1ST SEMESTER	SERI-CULTURE	CREDITS – 6

SERICULTURE
NOTES
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UNIT 1: INTRODUCTION

Q:-Sericulture and its definition.

A: - Sericulture is the cultivation of silk through rearing of silkworm. It is an agro based industry. It involves the raising of food plants for silkworm, rearing of silkworm for production of cocoons, reeling and spinning of cocoon for production of yarn etc. for value added benefits such as processing and weaving.

Sericulture also includes the practical aspects such as increasing productivity of land as well as labour, stabilization of cocoon production, improvement of silk yarn, fabric and generating profitable income for rural poor, SC, ST and OBC people. Silk is an animal protein fibre secreted (produced) by the silkworm larva for spinning of the cocoon. This cocoon provides a protective shell (shelter) for the soft and delicate caterpillar to pass the pupal stage inside it and metamorphose into an imago (moth). Silk yarn is obtained from the silk cocoons.

Definition of Sericulture

Sericulture or silk production is the breeding and management of silk worms for the commercial production of silk. In other words, sericulture deals with a series of events that include the rearing of the silkworms on mulberry plants, collection and processing of silkworm cocoons to extract raw silk fibers from them and the production of commercial silk. There are several commercial species of silk worms but very few are commercially exploited.

Q: - Silkworms.

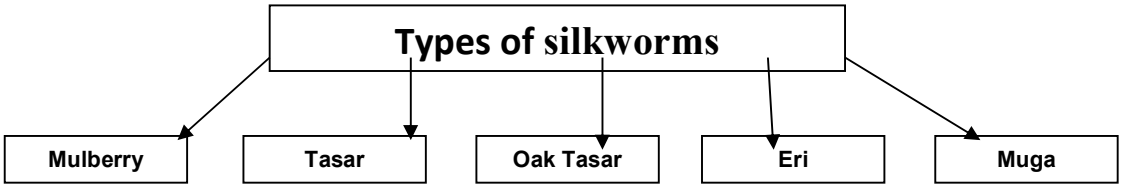
A:-The **silkworm** is the larva or caterpillar of the **domesticated silk moth**, **Bombyx mori** (Latin: "silkworm of the mulberry tree"). It is an economically important insect, being a primary producer of Silk. A

silkworm's preferred food is white mulberry leaves (monophagous). Domestic silk moths are closely dependent on humans for reproduction, as a result of millennia of selective breeding. Wild silk moths are different (having not been selectively bred) from their domestic cousins; they are not as commercially viable in the production of silk.

Silkworm Neolithic age; before then, the tools required to facilitate the manufacturing of larger quantities of silk thread had not been developed. The domesticated B. mori and the wild B. mandarina can still breed and sometimes produce hybrids.

Q:-Types of silkworms.

A:-



There are five major types of silk of commercial importance, obtained from different species of silkworms which in turn feed on a number of food plants: Except mulberry, other varieties of silks are generally termed as non-mulberry silks. India has the unique distinction of producing all these commercial varieties of silk.

Mulberry:-The bulk of the commercial silk produced in the world comes from this variety and often silk generally refers to mulberry silk. Mulberry silk comes from the silkworm, Bombyx mori L. which solely feeds on the leaves of mulberry plant. These silkworms are completely domesticated and reared indoors. In India, the major mulberry silk producing states are Karnataka, Andhra Pradesh, West Bengal, Tamil Nadu and Jammu &

Kashmir which together accounts for 92 % of country's total mulberry raw silk production

Tasar:-Tasar (Tussah) is copperish colour, coarse silk mainly used for furnishings and interiors. It is less lustrous than mulberry silk, but has its own feel and appeal. Tasar silk is generated by the silkworm, Antheraea mylitta which mainly thrive on the food plants Asan and Arjun. The rearings are conducted in nature on the trees in the open. In India, tasar silk is mainly produced in the states of Jharkhand, Chattisgarh and Orissa, besides Maharashtra, West Bengal and Andhra Pradesh. Tasar culture is the main stay for many a tribal community in India.

Oak Tasar:-It is a finer variety of tasar generated by the silkworm, Antheraea proyeli J. in India which feed on natural food plants of oak, found in abundance in the sub-Himalayan belt of India covering the states of Manipur, Himachal Pradesh, Uttar Pradesh, Assam, Meghalaya and Jammu & Kashmir. China is the major producer of oak tasar in the world and this comes from another silkworm which is known as Antheraea pernyi.

Eri:-Also known as Endi or Errandi, Eri is a multivoltine silk spun from open-ended cocoons, unlike other varieties of silk. Eri silk is the product of the domesticated silkworm, Philosamia ricini that feeds mainly on castor leaves. Ericulture is a household activity practiced mainly for protein rich pupae, a delicacy for the tribal. Resultantly, the eri cocoons are open-mouthed and are spun. The silk is used indigenously for preparation of chaddars (wraps) for own use by these tribals. In India, this culture is practiced mainly in the north-eastern states and Assam. It is also found in Bihar, West Bengal and Orissa

Muga:-This golden yellow colour silk is prerogative of India and the pride of Assam state. It is obtained from semi-domesticated multivoltine silkworm, Antheraea assamensis. These silkworms feed on the aromatic leaves of Som and Soalu plants and are reared on trees similar to that of tasar. Muga culture is specific to the state of Assam and an integral part of the tradition and culture of that state. The muga silk, an high value product is used in products like sarees, mekhalas, chaddars, etc.

Q:-History of Sericulture.

A: - Sericulture or silk production from the moth, Bombyx mori has a long and colourful history unknown to most people. This insect is the only living species of family Bombycidae and has been domesticated for so long that it is possible that there are no survivors in the wild any longer.

According to the Chinese records, the discovery of silk production from B. mori occurred about 2700 BC. It is believed that empress Si-lung-Chi was asked by emperor Huang-ti to find the cause of damaged mulberry leaves on trees in their garden. The empress found white worms eating the leaves. She noticed that they were also shiny cocoons around themselves. A cocoon dropped in her cup of tea and silky threads separated from the cocoon. Silk industry began in China where the source of silk was kept a secret for more than 2000 years. After some time, China lost their monopoly in silk production, sericulture reached Japan through Korea and then to other countries.

Sericulture has been growing in India as an agro-based industry playing a vital role in the improvement of rural economy.

Q: - Present status of Sericulture.

A:- Sericulture at present is carried on in many parts of the world. India stands fifth in the production of silk. The

other major silk producing countries in order of production are Japan, China, South Korea, U.S.S.R., Brazil, Bulgaria and Italy. India accounts for little over 5% of the total global output of mulberry raw Silk and 10% of the tasar.

However, it is only next to China in production of tasar Silk. Munga is specially an Indian variety. Probably India is the only country which produces all the four types of Silk viz., Mulberry, Tasar, Eri and Munga. Inspite of the challenge posed by the artificial Silk, the production of natural Silk has increased to about 40% in last 15 years and the global output of 1974 was 45 thousand tonnes.

In India the major silk producing states are Mysore, West Bengal, Jammu and Kashmir, Assam, Bihar, Orissa, Madhya Pradesh, U.P., Andhra Pradesh, Tamil Nadu, Punjab, Manipur, Tripura and Maharashtra. The total annual production of raw silk in India is about 31 lakhs kg. out of which mulberry alone accounts the highest i.e., 25 lakhs kg. and non-mulberry is around 6 lakhs kg. The total output of Silk waste in India is about 12.5 lakhs kg. annually, out of which mulberry shares about 10 lakhs kg. and the rest is shared by non-mulberry Silk.

The value of Silk- product in India is about Rs. 80 crores per annum. Export of Silk brings about Rs. 15 crores in foreign exchange. Mysore state has the distinction of producing alone about 76% of total production of raw silk in this country. In Mysore, W.B., J. and K„ T.N., Punjab and H.P. silk produced is mainly of mulberry type, whereas in the states of Assam, Bihar, Manipur, M.P., Orissa, silk produced is mainly of non-mulberry type.

Bihar has the oldest set up of this industry and produces all the varieties except the munga. Bihar has also the privilege of producing tasar in largest quantity. The tasar production in the State is mainly based in Santhal

Pargana, Chotanagpur and Chaibasa districts. Altogether 16 tasar seed supply stations are functioning in Chotanagpur.

The Eri Silk is mainly limited in the state at Gangetic plains. Ranchi, Patna, Bhagalpur, Monghyr, Muzaffarpur and Saran districts has Eri Seed Supply Station one each. 48 demonstration centres for spinning of Eri Silk have been established in the state. Mulberry Silk is restricted to Pumea district along the border of West Bengal. The total production of Silk is of the value of about 3—5 crores in Bihar. In Bihar alone about 1.25 lakh persons are engaged in different aspects of this industry.

Rearing of silkworms on large scale is carried on in villages and remote forests by villagers and tribals. They are assisted by State Government and Central Government agencies. In each Silk producing state there is a special unit under State Government to look after this industry. Assistance in the form of money, seeds, technical know-how, insecticides etc. are provided to the rearers. This unit is also responsible for maintaining a liasion between rearers, weavers and cloth manufacturing industries.

Q:- life cycle and their food plants.

A:- House:

Any building or thatch which is well ventilated may be used for rearing the worms, but mud-walled thatched houses are the best as they are cool in summer and warm in winter season.

During summer season water may be sprinkled inside the thatch to lower the high temperature. For proper growth and development of silkworms the temperature inside the house should be maintained more or less between 70° – 75° F with similar percentage of humidity.

