, Apricot, Apple, Banana, Grapefruit, Plum and Almond* *Chillies, Colocasia leaves, Tomato, etc.*
Vitamin – B_2	1. Important for growth, health of skin and for respiration in poorly vascularised tissue such as the cornea. 2. Deficiency causes pellagra and alopecia, loss of appetite, loss of weight, sore throat, and development of cataract, swollen nose and baldness.	*Bael, Papaya, Litchi, Pomegranate, Wood apple and Pineapple.* *Amaranthus, Fenugreek leaves etc*
Vitamin – C	1. Deficiency causes scurvy, pain in joints, swelling of limbs, unhealthy gums, tooth decay, delay in wound healing and rheumatism.	*Barbados cherry, Aonla, Guava, Lime, Lemon, Sweet oranges, Ber, Pineapple and Pear.* *Chillies, Tomato, Coriander leaves, Drumstick leaves etc.*
Fat	Walnut, Almond, Avocado	
Fibre	Guava, Pomegranate, Aonla, Grape, Amaranth, Mustard, Beet leaf, Spinach etc.	

Minerals are essential for the growth and development for the human body:

Minerals		Deficiency causes	Sources
1.	Calcium	Causes Rickets, Osteomalacia.	*Sitaphal, Ramphal, Fig, Phalsa, Citrus, Sapota, Grapes, West Indian Cherry etc.* *Curry leaves, Amarantus, Radish leaves, Fenugreek leaves ete*
2.	Phosphorous	Essential for cell multiplication of bones and soft tissues. Helps in liberation of energy on oxidation of carbohydrates.	*Wood apple, Avocado, Dates, Pomegranate and Grape raisins.*
3.	Proteins	Important for body growth, formation and maintenance of body tissues	*West Indian cherry, Avocado, Custrad Apple, Banana, Apricot, Guava, Grapes etc.,* *Peas, cowpea, Bean etc..*
4.	Iron	Act as oxygen carrier in the body.	*Karonda, Date palm, Grape raisins, West Indian Cherry, Guava, Sitaphal, Avocado, Sapota, plum etc.* *Amarantus tender, Coriander leaves etc.*

SCENARIO OF HORTICULTURE

- India is one of the leading producers of horticultural crops in the Globe.
- Horticultural crops cover 13.08 % of the total area under agriculture and contribute to about 28 % of the GDP.
- These crops accounts for 37 % of the total exports of agricultural commodities.
- Due to planned emphasis laid on horticulture, India is accredited as the second largest producer of fruits and vegetables,
- India is the largest producer and consumer of cashew nut, tea and spices.
- Third largest producer of coconut.
- Fourth largest producer and consumer of rubber.
- Sixth largest producer of coffee in the world.
- India exports fruits, vegetables, processed products, flowers, seeds and planting materials, spices, cashew nut, tea, coffee etc.
- During 2005-06, the value of export material was worth Rs.1, 24,175 million. During the year, export of cashew nut was dominantly higher followed by spices, tea and coffee.

Fruits:

- India is the largest producer of mango, banana, grape and litchi. However, the bulk of the production is consumed domestically.
- Of the total global exports for fruits, India_s share is only 0.3%.
- Fruits accounts for about 11% of total horticultural export from country.
- Grape and mango together constitute 60% of India's exports of fresh fruits.
- Citrus, banana, apple and papaya are other important fruits for export.

Vegetables:

- During the year 2005-06, the export of fresh vegetables was of the order of Rs 919.8 crore.
- Onion accounts for maximum share in exports trade.
- Other major vegetables are tomato, potato, bean, pea, mushroom, asparagus, capsicum and okra.

Floriculture:

- In floriculture, cut flowers alone account of 86% of the total trade in this sector.
- Dried flowers and other plant parts are other prominent commodities.

Processed products:

- Of the total horticultural trade, processed fruits and vegetables account for 20% and 17% respectively.
- Among the processed fruits, fruits juice and dried fruits contribute to 41% and 12% of trade respectively.
- Mango pulp, pickles and chutneys of various fruits remain in high demand in export trade.
- Among processed vegetables, mushrooms, gherkins, dehydrated onion and frozen pre-cut vegetables are important items.

Spices:

- World trade in spices has been estimated of the magnitude of 7.5 lakh metric tonnes valued at Rs 1650 million US$.
- Indian spices command 43% share in volume and 31% in value of the world trade (2005-06).

- These commodities account for more than 5% of the total agricultural export earnings in the country.
- Value added spices are in large demand in export trade and their share is 60% of total export under spices.

Seeds and planting materials:

- The country exports seed and planting materials of fruits and vegetables.
- The export of these commodities was of the order of Rs.63 crores during the year 2004-05

Medicinal and aromatic plants:

- The country has its credits of exporting herbal material raw drugs to world market.
- Before 2005, Indian export of herbal material was worth Rs. 446 crore.
- China export in this regard has been worked out of the tune of Rs.18, 000-22,000 crore. Aloe veera, belladonna, acrus, cinchona, *Cassia tora*, dioscorea, senna, isbgol, etc., hold prominence in export trade under the sector.

Cashew nut:

- During the year 2004-05, cashew nut kernels worth Rs.2709 crore were exported.
- At present, the country exports about 1.27 lakh metric tonnes of cashew kernels worth Rs. 2500 crore.

Tea:

- Until 1987-88, India was dominant exporter of tea in the world market.
- The share of tea in total agricultural export was 20.7%.
- In view of stiff competition from Sri Lanka, Kenya, China tea export from the country has been divided down.
- At present share of tea in total agricultural export has been merely 5%.

Coffee:

- After petroleum, coffee is the second largest commodity in the world trade. From India, 70% of the total production of coffee is exported.

Coconut:

- The recent trends in the exports of coconut products witness decrease in export of copra and copra meal.
- There has been moderate increase in coconut oil, desiccated coconut and shell charcoal while
- There is significant increase in coco chemicals, activated carbon, coir and coir products.
- Coir and coir products are major coconut based commodities in the export basket.

Rubber:

- The country exports natural rubber.
- Under this sector, it accounts for 1.1% of the global share.
- The export of natural rubber rose from 6995 metric tonnes in 2001-02 to 75,905 metric tonnes during 2003-04.

Cocoa:

- India exports cocoa products.
- During the year 2005-06, India earned foreign exchange worth Rs.24.80 crore out of export of cocoa beans/products.

Imports

- There is rise in the imports of certain commodities.

- Commodities like dried pea, apples, apple juice, dried vegetable, black pepper, raw cashew nut, areca nut, cocoa etc., are important items imports by India.
- In spice sector, India is leading producer but bulk of its production is utilized domestically itself.
- In cashew nut production scenario, the country produces 5.4 lakh tonnes of raw cashew nuts, as against the requirement of 11-12 lakh tonnes per annum to feed out 1700 cashew processing units.

HORTICULTURAL ZONES OF INDIA AND CLASSIFICATION OF HORTICULTURAL PLANTS

- can be made and development is planned. They are;

1. **Temperate:** Kashmir, Himachal Pradesh, North Uttaranchal, Sikkim and part of Arunachal Pradesh.
2. **N.W. Subtropical**: Punjab, Haryana, Rajasthan, Central Uttar Pradesh and North M.P.
3. **N.E. Subtropical**: Bihar, Jharkhand, Assam, Meghalaya, Nagaland, Manipur.
4. **Central tropical:** South Madhya Pradesh, Chattisgarh, Gujarat, Maharashtra, Orissa and West Bengal.
5. **Southern tropical**: Karnataka, Andhra Pradesh and Tamil Nadu.
6. **Coastal tropical humid:** Konkan, Goa, Kerala, Western Ghats, Eastern Ghats in Tamil Nadu, Andhra Pradesh and Orissa.

- To exploit the potential of a crop and its sustenance, right choice based on climate and soil is necessary otherwise the management of the crop becomes difficult and the cost of cultivation increases. To be precise, most adaptable crop should be chosen for sustenance.