Feeding Trays:

Freshly hatched worms are kept in flat trays along with small pieces of mulberry leaves. These trays are made up of bamboo mattings with their edges turned up, which afford a raised border made by stout stripes of bamboos. On the back of the tray two strong stripes are firmly fastened longitudinally.

Machan:

Machans are needed to accommodate large number of trays in a limited space. Machans are easily and best made by fixing two pairs of bamboo or wooden poles in the ground and tying across bars of bamboo or wood horizontally.

Nets:

Large amount of excreta, dirty products and remains of leaves may fall on the trays from the holes of the upper trays. If worms are not protected from these by-products they may get diseased. To prevent this, trays are covered with the nets.

Spinning Trays:

Before cocoon formation, mature worms are transferred to special type of trays known as spinning trays or chandraki. Here they spin the cocoon without any disturbance.

Cultivation of Food-plants:

Since they are wild in nature, cultivation of food plants is not at all necessary. The worms are mounted on the food plants in the nearby forests. But still for convenience plantation of food plants can be done. Their primary food plants are Asan, Arjun, Sal, Oak etc. and there are large numbers of secondary food plants.

For the cultivation of the food plants first of all particular piece of land selected for the purpose is prepared (ploughing, levelling, manuring etc.) and then the

samplings are implanted there after sufficient rain fall. The distance between two samplings should be 20—25 ft. Watering, manuring, and ploughing of the soil around the samplings are done at regular intervals according to the need. They are protected from cattles and other animals and villagers. Proper care is taken till they have attained a considerable height. Bushes are pruned 3—5 weeks before the start of the rearing reason.

It is not advisable to rear the worms on a plant every year because in that case sufficient foliages will not be available for the developing larvae. To overcome this problem, the land in which rearing is to be done is divided into two plots. In a particular plot rearing should be done every alternate year. For speedy and healthy growth of the offshoots, it is necessary to give proper care and attention to host plants which includes ploughing, manuring, watering, and prunning at regular intervals.

Q: - Prospects and problems of sericulture.

A: - Sericulture is an agro-based and economically rewarding enterprise consisting of several sets of activities and plays a predominant role in shaping the economy destiny of the rural people with lot of employment potentially. The production process of silk fabric contains a long chain of interdependent operations i.e, cultivation of mulberry, silkworm seed production, silkworm rearing, silk production, twisting, warp and weft making, dyeing and printing, spun silk production, finishing of silk fabric, designing of silk garments etc, that provides medium of live hood to rural and semi urban people. India is blessed with favourable climatic conditions throughout the year and availability of human resource remained the advantage to the Indian silk industry. Sericulture provides rich dividends with low investment and portable return within short gestation period and provides

employment throughout the year. it is obvious that, Sericulture plays a pivotal role in economic development of the country by generating employment, income, as well as foreign exchange.

Problems Of Indian Sericulture Industry: Though sericulture is ideally suited for improving the rural economy of the country, as it is practiced as a subsidiary industry to agriculture, it is hindered by various factors like imports of cheap and alternative textiles from other Asian neighbors, use of outdated manufacturing technology, primitive and unscientific "reeling" and "weaving" techniques, use of poor quality seeds, low production of bivoltine seeds, use of non-graded and diseased seeds, poor knowledge of farm disease amongst farmers, poor supply chain management ,huge unorganized and decentralized sector, high production cost, recurring droughts and increased import of silk from China and accompanied with the following problems like:

- ❖ Price fluctuation
- ❖ Absence of proper market
- ❖ Long distance to market
- ❖ Lack of transport facilities
- ❖ Absence of storage facilities
- ❖ Poor information on market trend
- ❖ Lack of finance

Q:- Role of women in sericulture.

A:- Sericulture provides stable income and employment to many rural agriculture families and livelihood to scores of landless farm and non-farm women labourers giving them economic gains.

- Role of women in the process of value chain in the Silk sector has increased as more women are engaged in leaf to cloth activities.

- The benefits of Sericulture are not fully reaching the women in the rural agriculture families as they are not involved in marketing, financial transactions and lack of control over incomes.
- Mulberry cultivation is spread over 1.0 lakh acres in Andhra Pradesh which is labour intensive and agro-based cottage industry. More than 5 lakh agriculture labours are engaged in Mulberry cultivation out of which 3 lakhs are women labourers.
- Increasing out migration of men in Agriculture families in Anantapur and Chittoor Districts in search of White Collar Jobs to Bangalore and other Metros forcing increased participation of women in the farm and non-farm activities in Sericulture sector.
- Need for providing technical training to women farmers at the village and block level training institutions is well recognised besides identifying women lead farmers as trainers in Sericulture Technology.
- Activities like Chawkie Rearing and adult silkworm rearing involve more participation of women and needs careful handling of silkworms in the rearing house.
- Production of Chawkie worms is an important intervention in Bivoltine production and women's role in production of good quality Chawkie worms must be well documented and to reserve the activity totally in favour of Women farmers.
- Need to rework the subsidy provisions under Catalytic Development Programme (CDP) and Cluster Promotion Programme (CPP) Schemes in favour of women farmers.
- Sericulture suffered serious setbacks in the past due to outbreak of pebrin disease and recurring droughts. In order to ensure sustainable development of sericulture industry, there is a need to train women farmers in

disease identification, treatment and monitoring. Drought proofing technologies like Drip irrigation and Sprinkler irrigation in favour of women farmers with differential subsidies (90% subsidy for women farmers against 70% for men under CDP Schemes under IX & X Plan) paid rich dividends in the growth and expansion of Mulberry plantations. Women farmers are assisted for production of Bio-control agents.

- Input supply at farmers door steps through establishment of Seri Poly Clinics (One Stop Shop) is popularised amongst women self help groups in Andhra Pradesh. SERIFED is an apex organization supplies quality inputs like disinfectants, rearing equipment, bio-fertilizers and bio-pesticides, Old news papers, ropes and other materials at competitive prices to the women entrepreneurs managing Seri Poly Clinics, profit margins range from 10-20% on the sale of inputs made the scheme remunerative to women self help groups.
- Government of Andhra Pradesh is promoting Sericulture Development by protecting farmers against the risk of fluctuating cocoon and silk prices by providing production incentives @ Rs.50/Kg of Bivoltine cocoons and Rs.20/Kg of Improved Cross Breed Cocoons.
- To make Silk reeling as an economically viable activity for many women reelers belonging to minority community, State government provides production incentive for reeling @ Rs. 35/ Kg for Charka Silk, Rs.80/Kg for CB Silk and lRs.130/Kg for Bivoltine Silk.
- Shortage of skilled workers for the reeling industry is well recognised and training is provided to adolescent girls and women in silk reeling on multi end reeling machines under RKVY Scheme in 2012-13.
- Positive bias to women sericulturists is well reflected in designing and implementation of a separate scheme for

health insurance to women beneficiaries with treatment under out-patient category in CDP Scheme of XI five year Plan.

- Proper implementation of Creche facilities and Rest rooms for women in the Cocoon markets under CDP Scheme of XI five year Plan enhanced the scope of women farmer's participation in cocoon markets.

Recruitment of well qualified women as extension workers, support schemes to women farmers for Chawkie production, Reeling, Weaving and access to markets, engagement in value chain activities like garment making, fashion accessories and marketing of value added products through a chain of Silk Mark outlets will further enhance the participation of women in Sericulture sector. "Pattu Seri" Awards given to women sericulturists on the eve of International Women's Day is a confidence booster for many women to share their experiences and replicate the successes. Regular interactions with women farmers, reelers and weavers at the field level further bring administrative machinery appreciate problems of women sericulturists and help them in formulating appropriate schemes for maximising their participation.

UNIT 2: MULBERRY CULTIVATION-1

Q:- Morphology.

A:- Morphology is the study of external characters of an animal. It helps us to identify the animal and also to know the different functional significance of the organs (or) structures found. The domestic silkworm undergoes complete metamorphosis (Holometabola) and passes through four morphological stages i.e. egg, larva, pupa and adult. The fundamental knowledge of rearing silkworms for reeling cocoons is to learn the morphology and physiology of silkworm life stages and their importance.

Morphology of life stages

Out of these four stages larval period continues for several days at the silkworm larvae spin cocoon first prior to pupation. The morphological features of these stages are as follows.

Egg Stage

The silkworm eggs are tiny and weigh around 2000 eggs to a gram. It measures 1-1.3 mm in length and 0.9 – 1.2 mm in width. The size, weight, shape, colour of the egg, number of eggs per laying vary among the different races and according to the season. The eggs of European races are comparatively larger and heavier. An average Indian cross breed multi-voltine races lays about 400 eggs per laying.

Larval Stage

The newly hatched larva is black or dark brown in colour measuring about 3 mm in length. It is commonly called as ANT or KEGO. The head is large and the body is densely covered with bristles. There are four pairs of tubercles i.e., sub dorsal, supra spiracular, intra spiracular and basal tubercle each carrying 3-6 setae. As the larva grows by

passing moults to enter into later instars the body becomes smooth and light in colour due to rapid stretching of cuticular skin.The body has 3 divisions i.e., head, thorax, abdomen.The thin elastic chitinous cuticle permits rapid growth of the larvae during any instar.

Head

The head consists of six body segments fused together with a cranium.

The 2nd, 4th, 5th and 6th segments carry appendages which are modified into antennae, mandibles, maxillae and labium respectively. Median epicranial stature is well developed and prominent. Similarly on the outside, the clypeus and the labrum are also prominent. There are six pairs of Ocelli or larval eyes which are located behind and a little above the base of the antennae. There is a pair of antennae formed of five jointed segments and they are used as sensory organs(feelers).