Table 3: Climatic requirements for important fruits of India

Mango	:	Tropical and sub tropical.
Citrus	:	Subtropical but can be grown under temperate conditions.
Grapes	:	Temperate but can be grown under subtropical and tropical conditions.
Peaches	:	Temperate but low chilling varieties can be grown under subtropical conditions.
Sapota	:	Tropical but can be grown under subtropical conditions which are free from frost.
Papaya	:	Tropical and mild subtropical climate.
Banana	:	Tropical, can be grown under subtropical climate provided it is free from hot winds and frost.
Almond	:	Temperate but some low chilling varieties can be grown under subtropical climate.
Apple	:	Temperate but low chilling varieties can also be grown on lower hills.

FRUIT ZONES ARE:

1. Tropical fruit zone:

- This class includes fruit crops which are ever green unable to endure cool temperature but can tolerate warm temperature of about 1000F.
- The fruit plants of this zone need strong sunshine warm and humid climate and a very mild winter.
- They cannot stand against frost. Areas under this zone include West Bengal, Parts of Punjab, Haryana, Rajasthan Orissa, Maharastra, AP, Karnataka, TN and Kerala.
- Fruits crops: Banana, Pineapple, Sapota, Papaya, Cashew, Pomegranate.

2. Sub- tropical fruit Zone:

- This class includes fruit crops intermediate characters to tropical and temperatures.
- The summer is hot and dry and winter is less mild.
- They may be either deciduous or ever green & are usually able to withstand a low temperature but not the frost.
- Some require chilling for flower bud differentiation the fruits grow mostly in plains,
- The fruits include Citrus, Grapes, Phalsa, fig, guava, pomegranate, Banana etc.
- This fruit zone covers the plains of Punjab, UP, Parts of Bihar, MP, WB, Maharastra, Rajasthan, Karnataka, AP, TN, Kerala, Orissa. etc.

3. Temperate fruit zone:

- This class of fruits grows successfully in cold regions where temperature falls below freezing point during winter.
- During the cold season, the trees shed their leaves and go into rest period.
- For breaking the rest/dormant period, a definite chilling period is required. This chilling temperature helps the plants to put forth new growth, flowering and fruiting with the onset of spring season.
- The regions under this zone are J&K, Kuluvally, HP, Parts,
- Peaches, Plum, Cherries, Almond, Walnut, Strawberry, Apricot, persimmon, Pecan nut, Kiwi fruit etc.

4. Arid Zone:

- The arid zone has an extreme climatic condition, high temperature low humidity, rainfall is very low and its distribution is erratic, poor textured soil.
- The area of Rajasthan (62%) and Gujarat (20%) parts of the Punjab, Haryana, Karnataka & Maharashtra
- The crops are Phalsa, Date palm, Pomegranate, Ber, Custard apple, Tamarind etc.

5. Semi- arid zone:

- This region exhibits low and erratic rainfall, low humidity and high temperature
- Fruits of arid region can be cultivated in this zone also Mango, Sapota, Guava, Jack, Avocado, Ber, Pomegranate and Tamarind etc.

6. North- Eastern sub-Tropical zone:

- All tropical and sub-tropical fruits are grown in this region.

7. North- Western region:

- It is again classified into 4 regions; temperate- low winter temperature, dry temperature- highly cold condition, Sub- Temperate- winter temperature & lesser cold, Low hill valley- low winter temperature & lesser cold.
- Parts of J&K, HP, hills of UP, South of Punjab and Haryana.

8. Central tropical fruit zone:

- This region covers Southern parts of MP, Maharastra Orissa, parts AP, WB, Gujarat etc.

9. South tropical fruit zone:

- Karnataka, TN, Kerala & AP

10. Coastal tropical fruit zone:

- Kerala, Goa, Diu-Daman, Tripura, Coastal parts of Maharastra, AP, WB, TN, Orissa, Karnataka.

11. Humid zone fruit crops:

- This region is characterized by low temperature and high humidity.
- The crops are Litchi, Strawberry, Avocado, Mangosteen, Passion fruit etc.
- Apart from these fruit zones, India has been classified in to 21 agro ecological regions based on the physiography of soils, bioclimatic types and growing periods.

CLASSIFICATION OF HORTICULTURAL PLANTS

- India is endowed with rich vegetation wealth with rich diversity of plant wealth.
- About 9,500 species of ethno botanical interest have been recorded.
- Out of these, more than 50 types of fruits and vegetables, many individual types of spices, plantation crops etc. are under commercial cultivation in different parts of the country, under different sets of growing conditions.
- An attempt to deal with all these plants separately becomes tedious, cumbersome and infeasible and more so repetitive.
- To avoid these difficulties, it is better to classify the plants in groups, based on similarity or dissimilarity of attributes.
- Plants having similarity in either of the traits are placed under one group. Such type of grouping plants in different categories is referred to as classification.
- The overall objective of the classification is to systematize the presentation and make the remembrances of the plants easy and convenient.
- Generally based on botanical relationship, the plants are classified.

PRODUCTION TECHNOLOGIES

i. Some of the key technologies developed for commercial adoption are listed hereunder;

a. High density planting systems standardized in mango, banana, Kinnow, pineapple and papaya for higher productivity & profitability.
b. Use of plant growth regulators / chemicals for flower production /regulation in mango, improvement of berry size and quality in grape, control of fruit drop in citrus, mango, ripening of fruits standardized.
c. Off-season, round the year production technology in radish and tomato.
d. Production technologies for Kharif season onion in North India and long day type onions for high altitudes. Technology has been perfected for low cost cultivation of mushrooms like Agaricus, Pleurotus etc. for different agro-climatic conditions.
e. Technology developed for successful cultivation of high value medicinal mushroom Reishi or Ling Zhi (Ganoderoma lucidum).
f. On-farm trials for mass cultivation of white button and oyster mushrooms on wide adoption in hilly areas.
g. Agro-technique developed for open and protected cultivation of quality cut roses, carnation, gladioli, tuberose etc. • Rootstocks recommended for different agro-climatic conditions like Rosa indica var. odorata, R. multiflora, IIHR-Thornless and R. chinensis.
h. Spacing, fertilizer application and weed control techniques standardized for chrysanthemum, carnation, tuberose, marigold and different annuals.
i. Growing media standardized for both Epiphytic and Terrestrial orchids.

j. Agro-technique for cultivation of over 50 MAPs including Guggulu and Saffron (Kumkum) standardized.
k. Technology for primary processing of different MAPs and their value addition developed. Technology for drying of flower and foliage, extraction technique of essential oils, pigments etc. developed.
l. Multi-species cropping systems or multi-storeyed cropping systems standardized for coconut, areca nut and oil palm.
m. In cashew, technologies like high density plantation, rejuvenation, drip irrigation and biocontrol of Tea mosquito has been standardized.

n. Standardization longer pruning cycle in tea for higher yield and better distribution of crop to increase production (7 to 20%).
o. Development of compatible rootstocks in superior tea clones for increasing yields by 26 to 27%. Technique of rejuvenation, pruning, infilling and consolidation developed for increasing productivity by 2 to 4 times.
p. Technology for organic production of tea developed.
q. Planting density standardized for close planting (420 to 445 plants per ha) in the case of buddlings and 445 to 520 plants per ha in the case of seedlings in rubber.
r. Intercrops such as banana, pineapple, ginger, turmeric, vegetables and medicinal plants recommended for rubber, norms for diagnosis and recommendation integrated system (DRIS) have been evolved and fertilizer recommendations and use of organic mulch have been recommended for resource conservation.

PLANTATION

Plantation: A large contiguous area in which a forest crop raised either by direct sowing or transplanting.

Plantation crop:

In original sense the term plantation refers to a forest crop raised artificially either by direct sowing or planting. In horticulture sense the term plantation crop refers to a woody perennial crop grown on a large contiguous area, managed by an individual or a company, the produce of which is consumed only after processing.

Requirements of a crop to be categorized under plantation crop:

1. It should be a woody perennial (palm, tree, shrub or vine).
2. It should be grown on a large contiguous area (estate or plantation)
3. It should be managed by an individual or company.
4. The produce is suitable for consumption only after processing.

Estate or plantation:

The term estate or plantation refers to a large scale agriculture unit, usually of a single crop or a large contiguous area usually under a single crop managed by individual or company. Plantation crops are cultivated on an extensive scale. Produce has to be processed before they are put to use. They are high value commercial crops. All are perennials. Areca nut, Cacao, cashew nut, coconut, coffee, oil palm, betel vine, rubber and tea are some of the plantation crops.

Economic importance:

- They are **export oriented**. Ex: cashew nut, betel vine, tea comprise of 75% of total export earnings from the export of all agricultural produce.
- **They provide gainful employment:** Cashew cultivation employs 2 lakh people; processing industry employs 3 lakh people. Areca nut crop employs 6 million people. Coconut crop

employs 10 million people. They occupy only 2% of total cultivated area, but generate 36,000 million rupees per annum.

- They support many ancillary industries.
- They conserve soil and eco system.
- Tea and coffee are cultivated over hill slopes; cashew nut is cultivated on waste lands. They protect soil from erosion losses.

Geographical distribution of plantation crops:

Almost all plantation crops are restricted geographical distribution to the tropics. Certain plantation crops are sun loving (coconut, cashew nut, rubber, oil palm, areca nut), others are shade loving (cocoa, tea, coffee, betel vine). In general coconut and cashew nut are cultivated in coastal belt. The sun loving plantation crops should always be raised under mono culture as sole crop, while the shade loving plantation crops (cocoa, coffee) may be raised as inter crop in the inter spaces of grown up sun loving plantation crops (coconut, oil palm and areca nut) or grown along with shade or nurse trees (silver oak) to have either shade (coffee, tea) or support (betel vine) or both (betel vine)

Importance and Area of Plantation Crops

Importance of Plantation Crops:

The term Plantation crops refers to those crops which are cultivated on an extensive scale in a large contiguous area, owned and managed by an Individual or a company. The crops include tea, coffee, rubber, cocoa, coconut, arecanut, oil palm, palmyrah, cashew, cinchona etc. These plantation crops are high value commercial crops of greater economic importance and play a vital role in our Indian economy. The main draw back with this sector: of crops in India is that major portion of the area is of small holdings (except Tea) which hinders the adoption of intensive cultivation. In the case of coffee 97.13 per cent of the growers have holdings below ten hectares and in Rubber, 82 per cent of the total area is of small hojdings having an average size of 0.5 ha.

The Economic Importance of these Crops are:

1. They contribute to national economy by way of export earnings. These crops occupy less than 2 per cent of the total cultivated area (i.e. 3.82 per cent of total crop land) but they generate an income of around Rs. 16,000 million or about 12.72 per cent of the total export earnings of ail commodities or 75 per cent of total earnings from the export of agricultural produces.

2. India is the leading country in the total production of certain plantation crops in the world. For instance, our production meets the share of 47 per cent in tea and 66 per cent in each of cashew and arecanut,

3. Plantation industry provides direct as well as indirect employment lo many millions of people. For instance, tea industry offers direct employment to 10 lakhs and indirect employment to 10 lakh people, while-cashew processing factories alone provide employment to 3 lakhs people besides 2 lakhs farmers are employed in cashew cultivation.

4. Plantation industry supports many by-product industries and also many rural industries. For example, coconut husk is used to produce coir fiber annually to a tune of 2,19,600 tones in India.

5. These crops help to conserve the soil and ecosystem. Tea planted in hill slopes and cashew in barrel and waste lands protect the land from soil erosion during the rainy season or due to heavy winds.

Post-Harvest Management

Improper harvesting, handling transportation and distribution of fruits and vegetables result in the significant losses which cause ultimately economic loss. The reduction of post-harvest losses reduces the dependence on imports of commodity fertilizers pesticides and other chemicals save a substantial amount of foreign exchange. It is estimated that total loss of vegetable and fruits in India due to inadequate post-harvest handling transportation of storage at less 20-25%.

The importance of reduction in post-harvest loss of fruit and vegetable is of vital importance countries like India, Malaysia and knowledge of post-harvest management and loss of fruits and vegetables.

Several factors influence the post-harvest losses due to physical, physiological, mechanical and hygienic conditions. Fruits and vegetables are characterized by high metabolic activities and known to possess short shelf life. Recent development has improved shelf life of fruit and vegetables.

Supply Chain Management in Horticulture

some case studies of organised supply chains of some horticultural commodities in the first chapter. However, there is a need to make an in depth analysis of the issues regarding supply chain management of horticultural produce in India. The chapter covers an all India scenario of horticulture sector, followed by a case study of supply chain management issues prevailing in A.P., as the scenario is, more or less, same through the country.

Horticulture production in the National context

India is the fruit and vegetable basket of the world. It grows a variety of fruits and vegetables and has huge production of both fruits and vegetables. India is the second largest producer of both fruits and vegetables in the world after China. In fruits, India is the largest producer of banana, mango and papaya, sixth largest producer of pineapple and seventh largest producer of apple in the world. In vegetables, it is the largest producer of okra, second largest of producer of brinjal, cabbage, cauliflower, onion and potato and third largest producer of tomato in the world. The production and productivity of fruits and vegetables in India for the last three years is given the adjacent chart.

The vast production base of horticultural produce offers India tremendous opportunities for export. During 2012-13, India exported fruits and vegetables worth Rs.5730.85 crores which comprised fruits worth Rs.2467.40 crore and vegetables worth Rs. 3263.45 crore. Mangoes, Walnuts, Grapes, Bananas, Pomegranates account for larger portion of fruits exported from the country while Onions, Okra, Bitter Gourd, Green Chilles, Mushrooms and Potatoes contribute largely to the vegetable export basket.

The major destinations for Indian fruits and vegetables are UAE, Bangladesh, Malaysia, UK, Netherland, Pakistan, Saudi Arabia, Sri Lanka and Nepal. Though India's share in the global market is still nearly 1% only, there is increasing acceptance of horticulture produce from the country. This has occurred due to concurrent developments in the areas of state-of-the-art cold chain infrastructure and quality assurance measures. Apart from large investment pumped in by the private sector, public sector has also taken initiatives and with APEDA's assistance several Centres for Perishable Cargoes and integrated post-harvest handling facilities have been set up in the country. Capacity building initiatives at the farmers, processors and exporters' levels has also contributed towards this effort.

Domestic consumption and exports

Fruit and Vegetable (both fresh and processed) based products constitute close to 17% of the food and groceries consumption of the Indian households. Consumers in India are used to buying fruits and vegetables in the primary form and process the same at their homes. Households spend time in cleaning, sorting and cutting, before cooking food. Close to 80% of the fruits and vegetable are consumed in primary form with little value addition. In case of tertiary products, confectionery products and potato chips have a major share. Consumer spending on categories such as canned food, jams, pickles, and other ready to eat processed products is still at a low level in India, thereby showing high potential for growth. An opportunity exists for players to offer tertiary processed products, which can substitute the home, based processing — such as soups, ready-to-eat meals, and canned food amongst others.

AGRONOMIC PRACTICES AND PRODUCTION TECHNOLOGY OF VARIOUS PLANTATION AND HORTICULTURE CROPS

Read Here: (just simple reading of all topics in below links)

Production Technology Plantation Crops

http://agriinfo.in/default.aspx?page=topiclist&superid=2&catid=51

Production Technology of Spices

http://agriinfo.in/default.aspx?page=topiclist&superid=2&catid=52

Production Technology of Aromatic Crops

http://agriinfo.in/default.aspx?page=topiclist&superid=2&catid=53

Production Technology of Medicinal Crops

http://agriinfo.in/default.aspx?page=topiclist&superid=2&catid=54

The Flash's

Articles

For

NABARD Gr. A & B

By:- Gaurav(The Flash)

#6

Animal Husbandry

&

Fisheries

Animal Husbandry

Ever since the beginning of civilisation, humans have depended on animals for many requirements, such as that of food (milk, meat and egg), clothing (hide or wool), labour (pulling, carrying load) and security etc. The development of desirable qualities in all such animal species, through creating better breeds, has been an important human achievement. For this, humans have consistently tried to improve the breeds of domesticated animals to make them more useful for them. In this lesson, you will learn about the common breeds of such animals, their uses and some methods of improving their breeds.

The branch of science, which deals with the study of various breeds of domesticated animals and their management for obtaining better products and services from them is known as **Animal Husbandry**. The term husbandry derives from the word "husband" which means 'one who takes care'. When it incorporates the study of proper utilisation of economically important domestic animals, it is called **Livestock Management.**

Different Categories of Animals

Wild –Those that breed better where they are free than they do when they are captivated. They have no common use for humans. Example Lion, Tiger, Rhinoceros, Deer etc.