Throax

Thorax consists of three body segments called the pro-meso and metathorax.

Each of the three thoracic segments carries ventrally a pair of legs each comprising in turn three jointed segments. These are the true legs which are conical in shape and carry sharp distal claws. These claws are not used for crawling, but are used for holding mulberry leaves while feeding. Silkworms contain eye spot (spiracle) on the dorsal side of the meso-thorax.

Abdomen

The abdomen is comprised of eleven body segments although only nine can be distinguished and the last three are fused together to form the apparent ninth segment, the anal plate and the caudal legs. The third to sixth and the last abdominal segments bear a pair of abdominal legs in each segment which are fleshy, un

jointed muscular protuberances. At the extremity they form a sort of disc with a series of hooks inwardly curved and arranged in a semi-circular fashion. On the dorsal side of the eighth abdominal segment, the larva carries the caudal horn.

Q:- Taxonomy of mulberry and popular mulberry cultivars.

A:- Mulberry is tree in nature and believed to have originated on the lower slopes of the Himalayas. Mulberry is one of the oldest plant species used for the welfare of the human beings. Though the technique for use of mulberry in silkworm rearing was invented long back by the Chinese, the spread of sericulture throughout the world is not very encouraging. Moreover, though a large number of mulberry varieties are available in the world, the lists of varieties cultivated in different countries are very limited.

The taxonomy of Morus is complex and disputed. Mulberry has been classified based on various parameters particularly floral characteristics. Morus has been placed under the Order Urticales of series Unisexuals and family Moraceae by Hooker (1885) and described as mono or dioecious species. Floral characters have been used for classification by many taxonomists. There are about 68 species of genus Morus distributed in different parts of the world. Majority of these species occur in Asia especially China, Japan and India. Continental America is also rich in Morus species. The genus is poorly represented in Africa, Europe, Near East and Australia. In China four species viz., M alba, M multicalulis, M atropurpurea and M mizuho are cultivated for sericulture. The sericulturally important species in Japan are M alba, M latifolia (M multiculis) and M bimbycis. The centre of diversity for mulberry exists in the Himalayan region

(Vavilov, 1926) with rich array of wilk species and land races. Four species are reported in India viz., M indica, M alba, M laevigata and M serrata. Majority of Indian cultivars belong to the species M india and M alba. Morus classification is even further complicated by widespread hybridization, wherein the hybrids are fertile. Morus is a genus of flowering plants in the family Moraceae. They are native to warm temperate and subtropical regions of Asia, Africa, Europe, and the America, with the majority of the species native to Asia. Mulberry is a fast growing deciduous woody perennial plant. It has a deep-root system. The leaves are simple, alternate, stipulate, petiolate, entire or lobed. Number of lobes varies from I to 5. Plants are generally dioecious.

Inflorescence is catkin with pendent or drooping peduncle bearing unisexual flowers. Inflorescence is always auxiliary. Male catkins are usually longer than the female catkins.

Male flowers are loosely arranged and after shedding the pollen, the inflorescence dries and falls off. Number of perianth lobes are 4. Number of stamens is 4 and implexed in bud. Female inflorescence is usually short and the flowers are very compactly arranged. Ovary is one-celled and stigma is bifid. Mulberry is open pollinated and the chief pollinating agent is wind. Fruit is sorosis and the colour of the fruit is mainly violet black.

Morus indica is commonly cultivated mulberry species in South Tamil Nadu. In M indica, several cultivars are developed every year and the most important are, V1, MR2, S31, S34, S36 etc. Mulberry is appropriately known as "Kalpa Vruksha" as all the parts of the plant has many uses. It is essential to sericulture as the foliage constitute the sole feed of mulberry silkworm B. mori. Mulberry (Morus spp.) is a fast growing tree which for convenience

of sericulture practices is maintained as a bush. It produces very large amounts of renewable biomass in the form of branches, shoots leaves and fruits. If mulberry is used for silkworm rearing, it is possible to get 50-55 MT/ha of leaf every year (Masilamani et al., 1996).

Q:- Morus alba.

A:- In India, there are many species of Morus, of which Morus alba, M. indica. M. serrata and M. laevigata grow wild in the Himalayas. Several varieties have been introduced belonging to M. multicaulis, M. nigra, M. sinensis and M. phillippinensis. Most of the Indian varieties of mulberry belong to M. indica.

M. alba: It is cultivated in the hilly and plain areas of India (Himalayan region) for silkworm rearing. It is also used as a avenue tree and in social forestry. Fruits are made into juice, liquor and stews. The wood finds use in sports goods industry. It is also used for house building, agricultural implements, furniture, for making spokes, poles, shafts and bent parts of carriages and carts. The stem bark is used for paper making.

M. indica: The cultivated forms belong to M. indica which are utilized in silkworm rearing. There are few profuse fruiting varieties occurring in Maharastra and Meghalaya which can be utilized as female parent in breeding programmes. The fruits are used for jam, jelly and juice making in Maharashtra. The pruned branches are used as fuel.

M. serrata: The wood is used for furniture making and carving, toys making, sports goods, agricultural implements and cheap types of rifles and guns.

M. laevigata: The trees of this species produce sweet fruits which are used in juice and jam making in central India. In North-east India the wood is utilized as firewood, house building, furniture making, for making stocks,

spokes, poles, shafts of carriages and casts. The wood is suitable for plywood making and paneling, carving and making of toys and tea chests. It is used for making tennis rackets. The straight log of the tree is used as support in house building work.

Medicinal uses: The various parts of mulberry plant finds use in ayurvedic preparations. The leaves have diaphoretic and emollient effects. The leaves are used for making a decoction which can be used as a gargle to get relief from throat inflammation. The fruits are used to treat sore throat, depression, high fever and is both a coolant and laxative. The roots extract have hypoglycemic properties. The root bark is used as an anthelmintic, purgative and vermifuge. Mulberry root juice is administered to patients with high blood pressure. The chinese use the leaf tips from young leaves to boil with tea and use it to control blood pressure. The milky latex is used as a plaster for sores and for preparation of dermal creams.

Q:- Anatomy of root, stem and leaf.

A:- Canes - Canes are the main branches of the rose bush, emerging from the root mass in the case of an 'own root' bush and emerging from the bud union on a grafted rose.

Shank - The main stem of the rootstock rose. The 'preferred' roses has been grafted onto the top of the shank.

Bud Union - the area between the roots and the stems where the bud of the desired variety was grafted onto the rootstock.

Roots - There are two types of roots.

• The 'anchor' roots are thick and strong, they hold the rose bush upright while it is growing. They also store nutrients during the winter season.

• The 'hair roots' are the feeder roots. Their main job is to absorb the nutrients in the soil as they become available.

Basal Breaks - Basal breaks are new canes sprouting from the bud union (the graft) on a grafted rose. These new canes are the way the rose renews itself.

Sometimes mistaken for the 'sucker' cane which does not emerge from the bud union.

Leaf - The leaves of roses are pinnately compound - that means they are made up of leaflets arranged along the side of a common axis with one leaflet on the end. T example is of a five-leaflet leaf. Roses also have 3-leaflet leaves and many have 7-leaflets or more.

Petiole - The tiny stem holding all the leaflets.

Petiolul - a subdivision of the petiole that connects a leaflet to the petiole.

Leaf Margin - The edge of the leaflet, usually "toothed" like a saw blade. Some roses have very smooth leaf margins; others are very deeply 'dentate' or toothed.

Stipule - The tissue at the point of attachment of petiole to stem. Often long and exaggerated.

Auricle - the 'ear-like' projection from the tip of the stipule.

Q: - Mulberry foliage.

A: - Mulberry foliage is the only food for the silkworm (Bombyx mori) and is grown under varied climatic conditions ranging from temperate to tropical. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area have a direct bearing on cocoon harvest. In India, most states have taken up sericulture as an important agro-industry with excellent results.

Mulberry is a fast growing deciduous woody perennial plant. It has a deep root system. The leaves are simple, alternate, stipulate, petiolate, entire or lobed. The number

of lobes varies from one to five. Plants are generally dioecious. Inflorescence is catkin with pendent or drooping peduncle bearing unisexual flowers. Inflorescence is always auxiliary. Male catkins are usually longer than the female catkins. Male flowers are loosely arranged and after shedding the pollen, the inflorescence dries and falls off. These are four persistent parianth lobes and four stamens implexed in bud. Female inflorescence is usually short and the flowers are very compactly arranged. There are four persistent parianth lobes. The ovary is one-celled and the stigma is bifid. The chief pollinating agent in mulberry is wind. Mulberry fruit is a sorosis, mainly violet black in colour.

Economic: White mulberry was introduced along the Atlantic seaboard during colonial times when an attempt was made to establish the silkworm industry in this country (Harrar & Harrar 1962). A fiber was obtained from the bark and used in weaving. A brown dye can be obtained from the trunk.

Medicinal: The leaves are taken internally in the treatment of sore throats, colds, eye infections, and nose bleeds. The stems are used in the treatment of spasms, rheumatic pains, and high blood pressure. The fruit is used in the treatment of urinary incontinence, dizziness, diabetes, pre-maturing gray hair, and constipation in the elderly.

Medicinal uses

The various parts of the mulberry plant find use in Ayurvedic preparations. The leaves have diaphoretic and emollient effects and are used for making a decoction that can be used as a gargle that throat inflammation. The fruits are used to treat sore throat, depression, high fever and are both a coolant and laxative. The root extract has hypoglycaemic properties. The root bark is used as an

anthelmintic, purgative and vermifuge. Mulberry root juice is administered to patients with high blood pressure. The Chinese use the leaf tips from young leaves to boil with tea to control blood pressure. The milky latex is used as a plaster for sores and for the preparation of dermal creams.