Tamed – Those, which are caught from the wild and trained to be useful to humans in some way. Elephant, Chimpanzee, Gorilla, Yak etc.

Domesticated – Those that are of use at home and are easily bred and looked after by humans. Common domesticated animals are dog, horse, cow, sheep, buffalo, fowl etc.

Importance of domestic animals

On the basis of utility, domestic animals are categorised into the following functional groups

1. Milk giving animals Cattle, buffalo, goat, sheep etc.
2. Draught (used for load Bullock, horse, donkey, mule, bearing) animals camel, elephant, yak etc.
3. Fibre, hide and skin yielding Sheep, goat, cattle, buffalo, camel etc.
4. Meat and egg yielding animals Fowl (hen) and duck, goat, buffalo, pig etc.

MILK AND MEAT YIELDING ANIMALS

Depending upon the availability and regional considerations different animals are reared for the purposes of yielding milk and meat in India. India is the world's largest producer of milk. The majority of the milk consumed is also in liquid form in India. Over 53% of milk produced in India is from the water buffalo and a majority of milk processing plants in the country depend upon buffalo milk.

The **National Dairy Development Board (NDDB)** is the main agency behind the cooperative movement in India. India is now seeking joint ventures and financial participation from the private sector including foreign investment for production of milk and milk products in India.

Cattle

Cattle mainly include cow, bull, oxen, goat, sheep etc. The females of the species provide milk, which in turn contribute animal's protein to the diet of people. While the female species of these cattle are used for milk, the male species play an important role in the agricultural economy by providing labour, meat and hide. Milk itself is taken in many forms like ghee, curd, butter and cheese etc. The excreta of these animals (dung) is used as manure, in biogas and as fuel. There are several important breeds of cattle in India and abroad.

Milk yielding animals

What is a breed?

A breed is a group of one species of animals, which have the same descent and are similar in body shape, size and structure.

Categories of Important breeds:

There is following three categories
1. Indian breeds
2. Exotic Breeds
3. Improved breeds

(a) Indian Breeds

Gir, Sahiwal, Red Sindhi, Thararkar, Kankrej etc. are some high yielding varieties of Indian cattle

(b) Exotic Breeds (Imported breeds)

Hilstein, Friesian, Jersey, Swiss etc. are some of the high yielding varieties that have been imported from abroad and reared widely in India.

(c) Improved breeds of Indian cattle

Certain improved breeds have been developed by making a cross between two desired breeds. A cross between **Sahiwal** and **Friesian** varieties has been named as Friewal, Karan Swiss is another improved breed for milk production in large quantities. Table 33.1 shows some Indian breeds, their milk yield and distribution

Table 33.1 Some Indian Breeds and their Milk Yield

Breed	Milk yield (litres) Per lactation period	Distribution
Gir	1200-2200	Gujarat, Rajasthan, Maharastra
Red Sindhi	700- 2200 Pakistan	Andhra Pradesh, all part of world including India and
Sahiwal	1100- 3100	Haryana, Punjab, Uttar Pradesh
Kankrej	1400	Gujarat
Tharparkar	700-2200	Rajasthan
Mewati	1100	Rajasthan
Ongole	700	Andhra Pradesh
Hariana	500	Gujarat,Rajasthan
Hallikar	227-1134 litres	South India
Kangayam	665 litres	Tamil Nadu
Murrah	20-22 litre/day	Punajb, Haryana, Uttar Pradesh

Lactation Period is the period of milk production between birth of a young one and the next pregnancy and it usually lasts about 300 days.

Breeds of Buffaloes

Breed	Distribution
Murrah	Haryana and Punjab
Bhadawari	Uttar Pradesh and Madhya Pradesh
Jaffarabadi	Gujarat
Surti	Gujarat
Mehsana	Gujarat (cross breed between Surti and Murrah)
Nagpuri	Maharastra
Nill Ravi	Punjab
Porlakmedi	Orissa

Cattle feed

The main feed of cows and buffaloes are grass but this does not provide them all the nourishment. They require balanced diet in the form of roughage which is fibrous food containing large amount of fibres such as hay fodder, leguminous plants-soya beans, peas and cereals like maize, jowar etc The diet of cattle mainly consists of roughage (dry or green fodder or fibrous food) and concentrates like grains, oil cakes and seeds, mineral salts and vitamins.

Dairy Products

Milk as drawn from the animals is known as full cream milk. When the cream is separated and the remaining milk is called toned milk. This milk contains no fat and is known as **skimmed milk**. On the basis of fat contents the various milk product are as follows:

Cream : It is prepared by churning milk, the fat comes on the top which is separated by draining out the liquid. It is known as cream with 10-70% fat contents.

Curd : Milk is converted to curd due to bacterial activities.

Butter Milk : It is the left over liquid after removal of butter.

Ghee : After heating butter, the water evaporates and fat contents are almost 100%.

Condensed milk : Milk is concentrated by removing water contents with or without adding sugar. It has 31% milk solids with 9% fats.

Powdered milk : It is the powdered form of milk.

Cheese : It is coagulated milk protein-casein with fat and water.

Khoya : A desicated milk product prepared by evaporating water contents and reducing the bulk to about 70-75%.

Cattle Dung : Cattle dung is mainly used to make dung cakes for burning as fuels. It is used mainly in villages of India. The farmers also use cattle dung to produce bio gas and the leftover residue as manure.

Biogas plant (Gobar gas plant)

Bio gas plant is a chamber where animal excreta (Cow dung, buffalo dung etc) and some anaerobic bacteria are fed into airtight biogas chamber. Decomposition of excreta produces methane gas used as a smoke free gas for cooking. This gas can also be utilized for lighting. The left over solid residue serves as a good manure.

Meat yielding animals

(i) Sheep

Sheep is the second largest species reared by mankind and it provides wool, meat, milk and hide. Their droppings form good manure. Important breeds of sheep in India are as follows:

Breeds of Sheep

Breed	Distribution
Chokla	Rajasthan
Nial	Rajasthan and Haryana
Marwari	Rajasthan and Gujarat
Magra	Rajasthan
Jaisalmeri	Rajasthan
Pugul	Bikaner (Rajasthan)
Malpura	Rajasthan
Potanwadi	Uttar Pradesh and Delhi
Muzaffararanagari	Haryana
Hissardale	Himachal Pradesh and Haryana
Nellore	Andhra Pradesh
Bellary, Hassan, Mandya	Karnataka
Mecheri, Kalikarsal, Vembur	Tamil Nadu

Exotic Breeds

The main exotic breeds of sheep are Toggen berg, Saanen, French, Alpine and Nuibian and Angora.

Feeding of sheep

They feed on green grasses and other wild plants. When sheep are reared for a particular purpose, they are given protein, minerals and vitamin rich food. The main constituents of their food are as follows :

- **Leguminous fodder** : Urad, mung, berseem etc.
- **Oil cakes** : Groundnut, seasame cake, (rich in proteins)
- **Grains** : Maize, barley, oats and jowar.
- **Lime, common salt** : Sterilised bone meal (rich in mineral salts)

(ii) Goat

Important breeds of goats used for milk, meat and hide. There are about 19 well known Indian breeds, apart from a number of local non-descript breeds that are scattered throughout the country. The breeds are mentioned below on the basis of their location.

Himalayan Region (hilly track)
Cham, Gadd : Kashmir, Himachal Pradesh , Jammu and Kashmir
Pashmina : Himachal Pradesh, Ladakh, Lahul and Spiti valley
Chegu : Kashmir

Northern Region
Jamunaparu – Uttar Pradesh, Madhya Pradesh
Beetal – Punjab
Barhari – Delhi, Uttar Pradesh, Haryana

Central Region
Marwari, Mehsana and Zelwadi – Rajasthan, Gujarat and Madhya Pradesh
Kathiawar – Gujarat and Rajasthan

Southern Region
Surti – Gujarat
Deccani, Osmanabadi – Andhra Pradesh, Tamilnadu
Malabari – Kerala

Eastern Region
Bengali – West Bengal, Assam and Tripura

Feeding of goat

The goats are fed on open fields with enough green. They can be only given cereal and grain products. Sometimes however, a milk goat requires a balanced feed with 4-5 kg of fodder and a mixture of crushed grains such as yellow maize, jowar and other cereals and ground nut or linseed oil meal or steamed bone meal.

(iii) Pig

Pig farming is gaining importance in India. Pigs provide only 8% of total meat production in our country. Pig skin, fat and hair are required for leather, soap, oil, hair-brush industry respectively. Pig manure is rich in nitrogen, phosporus and potassium. Pigs contribute about 5% of total meat production in India, and constitute a rich source of animal protein available at low cost. The calorific value of Pork (pig's meat) is much more than the other edible meats. Pigs can feed on farm waste, garbage and spoiled grains.

DRAUGHT ANIMALS

Draught animals are animals need for carrying load. From time immemorial a number of animal species have been used for special purposes by humans, utilising their mechanical strength, endurance and speed. These include horse for riding and swift running; elephant for riding, strength and heavy load lifting, camel for riding in sandy desert and ability to survive without water for long duration, donkey and mule (a hybrid of male donkey and female horse) for carrying load. Most of the draught animals are herbivorous and survive on leaves of trees, shrubs and bushes. While raising them, they are also fed on grains, beans, cottonseeds, maize and bran besides dry/ green fodder. In Rajasthan, camel is used for yielding milk also.

Horse

The horse has fast movement, great stamina and endurance. Its body is suited for ride, load pulling, mountain climbing and forest travelling. So the horse is an important draught or work animal. They learn fast and can be maintained easily in various climatic conditions. Due to their ability to move swiftly in rough areas, they are still useful in hills and in the deserts. Common Indian breeds and their distribution are as follows-

Breed	Region
Kathiawari or kaunchi	Rajasthan and Gujarat
Marwari or malvi	Rajasthan
Bhutia	Tarai belt of Himalayan region (Punjab-Bhutan)
Manipuri Pony	Eastern hill region
Sipti Pony	Himachal Pradesh

FIBRE, HIDE AND SKIN YIELDING ANIMALS

Besides providing meat, milk and transport, livestock provide many commercially useful products such as fibre, skin and hide. Generally sheep and goat provide fibres for making of products like wollen strings, ropes, carpets, clothing and brushes etc.

EGG YIELDING ANIMALS

This category consists of egg producing animals whose eggs are used as food by mankind to provide proteins. **Poultry farming is defined as a term for rearing and keeping of birds such as fowl, duck and hen for egg and meat**. Poultry farming has become popular because it is comparatively easy to start and maintain. It gives quick return within one to six month of investments,, is easily manageable and requires less space and labour. Poultry birds and their eggs are a rich source of nutrients.

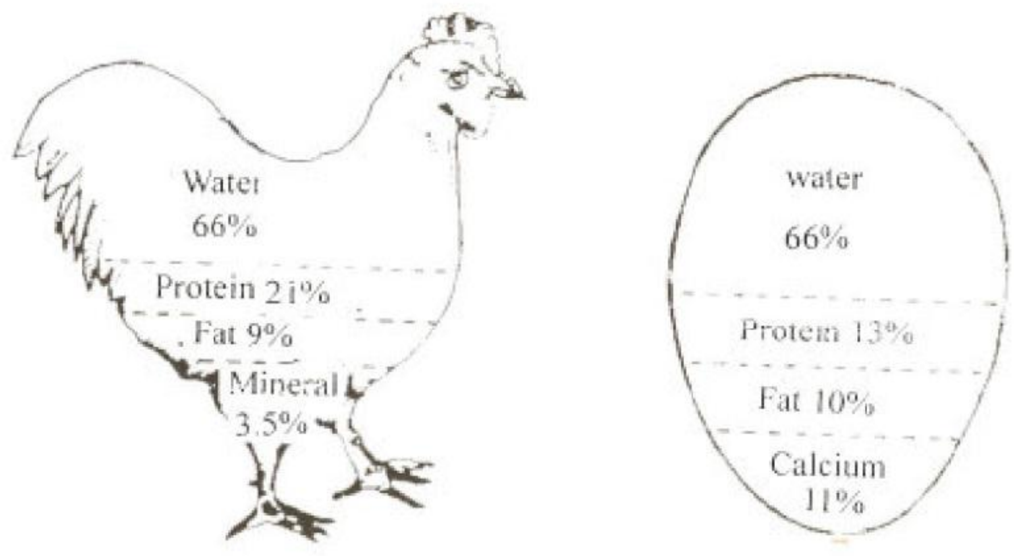


Fig. 33.2 Composition of chicken and egg.

Common breeds of Poultry birds

Indian poultry breeds provide good quality meat but produces small sized eggs. They have natural immunity against common diseases as compared to exotic varieties bred abroad which require greater protection and immunisation. The chicken is commonly classified on the basis of its origin.

(a) American,

(b) Asiatic,

(c) Mediterranean and

(d) English

1. Plymouth Rock, Rhode Island Red, New Hampshire - American
2. Brahma, Cochin, Langshan - Asiatic
3. Leg horn, Minoxa - Mediterranean
4. Cornish, Australorp – English

Indigenous Breeds

Aseel – Rajasthan, Andhra Pradesh, Uttar Pradesh
Busra – Gujarat and Maharastra
Chittagong – Eastern India
Karaknath – Madhya Pradesh

(i) Indian Breeds

The Indian breeds of hen include Aseel, Chittagaog, Ghagus and Basra. Their egg laying capacity is around 200 eggs per year.

(ii) Exotic Breeds

These breeds are important from other countries and include White leghorn, Minorca, Rhode Island red. These birds have high egg laying capacity but carry less flesh as compared to Indian birds.

(iii) Upgraded variety

Some improved varieties have been developed in India by hybridisation such as B 77, ILS 82 etc. They grow fast and also have as high an egg laying capacity as the exotic varieties and are better suited to the Indian climate.

Poultry Feed

Depending upon the requirement of meat or egg production, poultry feed mainly consists of maize, rice, wheat bran, ground nut cake, fish meal, lime stones, bone meal, common salt, vitamins and minerals.

GENETIC IMPROVEMENT IN ANIMALS

The application of laws of animal health and reproduction genetics has contributed towards increase in milk, egg and meat productivity. The increase in egg production brought about the silver revolution in the area of animal husbandry. The methods being widely used are **artificial insemination** and **embryo transplant**.

(i) Artificial insemination

Artificial insemination involves collection of semen from a healthy bull of the desired breed, its storage at low temperatures and introduction into the females of cattle of other breeds for bringing about fertilisation using sterilised (germ free) equipment. Advantages of this method are:

(a) Up to 3000 females can be fertilised from semen collected from one bull.
(b) The semen can be stored for a long period and transported over long distances.
(c) Economical and high success rates of fertilisation.

(ii) Embryo transplant

This method of breed improvement has been quite successful in sheep and goat. In this method, embryos (depending on their period of development) from superior breeds are removed during the early stages of pregnancy and are transferred to the other female with inferior characters, in whose body the gestation period is completed. By this technique, quality and productivity in the livestock can be improved. Unlike artificial insemination, this method has low success rate due to greater chances of contamination.

Agricultural Practices and Animal Husbandry

Our food items are either plant products, such as grains, vegetables or fruits or animal products like milk, egg, mutton, chicken etc. We eat various parts of plant as food. For example, grains of rice, wheat and corn are seeds; radish and carrot are roots; potatoes and ginger are the stem. We also eat leaves and stem of spinach and plenty of fruits. Thus, human beings depend on plants and animals for food.

AGRICULTURE AND AGRICULTURAL PRACTICES

The branch of science which deals with methods of food production is known as **agriculture**. Besides studying the new methods of food production, in this branch of science we also study about how new and better varieties of crops can be grown, how animals and birds like cows, hens, etc. can be reared well and made to give more milk or better quality eggs? All these new methods which scientists develop come under **agricultural practices**. We need vegetables, fruits, cereals, pulses, etc. as food. For our clothes, we need the fibre of plants or animals. We get all these foods and fibres by farming or agriculture.