Q: - Common weeds of mulberry –their effects on mulberry productivity.

A: - Mulberry (Morus spp), the traditional feed for the silk worm, has been selected and improved for leaf yield and quality in many environments and is spread throughout the world. Mulberry leaves are highly palatable and digestible (70-90 %) to herbivorous animals and can also be fed to monogastrics. Protein content in the leaves and young stems, with a good essential amino acid profile, varies from 15 to 28 % depending on the variety. Mineral content is high and no anti-nutritional factors or toxic compounds have been identified. The establishment of this perennial forage is through stakes or seed, and it is harvested by leaf picking or cutting whole branches or stems. Yields depend on variety, location (monthly temperature, solar radiation and rainfall), plant density, fertilizer application and harvesting technique, but in terms of digestible nutrients, mulberry produces more than most traditional forages. The leaves can be used as supplements replacing concentrates for dairy cattle, as the main feed for goats, sheep and rabbits, and as in ingredient in monogastric diets.

Mulberry weed (Fatoua villosa) (Figure 1 and 2), gives growers and Extension Agents a lot of problems. Also called crabweed or hairy crabweed, it invades landscapes, field nurseries, and containerized ornamentals.
In addition to Georgia, it has been reported in Arkansas, and all states East of the Mississippi from Florida to Indiana.

Mulberry weed is a herbaceous annual, with a taproot. Leaves are alternate and serrated along the margins. Purplish green flowers are without petals, and are produced in 1 inch clusters (cymes) in leaf axils. The plant grows to 3 or 4 feet tall.
Don't let weeds go to flower. If you see flowers, seeds are on the way, and they only led to more plants.
~ Keep vegetation mowed around production areas as far back as possible.
~ If you see any plants growing, eliminate them as soon as possible
~ Rotate pre-emergence herbicides so the plants are exposed to different herbicide chemistry. In other words, don't use Surflan followed by Factor. Both have the same mode of action. Instead, rotate to something like Gallery

(which has very different mode of action from Surflan or Factor). For excellent weed control, try tank mixing Gallery with products like Surflan. It provides an excellent spectrum of weed control. As always, read and follow product labels!

UNIT 3: MULBERRY CULTIVATION-II

Q:- Propagation of mulberry.

A:- Today mulberry is cultivated in about 2.90 lakh hectares in India and the stress is upon productivity. Earlier the mulberry production per hectare was around an average of 12,000 to 15,000 kgs of leaf under irrigated conditions. Presently the average production has been tremendously increased due to the adoption of new technology like proper maintenance of mulberry garden and planting high yielding varieties while the average mulberry production per hectare has enhanced from 25,000 kg to 35,000 kgs.

Propagation of Mulberry:

Mulberry can be propagated in two ways. i. Sexual, ii. Asexual

i. **Sexual Propagation:**

In mulberry the sexual propagation is through seedlings, particularly the seed propagation carries a varied population, this to utilize in selection and hybridization. For seed germination certain prerequisites are needed to be fulfilled such as selection of quality seed, preparation of land, and the seed should be selected such that can definitely germinate. This is possible only when the seed is subjected to suitable environmental conditions, embryo of seed is alive, and healthy, in internal conditions of seed are favourable for germination.

The fresh seeds will have greater germination rate than the stored once. Seeds must be washed with fresh water until the flesh of fruit is withdrawn and dried well, however minimum moisture percentage should be maintained, i.e. at least 6 %. Sowing of seeds may be by way of broadcasting or sowing in lines.

ii. Asexual Propagation:

In asexual type of propagation vegetative plant parts are used. In mulberry the propagation is mainly of three types.

1. Propagation by Cutting.
2. Propagation by Grafting.
3. Propagation by Budding.

In case of mulberry, mostly through "Cuttings" only the propagation is practiced. By asexual method of propagation the inherited characteristics of parent stock can be retained. The desired characteristics can be carried to next generation.

The asexual propagation in mulberry is carried out by grafting, cutting, layering.

Q;- Pruning : Bottom pruning, middle pruning and repeated pruning.

A: - Pruning of mulberry trees should be done after one year of plantation. By pruning the mulberry branches, leaf yield can be increased and production of leaf can be synchronized with silkworm rearing schedules all through the seasons. Pruning schedules controls the irregular growth of mulberry branches there by save wastage of nutrition and energy. Care should be taken during pruning, bark should not get peeled off since cut wounds do not heal, which leads infections and diseases.

Under pit system of mulberry plantation pruning can be carried once in June and again in November leaving a height of 8-10 cm above the ground level in wider spacing.

Further under row systems pruning should be done at a height of 3 to 8 cm above the ground level in closer spacing.

Various methods of pruning are: - (a) fist form (b) Non-fist form.

(a) Fist Form: - Means cutting of mulberry plant each year at one place on main stem. The part gets thick & becomes fist shaped after few years therefore, the name. Easy control of mulberry diseases & pests possible in this method.

(b) Non-fist form: - Pruning done such that 2-3 branches allowed to grow from main stem (basal parts) & secondary branches also develop therefore, non-fist form. Resistance towards disease / pest control comparatively less in this method.

i). Ground/Bottom Pruning:- In this type of pruning, branches are cut at the Base of the stem at ground level. Under the Kolar system and strip system of cultivation, the whole shoot is cut to the ground level at each harvest. in all, five harvests are made in a year and thus plant receives five pruning. This is suitable only for the areas where mulberry sprouts throughout the year with no dormant period for bud sprouting. This type of service pruning, however, needs heavy fertiliser doses and irrigation. Therefore, it is adopted in areas with high rainfall, comparatively high temperature and high densely planted areas.

ii) Middle pruning:- Middle Pruning is a method of cutting the branches of bush mulberry at the height of 45-60 cm above the ground level during December-January. Middle Pruning stimulating sprouting of the lower buds in the bush during winter season. This method a adopted in areas with less rainfall, flood

susceptible fields, broder mulberry fields and sparsely planted gardens.

iii) Top clipping:- Top clipping is a type of training of mulberry plant in order to produce more branches and leaves for rearing of silkworm. it consists of clipping off the top of the branch but not the whole branch. it is practised usually during winter season . It has more advantages in the production and harvestation of quality mulberry leaves. it is only a kind of branch training and hence does not alter the shape of the plant.

UNIT 4: ESTABLISHMENT AND MANAGEMENT OF MULBERRY GARDEN

Q:- Land preparation: Soil, leveling and ploughing.

A:-

Soils with good water retention capacity with high amount of clay and organic matter are ideal for rice cultivation.

- Clay or clay loams are most suited for rice cultivation.
- Such soils are capable of holding water for long and sustain crop.
- Rice being a semi-aquatic crop, grows best under sub-merge conditions.
- Rice is cultivated in almost all types of soils with varying productivity.
- The major soil groups where rice is grown are riverine alluvium, red-yellow, red loamy, hill and sub-montane, Terai, laterite, costal alluvium, red sandy, mixed red, black, medium and shallow black soils.
- It grows well in soils having a pH range between 5.5 and 6.5.

Special technologies for problem soils:

For fluffy paddy soils: compact the soil by passing 400kg stone roller or oil-drum with stones inside, eight times at proper moisture level (moisture level at friable condition of soil which is approximately 13 to18%) once in three years to prevent the sinking of draught animals and workers during puddling.

- **For sodic soils:** For sodic soils with pH values of more than 8.5, plough at optimum moisture regime, apply 50% of total gypsum requirement uniformly, impound water, provide drainage for leaching out soluble salts and apply green leaf manure at 5 t/ha, 10 to 15 days before transplanting. Mix 37.5kg of Zinc sulphate per ha with sand to make a total quantity of 75kg and spread the mixture uniformly on the leveled field. Do not incorporate the mixture in the soil. Rice under sodic soil responds well to these practices.
- **For saline soils:** For saline soils with EC values of more than 4 dS/m, provide lateraland main drainage channels (60cm deep and 45cm wide), apply green leaf manure at 5 t/ha at 10 to 15 days before transplanting and 25% extra dose of nitrogen in addition to recommended P and K and $ZnSo_4$ at 37.5 kg/ha at planting
- **For acid soils:** For acid soils apply lime based on the soil analysis for obtaining normal rice yields. Lime is applied @ 2.5t/ha before last ploughing. Apply lime at this rate to each crop upto the 5th crop.

Ploughing

Primary tillage

Ploughing is the primary tillage operations, which is performed to cut, break and invert the soil partially or completely suitable for sowing seeds.

Special technologies for problem soils

- To obtain a deep seed bed of good texture.
- To increase the water holding capacity of the soil.
- To improve soil aeration.
- To destroy weeds, insects and pests.
- To add fertility to the soil by covering vegetation.

Ploughing

Secondary tillage

Harrowing

Harrowing is a secondary tillage operation which is done to a shallow depth for smoothening and pulverizing the soil as well as to cut the weeds and to mix the materials with the soil.

Purpose of harrowing

- To pulverize the soil of the seedbeds in the field.
- To destroy grasses and seeds in the field.
- To cut crop residues and mix them with top soil of the field.

- To break the big clods and to make the field surface uniform and levelled.
- Harrowing is carried out when the moisture content of the clods are reduced.

Puddling

Puddling is churning the soil with water. It is done in paddy fields with standing water of 5-10 cm depth after initial ploughing with country plough. It breaks up the clods and churns the soil.