Need for animal husbandry

We have a large number of animals in our country. Yet we do not get as much food from these animals as we possibly can and need for our large population. Besides the food, which we get from animals, we need them to do a lot of our work. In India, we have about 80.4 million cattle, which work in the fields. If we take the ratio of working cattle to the area of land, which is being used for cultivation we find that only two individuals of cattle are available to plough 3.8 hectares of land. You all know that cattle wastes like urine and faeces are natural manure which enrich our soil. Unfortunately, in India we do not use all the cow dung available and a lot of it goes waste. Gobar gas plants have been developed so that we can make use of the cattle dung both for fuel as well as to make manure. Thus, we find that animal husbandry is a very important field which helps us to improve our livestock and other useful animals and make the maximum use of them.

Management of livestock

When we study about improving our livestock we learn how they must be sheltered, fed, and mated, what kind of drinking water should be given to them and how the sick and diseased animals ought to be treated? This way we learn to manage our livestock for better production and utilization.

1. Feeding of animals

All animals must be fed properly. The food should contain the requisite nutrients i.e. carbohydrates, proteins, fats, minerals, vitamins and water. The food which is given to cattle can be divided into two categories:

• **Concentrates** like cotton seeds, oilcakes, cereal grains, bran etc. They are very rich in most of the nutrients.

• **Roughage** includes fibrous and rough food like straw and stems of cereal crops. Generally roughage has a low nutrient content. An average Indian cow eats about 15-20 kg of green fodder and 4 to 5 kg drygrass, which is mixed with a sufficient amount of grain. A cow drinks about 32 litres of water. Goat and sheep eat grass, herbs and waste products from the farms. Pigs are usually given cereals and their products to eat. Poultry birds are given a mixed feed consisting of cereals, bone meal, minerals and vitamins.

2. Housing of animals

We must protect our animals from too much heat, rain and cold. We must, therefore, be careful where we house them. Their houses should have proper sanitation and ventilation. Too many animals should never be kept in a small space. Different animals require different types of houses. Hens and fowls are kept in cageswhile sheep and goats stay in open yard, which is partially covered with roof made of straw. This open yard should have a hedge of iron wires all around to prevent the animals from running away.

3. Water and its supply

To keep these animals healthy they should be given clean water to drink and in sufficient quantities. For example, on an average a cow consumes about 27-36L of water, pigs require 5-23L, camel 8-90L and poultry birds require about 240mL of water. Besides this we must also bathe the cattle with clean water.

TENTH PLAN FOCUS AND STRAREGY

Animal husbandry and dairying will receive high priority in the efforts for generating wealth and employment, increasing the availability of animal protein in the food basket and for generating exportable surpluses. The overall focus will be on four broad pillars viz.

(i) removing policy distortions that is hindering the natural growth of livestock production;
(ii) building participatory institutions of collective action for small-scale farmers that allow them to get vertically integrated with livestock processors and input suppliers;
(iii) creating an environment in which farmers will increase investment in ways that will improve productivity in the livestock sector; and
(iv) Promoting effective regulatory institutions to deal with the threat of environmental and health crises stemming from livestock.

The Tenth Plan target for milk production is set at 108.4 mt envisaging an annual growth rate of 6.0 per cent. Egg and wool production targets are set at 43.4 billion numbers and 63.7 million kg respectively. The allocation for animal husbandry, dairying and fishery is Rs. 2500 crore during the Tenth plan.

Transfer of Technology

Use of technological and marketing interventions in the production, processing and distribution of livestock products will be the central theme of any future programme for livestock development. The generation and dissemination of appropriate technologies in the field of animal production as also health care to enhance production and productivity levels will be given greater attention. Integration of Animal Research Institutes with the Department of Animal Husbandry and Dairying is essential to facilitate transfer of technology as well as to undertake sanitary and phyto-sanitary measures. This would provide an effective delivery machinery to the Department enabling it to work primarily as a regulatory body in the liberalised era.

Human Resource Development and Extension

Sustainable rapid growth and development in this sector can only be ensured if the livestock owners, service providers, veterinarians and planners become knowledge based and acquire the ability to absorb, assimilate and adopt developments in the veterinary sciences and related technologies. Efforts will be made to improve the skills and competence of all stakeholders by involving village schools, veterinary colleges and universities in collaboration with the ICAR and its institutions including Krishi Vigyan Kendras (KVK), State Agricultural Universities and their field stations. Steps will be taken to ensure that veterinary education is regulated as per the guidelines of the Veterinary Council of India. Introduction of animal science education (rearing of poultry, cattle, sheep, goat and pig) in the school curriculum will be one of the focus areas during the Tenth Plan. Training of para-veterinarians, Artificial Insemination (AI) technicians, and laboratory technicians on a regular basis will be given priority. Similarly livestock extension, which is primarily based on providing services and goods, will be treated differently from crop-related extension activities that are primarily based on transfer of knowledge. Livestock extension will be driven by technology transfer. As women play an important role in animal husbandry activities, deployment of women extension workers will be encouraged and they will work as links between farmers, the animal husbandry department and workers of NGOs.

Integration of Programmes

Besides the Ministry of Agriculture, schemes relating to animal husbandry and dairying are being implemented by other ministries viz. Ministry of Rural Development, Ministry of Nonconventional Energy Sources etc. Many schemes operated by these ministries have similar and overlapping objectives and target the same population. Generic components like extension, training, and infrastructure get repeated in most of such schemes and are not complementary. Efforts will be made to consolidate and bring in convergence in these areas.

Livestock Services

Most of the livestock services like artificial insemination/natural service, vaccination, deworming etc. are time-sensitive, which Government institutions, at times, are not able to deliver due to financial as well as bureaucratic constraints. This necessitates the providing for efficient and effective decentralised services in tune with demands emanating from users. Efforts will be made to provide such services at the farmer's door, linked with cost recovery for economic viability. Availability of credit in time and technology support are the two important services needed for livestock development in the rural areas.

Livestock Breeding Strategy

A national livestock breeding strategy needs to be evolved to meet the requirements of milk, meat, egg and other livestock products. Major thrust will be given to genetic up gradation of indigenous/native cattle and buffaloes using proven semen and high quality pedigreed bulls and by expanding the artificial insemination and natural service network to provide quality semen and other services at the farmer's level. Improved bulls for natural breeding will be made available to private breeders, Gaushalas, NGOs and panchayats in remote and hilly areas. The programme of providing exotic males for improvement of sheep in the northern temperate region and pigs in the north eastern region will continue in the Tenth Plan. Financial and technological support would be needed to promote breeding programmes.

Conservation of Breeds

Conservation of threatened breeds of livestock and improvement of breeds used for draught animals and packs would be one of the major goals of the Tenth Plan. It will be the national priority to maintain diversity of breeds and preserve those showing decline in numbers or facing extinction. The improvement programme of indigenous breeds possessing desirable characteristics like disease resistance, heat tolerance, efficient utilisation of low quality feed etc. will be taken up. This is essential even for a sustainable crossbreeding programme. Steps will be taken to coordinate all the activities related to the efficient utilisation of draught animal power and animal by-products. Similarly efforts will be made to conserve indigenous birds and propagation of other birds like quail, guinea fowl and duck in those parts of the country where they are popular

RECENT INITIATIVES

- Withdrawal of Milk & Milk Products Order MMPO)
- Introduction of National Project on Cattle & Buffalo improvement Programme
- Database & Information Network
- Creation of disease free zone (proposed)
- Conservation of threatened livestock breeds (Proposed)
- Feed & Fodder production enhancement (Proposed)
- Dairy/Poultry venture capital fund (proposed)
- Clean Milk Production (proposed)

Quality and Safety Of Livestock Products

Quality and safety of livestock products depend upon a quality and safety assurance system for which legislation for setting up standards, corresponding to Codex standards, is obligatory. These do not exist nor is there any method for reviewing and rationalising the quality and safety guidelines. Efforts will also be made for harmonisation of infrastructure facilities for testing food quality and safety with international standards.

Database

Currently, there is absence of a lot of data like those relating to breed-wise milk production of cattle and buffalo, egg production from commercial farms and households, cost of production of milk, egg and wool, availability of livestock resources etc. A National Animal Health and Production Information System will be established with the active involvement of research Institutions, Government departments, panchayati raj institutions (PRIs), urban local bodies (ULBs), private industries, cooperatives and NGOs. This will work as the national database.

Animal Welfare

Animal welfare is also related directly with the productivity of animals. The well-being of animals is affected during management under the intensive production system, in the animal market, during handling and transportation, rearing of buffalo male calves in urban areas etc. There is a great deal of wastage, as well as animal suffering due to ill-designed agro-implements, carts and implements attached to animals. Efforts will be made to strengthen the institutions working on a livestock care system so that they can ensure and promote animal care and well-being. Research and technology development will be taken up for enhancing efficiency and reducing drudgery of animals by improving the design of carts, yokes, implements and toolbars used in agriculture. A good example is the buffalo-drawn bogey fitted with rubber tyre and bearings.

Development of Location Specific Animals

Camel will continue to be important in desert areas for quite some time. Effective support for providing nutrition and health cover is needed for its improvement. The Department of Animal Husbandry will continue its programme for improvement of better studs both for horses and donkeys used for transport in hilly areas. Horse riding is now becoming an integral part of amusement parks and this will be encouraged as a niche industry. To encourage the breeding of horses, mules and asses, technological and financial support will be extended to entrepreneurs. Animals indigenous to specific agro-climate regions like Yak and Mithun will be developed.

Capital Formation

Public sector lending in the livestock sector is low and inadequate credit support leads to poor capital formation. As the organised financial sector is unwilling to finance livestock programmes that are not in their interest, especially after the initiation of financial sector reforms, the livestock farmers are mainly dependent on the financial intermediaries and they end up bearing a higher interest rate than would be available otherwise. Attempts would be made to create a favourable economic environment for increasing capital formation and private investment. Financial institutions would actively participate in livestock credit programmes through standardised ready-made bankable projects with back-ended subsidy. Creation of a venture capital fund is needed to assist the private entrepreneur in establishing units that could provide services and goods at the district/block level.

THE PATH AHEAD

The programmes that will be emphasised during the Tenth Plan are:

1. The major thrust will be on genetic up gradation of indigenous/native cattle and buffaloes using proven semen and high quality pedigreed bulls and by expanding artificial insemination and natural service network to provide services at the farmer's level. Production of progeny-tested bulls in collaboration with military dairy farms, government/institution farms and gaushalas will be taken up.
2. Conservation of livestock should be the national priority to maintain diversity of breeds and preserve those showing decline in numbers or facing extinction.
3. After the successful eradication of Rinderpest disease, the focus would now be to adopt a national immunisation programme to control prevalent animal diseases. Efforts will be made for the creation of disease-free zones.
4. Development of fodder through cultivation of fodder crops and fodder trees, regeneration of grazing lands and proper management of common property resources.
5. Improvements of small ruminants (sheep and goat) and pack animals (equine and camel) should be taken up in the regions where such animals are predominant.
6. Building infrastructure for animal husbandry extension network. Panchayats, cooperatives and NGOs should play a leading role in generating a dedicated band of service providers at the farmer's doorstep in their respective areas

7. Strengthening infrastructure and programmes for quality and clean milk production and processing for value addition.
8. Programmes would be implemented to improve indigenous birds and promotion of backyard poultry in rural areas.
9. An information network would be created based on animal production and health with the active involvement of Research Institutions, Government departments, private industries, cooperative, and NGOs.
10. Strengthening of veterinary colleges as per the norms of Veterinary Council of India. Strengthening of Department of Animal Husbandry and Dairying is also crucial if it has to work as a regulatory and monitoring authority. 11. A regular interaction between the Department of Animal Husbandry and Dairying and research institutes like the Indian Veterinary Research Institute, National Dairy Research Institute, Institutes on cattle, buffalo, sheep, goat, equine and camel.

Fisheries

India has vast potential for fisheries from both inland and marine resources. It has a large marine product and processing potential with varied fish resources along the 8041-km long coastline, 28000 km of rivers and millions of hectares of reservoirs & brackish water. Units mostly exist in the small-scale sector as proprietary/partnership firms or fishermen cooperatives. Over the last decade, the organized corporate sector has become increasingly involved in preservation, processing and export of coastal fish. The wide variety of fish resources found in Indian inland waters, coastal areas and deep seas comprising India's Exclusive Economic Zone has a large potential of growth.

Major products:

Frozen & canned products mainly in fresh form. Fisheries play an important role in the national economy, providing full-time or part time employment to 5.96 million people. The contribution of fisheries to GDP at the current price level is 1.3%. There are 10 363 registered fisheries societies in India, with a membership of 1122 000 people. It is also a major contributor to foreign exchange earnings. During 1997-98, the estimated foreign exchange earning was about Rs 4486 Cr which is increasing at an average annual rate of 17.3 %. The country exports annually around 390738 ton of processed sea foods with an export value of Rs 5124.6 Cr. The size of the market is Rs 26000 Cr (as of 1999- 2000).

There is growing export of canned and processed fish from India. The marine fish includes prawns, shrimps, tuna, cuttlefish, squids, octopus, red snappers, ribbon fish, mackerel, lobsters, cat fish etc. In the last six years there was substantial investment in fisheries to the tune of Rs. 30, 000 million of which foreign investments were of the order of Rs. 7000 million. The potential could be gauged by the fact that against fish production potential in the Exclusive Economic Zone of 3.9 million tonnes, actual catch is to the tune of 2.87 million tonnes. Harvesting from island sources is around 2.7 million tonnes.

World Scenario

Total world fish production in 2000 was estimated at a record 129.42 million times (as compared to 124.4 m tonne in 1999). The decline in 1998 was due to the "El Nino" phenomenon which affected catches of small pelages fishes in South America (Peru & adjoining coastal lines). China is now by far the top producer of fish with 30 million tonnes in 1999

The world import of fish product expanded in 1999 in value terms to reach US $ 57,600 million. Out of this, developed countries accounted for more than 80% of the total. Japan is the biggest importer accounting for over 25% of the global total. The EC is depending on over 35% of the share for its fish imports. Thailand and Norway are the world's major exporters of fish products in value terms accounting for 16% each of total world trade. US, besides being the world's fourth major exporting country is the second biggest importer of fish products. The net earnings of foreign exchange by developing countries – (deducting their imports for the total value of their exports) is impressive. The net earnings rose from US $ 5200 million in 1985 to US $ 15600 million in '99. For most of the developing countries, fish trade is a significant contribution in foreign currency earnings.

Current status

The world market was characterised by an overall growth is demand while supplies tightened, (India needs to take advantage of this situation), EU, US showed an increase in demand while Japan showed a decline in demand. This would invariably shoot up the prices of fisheries products.

Review by commodity

World's most important fish accounting for over 20% of international trade (in value terms)

1. Tuna (Asia)
2. Ground fish
3. Cephalopod (Japan, Korea are leaders
4. Indian Scenario

Marine fisheries

India's estimated marine resources potential is 3.9 million tonne. During 1998, the marine fish catch was 2.95 million tonne, with over 70% coming from the west coast. There were 220 903 traditional craft, 39444 traditional motorized craft and 51 744 mechanized boats operating in Indian waters. There are nearly 6 million fishermen in the country, of which 2.4 million are full-time, 1.45 million part time and the rest occasional. They use a wide range of fishing gear, including seines, stake nets, lines, bag nets, encircling nets and lift nets.

During 1987-97, there was a gradual increase in fish production, growing 44.1% in the ten-year period, of which pelagic species contributed 51.6%, the rest being demersal species. Among the species caught, Indian oil sardine (Sardinella longiceps), Indian mackerel (Rastrelliger kanagurta) and Sciaenidae are dominant. Bombay duck, anchovies, cephalopods, perches and Carangidae are also abundantly seen. Marine shrimp, although contributing only 10% of the total catch, is still commercially a most important one. Indian Fisheries often fluctuate, and depend largely on the vagaries of the monsoons. Conservation measures have been adopted in both the east and west coasts by enforcing closed seasons during the breeding seasons of important species.

There have been significant inputs to marine fisheries development in recent years. Plans have been approved for 6 major and 45 minor fishery harbours and 158 modern Fish Landing Centres (FLCs), of which the 6 major harbours have been completed, together with 30 minor fishing harbours and 130 FLCs. In order to improve the marketing of fresh fish internally, a number of cold storage, ice plants and cold chains have also been established. Export trade is completely in the hands of the private sector.