Puddling

Purpose of puddling

- To reduce leaching of water or decrease percolation of water,
- To kill the weeds by decomposition.
- To facilitate transplantation of paddy seedlings by making the soil softer.
- To decrease water and nutrient losses by reduced hydraulic conductivity.

Levelling

Land levelling is expected to bring permanent improvement in the value of land. Levelling work is carried out to modify the existing contours of land for efficient agricultural production system

Purpose of Levelling

- Efficient application of irrigation water and increased conservation of rain water.
- Improve surface drainage and minimize soil erosion
- Provision of an adequate field size and even topography for efficient mechanisation.
- Perfect land leveling for efficient weed and water management.
- Improves better crop stands and crop establishment

Q: - Plantation methods: Row and pit systems.

A:-The two major methods of planting followed in countries like India are the Pit and Row systems.

Pit System

This system is followed for rain-fed crops and adopts a wider spacing. instead of ploughing the entire field, pits of standard size (40×40×40 cm) are dug with an inter-plant and inter-row distances of 90×90 cm for a bush type of cultivation, 180×90 cm for high bush cultivation and 270× 270 cm for a tree-type plantation. Equal quantities of organic manure, red soil and sand are placed in each pit after mixing and a cutting or a sapling is planted. Initially it is watered daily until rooting takes place. if tree type plants are to be grown on hedges, roadside, etc., the pits are of a larger size (45×45×45 cm).

Row System

This system is followed for irritation mulberry crops throughout South India. The land is prepared by ploughing ridges and furrows. The distance between the ridges is generally 45-60 cm. A rope with knots at equal distances of about 45-60 cm is tied from one end of a ridge to the opposite end, and two cutting are planted at the point indicated by the knot on either side of the ridge. Thus, the inter-plant distance between the rows and plants within the row is about 45-60 cm . Irrigation water flows through the furrows between the rows and generally the crop is grown as bush mulberry and is harvested by bottom pruning.

Q:- Irrigation.

A:- irrigation is artificial application of water to soil for the purpose to access the crop production. It is supplied supplementary to water available from rainfall & ground water.

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 favorable 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 leveling
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. Labor 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 betureoil 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 behavior 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.

Q:- Drip irrigation /Micro irrigation.

A: - Micro irrigation is defined as the methods in which low volume of water is applied at low pressure & high frequency usually an irrigation interval is in the ranges of 1 to 4 days. The system has extensive network of pipes at operated at low pressure. At pre-determined spacing outlets are provided for emission water generally known as emitters.

Drip irrigation:

In drip irrigation the required quantity of water is applied by means of mains, sub mains, manifolds & plastic laterals in the with equally spaced emitters usually laid on the ground surface at low pressure & at low discharge at the root zone of the crop.

Advantage of drip irrigation

1. Water saving is up to 40 to 60%
2. Enhance the plant growth & increases the crop yield
3. Savoring in level & energy most. Suitable for poor soil.
4. Weed infestation is minimum
5. Economy in cultural practices & easy operations.
6. Chance of using saline water.
7. Improve efficiency of fertilizers.
8. Very flexible in operation
9. No soil erosion.
10. Easy installation, no land preparation.
11. Minimizing quantity of produce.
12. Enhances the maturity of the crop.

Limitations

1. High maintenance requirement.
2. Salinity hazard
3. Economy limitations (40,000Rs/ha)
4. High technical know-how is required.

Q:- Sprinkler irrigation.

A;- Definition: It is methods in which water is spread into air and allowed to fall on the ground surface somewhat resembling.

Water is forced under pressure through small nozzle/orifice which gets broken up to into droplets and fall back on the ground. Slow circular revolution is impacted to the nozzle uniformally covered the ground surface. The rate of application should not be more than the infiltration rate of the soil.

Adaptability of sprinkler irrigation

1. Sprinkler irrigation can be adopted where land reveling is uneconomical and other method of surface irrigation cant carried out.

2. Adapted to soils to pours highly avoidable or relatively impermeable which are difficult to irrigate by other methods like furrow, border etc.
3. Where it is designed to go for frequent irrigation.
4. It is designed to minimum cost towards labours, fertilizer, and irrigation.

Advantages of Sprinkler Irrigation:

1. It can be used for almost crops expect paddy & jute.
2. System can be adopted under varied topographic condition and especially suitable to steep-slope and irregular topography.
3. Soils-method is particularly suited for sandy soils having high infiltration rate.
4. It can eliminate surface run off of irrigation water (run off elimination)
5. To protect the crop against frost & high temp.
6. To reduce labour cost for irrigation as compared with surface method.
7. Savings in land construction of channel to the field.
8. It saves fertilizer & water as ferti-irrigation can be carried out.
9. Land leveling is not essential for sprinkle irrigation.
10. Gives higher water use efficiency.

Limitations of sprinkle irrigation:

1. Not suitable for very fine texture soil (<4mm/her)
2. Uneven distribution of water due to distortion by high water.
3. More evaporation losses.
4. Require clean, water free from debris sand slit & clay particles.
5. Saline water can no be used.
6. Initial cost is high.
7. High operating power is high (5-10kg/cm)

8. Unsuitable climate condition sprinkling may be encouraging spread of disease.
9. Ripening softy fruits need protection from the spray.

Q:- Systems of Sprinkle Irrigation.

A:-

Systems of Sprinkle Irrigation			
Based on Spraying Arrangement		**Based on Portability**	
1	Fixed Head	1	Portable
2	Rotating Head	2	Semi Permeable
3	Perforated Pipes	3	Semi Portable
	i) Dancing Water	4	Solid Structure
	ii) Oscillating Arms	5	Permanent

Portable system:

In sprinkle irrigation system in which main line, sub main line, lateral and the pumping units all are the portable generally the pipers are made up of light weight aluminum to facillate easy transportation such system can be shifted from place to another.

Semi-portable system:

This system is parallel to portable except that location of water source and pumping unit is fixed.

Semi-permanent:

In this system the main and sub-main are fixed, usually buried under the ground where as the laterals are portables.

Solid straight system:

These have enough laterals present to eliminate their movement from one place to another. The system is fixed at the beginning of system of season and remains through out the season for short & frequent irrigation.

Permanent irrigation system:

The permanent system is suited to automation using soil moisture sensor and are generally preferred in orchard. The sub main, lateral are permanently buried below the ground level.

Based on spraying arrangement fixed head:

The fixed head type of sprinkler arrangement system sprays water in one direction.

Rotating head:

Rotating head removes slow rate to distribute water in a circular fusion. They may be single, double, multiple nozzle sprinkler head. Single nozzle sprinkles system are referred for their low application rate however the double nozzle sprinkle head gives good uniformity of application at low pressure.

Multiple nozzle type of sprinkler also called as giant sprinkler are used to covered more area with single set. The operating pressure required for such sprinkler may be more than 10kg/cm2.

Perforated Pipes:

Such systems are preferred for application of water under lower operating pressure usually between 0.5 to 2.5 kg/cm2. The system is not recommended under heavy winds as the jets are distorted more easily.

Generally pipes are provided with holes, perforated along the upper 1/3rd perimeter in a proper designated to covered with between 6 to 15m such system are preferred on plains moderately high infiltration rate used for irrigation of lawns or vegetable crop where the plant height ranges between 40 to 60 cm.

Q:- **Components of Sprinkler Irrigation System.**

A:-

1. Prime mover/pump suction pipe, foot value:

Pumping sets or pump is required for lifting water from the source and push it through distribution system i.e.

main, sub main, laterals and finally through the sprinkler head under sufficient pressure.

The pumping set consists of a centrifugal pump (volume) or turbine type pump with a driving unit suction line and a foot value. Centrifugal pump are generally used where the lift is less than 5m i.e. when source is river, shallow well etc. for higher lift or if water level fluctuates widely turbine pumps are recommended.

The electric motors are generally used driving unit for fixed installation diesel engines are generally recommended for portable units.

2. Main line:

It carries water from the source (pumping unit) to the various parts in the field. It may fixed or portable. Permanent lines are generally buried below the working depth inside the ground. Light weight aluminum pipe with quick couples are preferred for portable lines something HDPF (high density pipes are also preferred because of its longer life. The fixed are generally of steel pipe or PVC pipe of suitable diameter). Te or L section is provided to connect the main with sub main or lateral.

3. Sub main:

It carries water from main to lateral lines.

4. Lateral Lines:

It carries water from main or sub main pipe line to the sprinkler head through the rise pipe. They are portable and equipped with quick coupling devices. Commonly they are available in 5,6 or 12m length are provided with U shaped rubber gasket in the female portion of coupling. The water pressure forces outside of 'U' gaskets to form water seal when the water is turned off the seal is broken and water is drained out from the pipe making it easy to uncouple and more.

Sprinkler head:

Sprinkler heads are used for spraying water on the fields they may be-

a) Rotating Head
b) Fixed head Type
c) Perforated Type

Fixed Head Type: Used in landscape

Sprinkler lead can be classified on basis of pressure

1) Low operating pressure sprinkler (1.5 to 2.5kg/cm2)
2) Intermediate pressure sprinkler (2.5 to 5kg/cm2)
3) High pressure sprinkler (5 to 10kg/cm2)

Problems:

Find the fertilizer does per settings of the sprinkler system if a lateral has 12 sprinkler 14m apart. Later lines are spaced 20m on the main line and the recommend does of fertilizer is 80kg/ha.

Solution:

$$WF = \frac{Ds \times DL \times Ns \times WP}{10{,}000}$$

$$DL\ 20 = \frac{14 \times 20 \times 12 \times 80}{10{,}000}$$

Q:- Irrigation Efficiency.

A:- Irrigation water is an expansive input and has to be used very efficiently. The main losses that occur during irrigation of fields as conveyance, run off, seepage and deep percolation. Irrigation efficiency can be increased by reducing these losses. Uneven spreading and inadequate filling of root zone are the other causes for low irrigation efficiency. Irrigation efficiency at the field level can be increased by selecting suitable method of irrigation, adequate land preparation and engaging an efficient irrigator. At the project level, it can be increased by proper

conveyance and distribution system. Irrigation efficiency is the ratio usually expressed as percent of the volume of irrigation water transpired by plants, plus that evaporate from the soil, plus that necessary to regulate the salt concentration in the soil solution and that used by plants in building plant tissue to total volume of water diverted, stored or pumped for irrigation.

$$Ei = \frac{Wt + Ws - Rs}{Wi} \times 100$$

Where,

Ei = Irrigation efficiency (percent)
Wt = the volume of irrigation water / unit area of land transpired by plants, evaporation from the soil during the crop period.
Ws = the volume of irrigation water per unit area of land to regulate the salt Content of soil solution.
Re = Effective rainfall
Wi = the volume of water per unit area of land that is stored in reservoirs or diverted for irrigation. Irrigation efficiency indicates how efficiency the available water supply is being used. The efficiency of irrigation projects in India is as low as 20 to 40%.

Q:- Factors Affecting Frequency of Irrigation.

A:-

Humidity:

In rainy season, the humidity is high and rains may be received just when the crop is in need of water. In such case, some irrigation turns could be stopped and frequency may be extended to 20 days. During winter season, also the frequency will be longer than in summer because of less evapotranspiration, dewfall, nighttime

humidity, and less sunshine. The frequency may therefore be 15 to 20 days in winter and 6 to 8 days in summer. In summer irrigation, water is given more frequently and hence more frequency of irrigation in summer, medium in winter and less in rainy season.

Stage of Growth of Crops:

During certain stages particularly at flowering and fruit formation stages of crop requires much larges quantities of water than earlier stages. In earlier stage, even if a little less water than estimated daily use is provided, the crop will stand the strain without any harm, perhaps a slight moisture stress may encourage better root growth.

Type of Crop:

The frequency of irrigation will also depend up on the crop. A succulent leaf vegetable will require irrigation more often than cereal crop like Jowar. Crops which are doses of fertilizers need more water than those with a little or no fertilizers.

Soil Type:

Light soil requires more frequent irrigation than the loamy soils. Sandy loam soil need to be irrigated every fifth day while clay loam may be irrigated every tenth day. Time required to irrigate an area: The time required to irrigate an area depends up on magnitude of discharge, quantity of water applied, irrigation efficiency and area. The time required to irrigate an area is calculated by formula.

IQT = Ad
Where,
I= irrigation efficiency
Q= discharge in cusec
T= time in hours
A= area in acres
d= moisture deficit in soil.

Problem: Calculate the time required to irrigate 4 acres of

sugar cane when soil moisture deficit is 2.5 inch, discharge from a weir is 2 cusec and irrigation efficiency is 80 percent.

Solution:

IQT = Ad
= 80/100 X 2 X t
= 4 X 5/2
= 6.25hours.

Q:- Flood irrigation.

A:- In flood irrigation, water floods over the soil surface and thus wets the soil.

Border irrigation:- With border irrigation, the water is diverted into a preconstructed bed and allowed to flow freely over the soil surface. The bed consists of an almost horizontal flow area and two earth borders to define the width of the bed.

Advantages

- Low energy costs, because the water flows by gravity over the field.
- The crop is not wetted, thus leaf and fruit diseases are reduced.
- Brackish soils can be leached with relative ease.
- Low capital input costs if the land is relatively level.

Disadvantages

- Considerable water losses may occur if the supply system is not properly designed and maintained.
- The system is very sensitive and small deviations from the design specifications can reduce application uniformity significantly.
- Not all crops can be grown in bordered beds and the type of crop to be planted may thus eliminate this irrigation method.
- The viability of such a system is mainly influenced by the extent of earthworks required for bed preparation.

- ❖ This type of system is relatively inflexible and difficult to alter once it has been installed.
- ❖ The system is relatively labour intensive.
- ❖ Very high management inputs are required. x Unsuitable for soils with very high infiltration rates.

Q:- weeding.

A:- The term, **'weed'** used by Jethro Tull for the first time, suggested an useless and harmful plant that persistently grows where it is quite unwanted.

According to Robinson: Weeds are that species of plants which grow unwanted or are not useful, often prolific, persistent, interfere with agricultural operations, increase labour cost and reduce the crop yields.

Weed is a plant growing where it is not wanted, unwanted plant, out of place, extremely noxious, useless, and poisonous.

Characteristics of weeds: Weeds are like any other crops plants in size, form, morphological & physiological characters but possess the following characteristics, on account of which they are considered as enemy of crops by the farmer.

1. The weed seeds germinate early and the seedlings grow faster. They being hardy, compete for light, moisture and nutrients.

2. They flower earlier, run to seed in profusion and mature ahead of the crop. They are difficult to control and it may be even impossible to eradicate some weeds completely.

3. They are non-useful, unwanted & undesirable.

4. They are harmful to crops, cattle and human beings.

5. They can thrive even under adverse conditions of soil, climate, etc.

6. They are prolific and have a very high reproduction capacity. E.g.: A plant of satyanashi (Argemone mexicana)

produces over 5000 seeds while a plant of striga produces over half a million seeds.

7. Viability of weed seeds remains intact, even if they are buried deep in the soil. In some cases, the seeds may remain viable even after passing through the digestive tract of the animals.

8. The seeds may have special structures like wings, spines, hooks, sticky hair, etc. on account of which they can be easily disseminated over long distances.

9. Many weeds like Cynodon dactyl on are vegetatively propagated and spread rapidly all over the field even under adverse conditions.

Classification of Weeds

Weeds can be classified in many ways as:

A) Classification based on life cycle:

a) Annuals: Weeds complete their life cycle within a year.

i) Seasonal weeds:

1. Monsoon annuals or Kharif season weeds: Weeds complete their life cycle during Kharif or rainy season. E.g.: Hazardana, kurdu, Aghada.

2. Winter annuals or Rabi season weeds: Weeds complete their life cycle during rabi or during winter season. E.g.: Pisola

ii. Two seasonal weeds: Weeds complete their life cycle within two seasons. E.g.: Jungli gobhiLunea sp.

b) Biennials: Weeds require two years for completion of their life cycle. E.g.: Wild carrot (Daucus carota)

c. Perennials: Weeds continue their life cycle for years together. E.g.: lavala, hariyali, Kans, lajalu.

B) Classification based on habitat or place of occurrence:

a. Weeds of cropped land: Bathua, Kurdu.

b. Weeds of pastures & grazing lands: Hariyali, Unhali, Kans.

c. Weeds along water channels: Jalkumbhi (Eichhornia crassipes).
d. Weeds along roadside: Tarota, Unhali.
e. Weeds of waste lands: Ber, Sarata, Reshimkata.
f. Weeds of lawn & orchards: Ganja, Ghaneri.g.
g. Weeds of forest lands: Ghaneri, Nagphana.

C) Classification based on dependence on other hosts:

a. Stem parasite: Amerbel
b. Root parasite: Striga on Jowar, Sugarcane, and Bambakhu on Tobacco, Brinjal or Chilli.
c. Independent: Chandvel.
D) Classification based on soil type:
a. Weeds of black soils: Hariyali, Kans, Kunda.
b. Weeds on sandy loam soil: Aghada, Kurdu.
c. Weeds of ill drained soil: Lavala, Panbibi.
d. Weeds in tank: It may be submerged, immersed or floating. E.g.: Aquatic weeds like water hyacinth, cattails.
E) Classification based on plant family:
a. Graminae: Hariyali, Kunda, Kans.
b. Commelinaceae: Kena, vinchu, Panbibi.
c. Cyperaceace: Nagarmotha.
d. Amaranthaceac: Aghada, math, Kurdu.
e. Euphorbiaceae: Dudhi, Pisola, Wild castor.
f. Composite: Gokhuru, Jakham Judi, Gajar Gawat.
g. Leguminous: Lajalu, wild Mung, Unhali.
h. Malvaceae: Petari, wild bhendi.
i. Tiliaceae: Wild jute.
j. Cruciferae: Wild mustard.
k. Chenopodiaceae: Chandan Bathua.
l. Solanaceae: Kamuni, Wild Brinjal.
m. Papaveraceae: Satyanashi, Dhatura.
n. Portulacaceae: Ghol

o. Orobanchaeceae: Bambakhu
p. Cactaceae: Nagphana

Q:-Damages Or Losses Caused By Weeds or Disadvantages of Weeds

1. Reduction in crop yield: Weeds compete for water, nutrients & light. Being hardy & vigorous in growth habit, they soon outgrow the crops & consume large amounts of water & nutrients, thus causing heavy losses in yield. E.g.: 40% reduction in yield of groundnut & 66% reduction in yield of chilli. The loss of N through weeds is about 150 kg/ha.
2. Increase in the cost of cultivation: One of the objects of tillage is to control weed on which 30% expenditure is incurred and this may increase more in heavy infested areas & also cost on weed control by weeding or chemical control. Hence, reduce margin of net profit.
3. Quality of field produce is reduced: Weed seeds get harvested & threshed along the crop produce which lowers the quality. Such produce fetches fewer prices in the market. E.g.: Leafy vegetables, grain crop.
4. Reduction in quality of livestock produce: Weeds impart an undesirable flavor to the milk (Ghaneri), impair quality of wool of sheep (Gokhuru, Aghada), and cause death of animals due to poisonous nature of seed (Dhatura).
5. Harbour insect-pests & disease pathogens: Weeds either give shelter to various insect pests & disease pathogens or serve as alternate hosts & thus helps in perpetuating the menace from pests & diseases. E.g.: Gall fly of paddy, midge fly of Jowar, leaf minor of soybean & Groundnut, rust of Wheat, tikka of Groundnut, Black rust of wheat ,Downey mildew (Saccharum spontaneum).