Inland fisheries

During the period 1987-1997, there was a steady increase in inland fisheries production, registering 45.4% during the ten-year period. Inland production, including farming, is now catching up with production from the marine sector and is likely to overtake marine capture fisheries in the next millennium. Inland production includes catches from rivers, upland lakes, peninsular tanks, reservoirs and oxbow lakes.

The major states contributing are

- West Bengal (33%),
- Andhra Pradesh (9.09%),
- Bihar (8.71%),
- Assam (6.92%)
- Uttar Pradesh (6.49%),
- Orissa (6.01%),
- Tamil Nadu (4.82%),
- Madhya Pradesh (4.07%),
- Karnataka (3.89%) and
- Maharashtra (3.4%).

Freshwater aquaculture

Inland aquaculture has emerged as a major fish producing system in India, with production currently (1998) around 1.7 million t/yr. Carp accounts for over 80% of farmed fish. Major species cultured are roho (Labeo rohita), catla (Catla catla), mrigal carp (Cirrhinus mrigala), grass carp (Ctenopharyngodon idellus), common carp (Cyprinus carpio), silver carp (Hypothalmitchthys molitrix), catfish (Clariusmbatrachus), singi (Heteropneustes fossilis), rainbow trout (Onchorhynchus mykiss), and giant river prawn (Macrobrachium rosenbergii).

Brackish-water aquaculture

The estimated area of brackish water available for aquaculture is 1.19 million ha. Traditional shrimp farming practices are popular in Kerala, West Bengal and Goa. The yields from this system vary from 300 to 1 000 kg/ha/year. Intensive shrimp farming has become very common in recent years. Because of its high commercial value, giant tiger prawn (Penaeus monodon) is the dominant species in commercial production, although Indian white prawn (Penaeus indicus; around 5% of total production) is also farmed in several places. Shrimp production by farming reached a record value in 1994-95. Subsequently production suffered a set back due to a ban imposed by the Supreme Court of India in response to petition filed by environmentalists pleading that shrimp farming had created several environmental damages. Subsequently, in the last three years many shrimp farms in coastal areas have been closed. Intensive shrimp farming is banned, and only modified, improved traditional and extensive farming are permitted, with a productivity of around 2 to 2.5 t/ha/yr. Aquaculture, particularly shrimp farming, is now regulated and controlled by the Aquaculture Authority of India.

Utilisation of Catches

Nearly 70% of the fish catch is marketed fresh. The fish drying and curing industry in India is on the decline, with only about 14% fish being used for curing. Frozen fish production accounts for 6.5%, 8.4% goes for reduction to fish meal, 0.8% for offal reduction and 1.6% for miscellaneous purposes. The fish canning industry has also declined recently, in part due to the high cost of metal cans. Only 0.3% of the total catch is used for canning purposes.

Research

Fisheries research in India is coordinated by the Indian Council of Agricultural Research (ICAR), an autonomous organization under the Ministry of Agriculture, the Agricultural Universities, and institutes under the Ministry of Agriculture.

Future needs

India's future fisheries development plans are aimed at increasing fish production, improving the welfare of fishers, promoting exports and providing food security. The per capita availability and consumption of fish is to be increased to a level of 11 kg per annum for the fish eating population and production has to be increased proportionately. Aquaculture is recognized as an important way to meet future demands. A number of schemes have been instituted by state and central sectors to increase brackish-water aquaculture and fish production from tanks and ponds, lakes, reservoirs and rivers. The private sector has emerged as a major player in brackish-water aquaculture, particularly in shrimp farming.

Economic role of the fishing industry

Seafood export is now recognized as a major avenue for export earnings. In order to meet EU regulations, massive centrally sponsored schemes have been initiated to provide infrastructure at fishing harbours and landing centres to improve fresh fish handling and provide sanitation and other assistance for quality processing of fisheries produce. India exports today marine products worth Rs 5124.6 Cr, covering 60 commodities. The share of marine products in total export earnings is around 3.4%. The share of Frozen shrimp in the export earnings is very high and contributes about 65 –70 % of the total export earnings. Establishments connected with marine products export (as registered with MPEDA, 1996), include 625 exporters (380 manufacturer-exporters and 240 merchant-exporters), 376 freezing plants, 13 canning plants, 4 in the agar-agar industry, 149 ice plants, 15 fish meal plants, 903 shrimp peeling plants, 451 cold storage units, and 3 chitosan/chitin plants, with 95% of the seafood processing units concentrated in 20major clusters in 9 states. The total installed freezing capacity is 7 500 tons per day, and the commercial production is mostly export oriented.

Development Prospects

India's marine fisheries production has reached a plateau and, at best, only marginal increase is predicted in the near future. Most major stocks are fully exploited and further increase has to come from exploitation of deep-sea resources. However, inland production has shown rapid growth, recording an annual growth rate of 6%. Aquaculture is the principal factor in this development. All future additional demand for fish will have to be met from aquaculture. Objectives for future fisheries development include enhancing fish production, generating employment, improving socio-economic conditions of fishers, increasing marine products for export, and increasing per capita availability of fish to about 11 kg / yr. These objectives will be achieved through an integrated approach to marine and inland fisheries and aquaculture, taking into account the need for responsible and sustainable fisheries. Conservation of aquatic resources and genetic bio-diversity is another thrust area for the next millennium.

Seafood Export

The marine product exports from the country have crossed US $ 1 billion for the fourth consecutive time. The export touched 3,90,738 tonnes valued Rs.5124.6 crores during 1999-2000 registering an increase of 21.84% in terms of volume and 1.5% by value. During the previous year, it was 3, 11,257 tonnes valued at Rs.4368.6 crores. The export mainly consisted of low valued fin fish varieties (35.83%) followed by frozen Shrimp (33.83%), frozen Cephalopods (22.88%) and dried seafood items (2.07%), Japan continues to be the top most importer of Indian seafood shared close to 22.21% of our export in terms of volume and 49.61% by value. The major change noticed in the export trend, during the year is the emergence of South East Asia who continued to be the top most importer of marine products in terms of volume. The other individual markets, which increased their shares during 1999-2000, are Canada, Mauritius, Australia, Switzerland, Maldives, New Zealand, Reunion, Panama, Venezuela, Taiwan, Bangladesh, Philippines, Turkey and Malta give the export figures of seafood's from India to major destinations in the world.

Policies in Fisheries

Foreign equity is permitted in fish processing sector. Fish processing projects with a minimum of 20% value addition can be set up as 100% Export Oriented Units. All items can be exported freely except for silver pomfrets of weight less than 300 gms.

The Path Ahead

The main thrust for fisheries development during the Tenth Plan would be to utilise the full potential of inland fishery resources as well as deep seas to increase per capita consumption to a substantial level from the present level of 9 kg. per head per annum. Special emphasis will be given on : l Increasing the depth of fishing harbours especially for small fishermen using dredgers and the upgradation of hygienic conditions there.

- Strengthening of data base and information networking in the fisheries sector for standardisation of methodologies and estimation of catch from diverse aquatic resources.
- Aquaculture and development of capture fisheries of inland water resources.
- Measures will be taken to increase fish production from the deep sea marine sector.
- Infrastructure development, post-harvest management for marketing by setting up of model fish markets and establishment of cold chain through viable fishermen cooperatives.
- Popularisation of pearls developed by CIFA, CMFRI etc. and value added products developed by the Central Institute of Fisheries Technology (CIFT), Kochi and Integrated Fisheries Project (IFP), Kochi made out of low value fish with suitable credit/subsidy support.
- Welfare measures for fishers will be strengthened to ensure their safety at sea etc. and also to involve more women in fisheries sector.
- Research & technology needs in fisheries institutes to be upgraded to meet the growing demands
- Formulation of a comprehensive deep sea fishing policy and passing of the Aquaculture Authority Bill in Parliament to be expedited for rational exploitation of deep sea fishery resources and sustainable aquaculture development.
- Strategy for an effective enforcement mechanism is needed to prevent poaching in the EEZ and thereby safeguard our resources.

- Suitable Mari culture programmes need to be undertaken for commercially important fin/ shell fish species for replenishment of resources in our seas.
- Setting up of disease control laboratories and quality certification centres to ensure international standards for fishery products.
- Ethnologically improved fishing boats with proper communication network etc. to be introduced for the benefit of small fishermen.