6. Check the flow of water in irrigation channels: Weeds block drainage & check the flow of water in irrigation canals & field channels thereby increasing the seepage losses as well as losses through over through over flowing, so reduce the irrigation efficiency.

7. Secretions are harmful: Heavy growth of certain weeds like quack grass (Agropyon repens) or lavala lowers the germination & reduce the growth of many crop plants due to presence of certain phytotoxins secreted by weeds.

8. Harmful to human beings and animals: Weeds cause irritation of skin allergy & poisoning to human beings, also death of castles.

9. Cause quicker wear & tear of farm implements: Being hardy & deep rooted; the tillage implements get worn out early & cannot work efficiently unless they are properly sharpened or mended.

10. Reduce value of the lands: Heavily infested lands with perennial weeds fetch less price as require heavy expenditure to brought under cultivation.

Benefits Or Advantages Derived From Weeds:

1. Weeds when ploughed under, add nutrients, organic matter.

2. Weeds check winds or water erosion by soil binding effect of their roots (undirkani).

3. Useful as fodder for castles (Hariyali) & vegetable by human beings (Ghol, Tandulja).

4. Have medicinal value, Leucas aspera isused aga9inst snake bite, oil of satyanashi seed is useful against skin diseases, nuts of lavala are used in making scents (Udabattis/Incense sticks).

5. Have economic importance e.g.: saccharum spp used for makingthatches.

6. Reclamation of alkali lands (Satyanashi).

7. Serve as ornamental plants (Ghaneri).
8. Used for fencing (Cactus, Nagphana).
9. Used as mulch to check the evaporation losses of water from soil.
10. Used as green manuring & composting.
11. Fix atmospheric 'N' (Blue green algae, Tarota, Unhali, etc.)

Q:-**Dispersal Or Dissemination Or Spread Of Weeds**
Agencies responsible for dissemination are:
1. Wind: Seeds may be very small & light, equipped with parachute like arrangement, plumes or fuzz. They blow by wind to along distance. E.g.: Seeds of Rui/Ruchki, Striga, Gajar Gawat.
2. Water: The irrigation canals, drainage channels, surface runoff, flood water of rivers & streams carry weed seeds.
3. Animals like wild & domestic: Weeds having hooks (Gokhuru), twisted awns, spines, etc. E.g.: Ghaneri, weeds of Graminae family.
4. Man: Man disperse the weeds indirectly through compost (partially decomposed), feeding castles with hay or fodder having weed plants, using uncleaned farm machinery. E.g.: Ghaneri, weeds of Graminae family.
5. Crop weed: During harvesting, they get mixed with produce. E.g.: Jungli dhan, Bharad in rice and phallaris in wheat.

Q:-Principles Of Weed Control
For successful control, one has to consider the following points:
1. Habits of weed plants: A xerophytes weed (E.g. Alhagi camelorum) thriving under dry & arid conditions will die if fields are flooded with water. Similarly weeds which thrive under marsh or ill

drained condition of soil can be controlled by improving drainage.

2. Life cycle of the weed: Annuals & biennials can be controlled effectively if the land is cultivated before seedling stage of weeds. Perennials require deep ploughing to dig out rhizones, bulbs, etc. vegetative part by which they propagate.

3. Susceptibilities: Some weeds are susceptible to certain chemicals while others are not. E.g.: Dicots are susceptible to 2, 4-D while monocots are not, hence 2,4-D is used to control broad leaved weeds in monocot crops.

4. Dormancy period: While controlling dormancy weeds, period is to be considered as they have long dormancy period.

5. Resistance to adverse conditions without losing viability: Some weed seeds have hard seed coats which enable them to remain for a long time without losing their viability, hence they should be controlled before seed formation.

6. Methods of reproduction: Weeds propagate either by seeds, vegetative parts or by both. Seeded weeds should be removed or smothered before seed formation. Vegetatively propagated weeds should be exposed to sun heat to dry & die like rhizome, bulbs, solons, etc. by deep ploughing. Frequent cultivation leads to destroy green leaves & thereby exhaust the food reserves & starve the plants may have to be restored too. In weeds propagated by both mechanical & chemical methods may have to be followed.

7. Dispersal of seeds: Weeds can be controlled or kept in check if the ways in which different weed seeds disseminate are known and counter measures are undertaken.

Weed Control Methods
Broadly classified in two groups:

A)Preventive Measures.

B) Curative or Control Measures which includes: i. Mechanical
ii.Cropping or Cultural

iii.Biological &

iv.Chemical

A) Preventive Measures: In this, the weeds are prevented from its multiplication, introduction & nipped off the buds. It consists of:
1) Use clean seed,
2) Use well decomposed FYM/Compost,
3) Cut the weeds before seeding,
4) Remove weed growth or keep irrigation & drainage channels clean or free from seeds,
5) Avoid feeding of grain screenings, hay or fodder containing weed seeds without destroying their viability by grinding or cooking,
6) Avoid use of sand or soil from weed infested areas to clean or cultivated areas,
7) Avoid allowing castles to move from weed infested areas to clean or cultivated areas,
8) Clean all the farm implements & machinery properly after their use in infested areas & before using in clean areas,
9) Keep farm fences, roads & bunds clean or free from weeds.
10) Watch seedlings in nurseries carefully so that they do not get mixed with weed seedlings & get carried to the fields.

B) Curative Measures: These measures are followed to remove or to smother the weed growth & further multiplication. It includes:

i) Mechanical methods (Physical): It comprises:

1) Hand pulling;
2) Hand weeding;
3) Burning;
4) Flooding;
5) Hoeing;
6) Tillage;
7) Moving;
8) Smothering with non-living material (mulching). Burning of seed bed is called as 'rabbing'.

ii) Cropping and competition methods (Cultural): "One who establish first/early, will suppress other." Therefore, the cultural practices are so managed that the crop plants should establish early and grow faster ahead of the weeds.

It includes:

1) Crop roations: It checks the free growth of weed due to change of crops season to season.
2) Kind of crop: Groundnut covering crops like legumes will smother the weed growth. **E.g**.: sun hemp, groundnut.
3) Use of fertilizers: Application of optimum doses of fertilizers to crop will help to grow faster.
4) Date & rate of planting or sowing: Sowing of crops at proper time with optimum seed rate will help the crop to cover the ground & will make the weeds deprive of light.

iii) Biological methods: It includes the use of living organisms for suppressing or controlling the weeds. Plant, animal or micro organisms may be used for destruction of weeds. These are called as **bioagents** which feed on only the weeds and not on crop plants. E.g.: Prickly pear or

Nagphana weed in South India was controlled by Conchineal insects. (Dactlopius tomentosus). In Australia (Hawaii Islands) several kinds of moths were used to control Lantana Camara which eats the flowers & fruits. This method is very efficient & economical provided right type of predators, parasites or pathogens which even under starvation conditions will not feed upon cultivated crops are found out & introduced.

iv) Chemical methods: This is very effective in certain cases and has a great scope provided the chemicals are cheap, efficient & easily available. The chemicals used for weed control & which suppress or destroy the growth of weeds, called as herbicide. These either help in killing the weeds or in inhibiting their growth.E.g.2, 4-D, Atrazine, Glyphosate, etc.

Types of herbicide:

i) Selective herbicides are those which kill only weeds without injuring crop plants.

ii) Non-selective herbicides are those which kill all kinds of vegetations i.e. weed and crop plant.

iii) Contact herbicides kill all the plant parts which may get covered by the chemical by directly killing the plant cells. These chemicals are effective against annuals particularly when they are young but not perennials.

iv) Translocated/Systemic herbicides are first absorbed in the foliage or through roots and are then translocated to other parts of the plant. Or Kill plants after their absorption by accelerating or retarding the metabolic activities of plants. These are more effective in destroying deep rooted perennials.

Soil sterilents: are non-selective herbicides and have to be applied into the soil. They make the soil sterile and incapable of supporting any plant growth. As such any

weed seeds or weed seedlings present in the soil are killed.

Based on relative time of application to weed emergence the herbicides are classified as:

I) Pre-plant applied (Before planting of crop)

II) Pre-emergence (Before emergence of weeds)

III) Post-emergence (After emergence of weeds)

Acid equivalent (a.e.) refers to that part of the formulation that theoretically can be converted into the acid.

Active ingredient (a.i.) is that part of the chemical formulation which is directly responsible for the herbicidal effects.

Pre and post-emergence treatments to control weeds: Both the terms, Pre and post-emergence treatments are related with time of application of herbicides for control of weeds.

Pre-emergence treatment or application of herbicides: Application of herbicides after sowing of crop but before emergence of crop and weeds is called **pre-emergence application.**It is done from first to fourth day of sowing and only selective herbicides are used. Generally germinating weeds are killed by pre-emergence application and gives competitive advantage of crop. E.g.: Pre-emergence application of Atrazine @ 0.5 to 2.5 kg/ha in sugarcane, Jowar, Alachlor @ 1.5 to 2.5 kg ai/ha in Groundnut, Duiron @ 2.0 kg ai/ha or Oxadiazon @ 1.5 kg ai/ha in cotton.

Post-emergence application of herbicides: Application of herbicides after emergence of crop is called **post-emergence application.** It is generally resorted to when the crop has grown sufficiently to tolerate herbicides and to kill weeds that appear late in the crop. Generally, it is done about 30-40 days after sowing. For example,

application of Stam F34 @ 2 kg/ha or MCR 1 kg/ha in paddy 3 weeks after transplanting, 2,4-D @ 0.4 kg/ha in Wheat after 4-8 leaf stage, Pendimethalin @ 0.75 to 2.0 kg ai/ha in rice after 3-5 DAT, Isoproturon @ 1.0 kg ai/ha 30 – 35 days after sowing of Wheat.

Q:- Manures and Fertilizers.

A:- Plant requires food/nutrients/elements for its growth and development which are absorbed through soil. The nutrient supplying sources are manures and fertilizers. Application of manures and fertilizers to the soil is one of the important factors which help in increasing the crop yield and to maintain the soil fertility. N, P and K are the 3 major elements required for the crop growth.

Manure: It is a well decomposed refuse from the stable and barn yards including both animal excreta and straw or other litter. Or

The term **manure** implies to the any material with the exception of water which when added to the soil makes it productive and promotes plant growth.

Fertilizers: These are industrially manufactured chemicals containing plant nutrients. Or

It is an artificial product containing the plant nutrients which when added to soil makes it productive and promotes plant growth.

Difference between Manures and Fertilizers:

Sr No	Characteristics	Manures	Fertilizer
1	Origin	Plant or animal origin	Chemical synthesized or manufactured
2	Nature	Organic in nature	Inorganic in nature

3	Type	Natural product	artificial product
4	Conc. Of nutrients	less concentrated	More concentrated
5	Material	Supply organic matter	Supply inorganic matter
6	Nutrient availability	slowly available	May or may not be readily available
7	Nutrients	Supply all the primary nutrients including Micronutrient	Supply specific type of nutrients one, two or three. micro nutrients may or may not be present
8	Effect on Soil Health	Improves physical condition of soil	Do not improve the physical condition of soil
9	Effect on plant growth	No bad effect when applied in large quantities.	Adverse effect on plant whenever there is deficiency or excessive application

Q: - **Classification Of Manures And Fertilizers.**

A: - Manures and fertilizers may be:

1. Natural or
2. Artificial.

1. Natural Or Organic Manures: Natural manures are those which are bulky in nature and supply nutrients in small quantities and organic matter in large quantities. These are two types:

1. Bulky organic and

2. Concentrated org. manures.

1. Bulky OM: These are those which contain small percentage of nutrients and are applied in large quantities. E.g.: Farm Yard Manure (FYM), compost, Night soil, sludge and sewage, sheep and goat manure (Folding), Poultry dropping, Green manures, etc.

2. Concentrated OM: These are those which are organic in nature and contain higher percentage major plant nutrients like N, P and K as compared to bulky OM. These are made from materials of animal and plant origin. The examples of manures of plant origin are oilseed cake which may be edible or non-edible. Edible oil seed cakes are Groundnut cake, Linseed cake, Sesamum cake, Safflower cake (decort). Non-edible oil seed cakes are castor cake, Neem cake, Safflower cake (undercoat). The examples of manures of animal origin are Bone meal, Fish meal, Meat meal and blood meal.

A. Bulky Organic Manures:

a) Farm Yard Manure (FYM): FYM is a mixture of cattle dung, urine, litter or bedding material, portion of fodder not consumed by cattle and other domestic wastes like ashes, etc. collected and dumped into a pit or a heap in the corner of the back yard. Or

FYM refers to the decomposed mixture of dung and urine of farm animals along with the litter (bedding material) and left over material from roughages or fodder fed the cattle.

Because of the varied nature of the material, the composition of the manure itself varies widely but on an average well rotted FYM contains 0.5% N, 0.2%, P2O5 and 0.5% K2O. It also influences by various factors.

Q:- **Factors Influencing The Composition of FYM.**

A:- **1) Source of manure:** Composition of manures varies with kind of animal producing it. Poultry droppings is the

richest followed by sheep manure for nutrient contents. Dung contains phosphate while urine contains N and K2O. Amount of urine soaked in bedding material also decides the composition and vary with kind of animal.

2) Food of the animal: The richer the food in proteins, the richer will be the manure in 'N' which comes out in the dung and urine.

3) Age and condition of the animal: Young animals need more proteins to build up their body; hence manure is poorer in N content than old animals. Manure of sick animal is richer than healthy animals.

4) Function of the animals: Milch cantles utilize proteins for milk production; hence manure is poor in N, P & K content than draft purpose animals as they utilize more carbohydrates.

5) Nature & proportion of litter: The composition of litter varies with the kind of straw and hence will affect the quality of manure. Bajara stalks are rich in N, P & K followed by wheat & maize.

6) Preservation: Under ordinary storage, there are losses of N. Potash get lost due to leaching when the manure is too moist.

There are 3 methods of FYM preparation:

1. Heap**,**

2. Box and

3. Pit or Trench method.

Q:- **Green Manuring.**

A:- It is a practice of ploughing in the green plant tissues grown in the field or adding green plants with tender twigs or leaves from outside and incorporating them into the soil for improving the physical structure as well as fertility of the soil. It can be defined as a practice of ploughing or turning into the soil, undecomposed green plant tissues for the purpose of improving the soil fertility.

The object of green manuring is to add an organic matter into the soil and thus, enrich it with 'N' which is most important and deficient nutrient.

Types of green manuring: There are two types of green manuring:

1. Green manuring in-situ: When green manure crops are grown in the field itself either as a pure crop or as intercrop with the main crop and buried in the same field, it is known as Green manuring In-situ. E.g.: Sannhemp, Dhaicha, Pillipesara, Shervi, Urd, Mung, Cowpea, Berseem, Senji, etc.

These crops are sown as:

i) Main crop,

ii) Inter row sown crop,

iii) On bare fallow, depending upon the soil and climatic conditions of the region.

2. Green leaf manuring: It refers to turning into the soil green leaves and tender green twigs collected from shrubs and tress grown on bunds, waste lands and nearby forest area. E.g.: Glyricidia, wild Dhaicha, Karanj.

Characteristics/desirable qualities of a good manuring:

1. Yield a large quantity of green material within a short period.

2. Be quick growing especially in the beginning, so as to suppress weeds.

3. Be succulent and have more leafy growth than woody growth, so that its decomposition will be rapid.

4. Preferably is a legume, so that atm. 'N' will be fixed.

5. Have deep and fibrous root system so that it will absorb nutrients from lower zone and add them to the surface soil and also improve soil structure.

6. Be able to grow even on poor soils.

Stage of green manuring: A green manuring crop may be turned in at the flowering stage or just before the flowering. The majority of the G.M. crops require 6 to 8 weeks after sowing at which there is maximum green matter production and most succulent.

Advantages of green manuring:

i) It adds organic matter to the soil and simulates activity of soil micro-organisms.

ii) It improves the structure of the soil thereby improving the WHC, decreasing run-off and erosion caused by rain.

iii) The G.M. takes nutrients from lower layers of the soil and adds to the upper layer in which it is incorporated.

iv) It is a leguminous crop, it fixes 'N' from the atmosphere and adds to the soil for being used by succeeding crop. Generally, about 2/3 of the N is derived from the atmosphere and the rest from the soil.

v) It increases the availability of certain plant nutrients like P2O5, Ca, Mg and Fe.

Disadvantages of green manuring:

i) Under rain fed conditions, the germination and growth of succeeding crop may be affected due to depletion of moisture for the growth and decomposition of G.M.

ii) G.M. crop inclusive of decomposition period occupies the field least 75-80 days which means a loss of one crop.

iii) Incidence of pests and diseases may increases if the G.M. is not kept free from them.

Application of phosphatic fertilizers to G.M. crops (leguminous) helps to increase the yield, for rapid growth ofRhizobia and increase the 'P' availability to succeeding crop.

Q:- Artificial Or Chemical Or Inorganic Fertilizers

A:- These can be classified as:

1) Straight fertilizers: These are those which supply only one primary plant nutrient, viz. N, P or K. Depending

upon the nutrient present in the fertilizer, these are classified as:

a) Nitrogenous fertilizers: These are those which contain and supply only the nitrogen. Or are those fertilizers that are sold for their 'N' content and manufactured on a commercial scale.

These are classified into 4 groups on the basis of the chemical form in which 'N' is combined with other elements in a fertilizer (Chemical form of 'N').

i) Nitrate form (NO3): Sodium nitrate (Chilean nitrate), Calcium nitrate, Potassium nitrate and Nitrate of Soda Potash.

ii) Ammonical form (NO3): Ammonium sulphate, Ammonium Chloride and Anhydrous ammonia.

iii) Nitrate & ammoniacal form: Ammonium Nitrate, Calcium Ammonium Nitrate & Ammonium sulphate nitrate.

iv) Amide form (Cn2 or NH2): Calcium cynamide, Urea and Sulphur coated urea.

b) Phosphatic fertilizers: These are those which contain and supply only the 'P'. P content in fertilizers is expressed in oxidized form, phosphorus pent oxide (P2O5) while its content in soil and plant is expressed in elemental form as 'P'. The conversion factors for elemental to oxidized form and vice versa are 2.29 and 0.43, respectively.

These can be divided into 3 groups based on their availability to crop and solubility.

i) Containing water soluble phosphoric acid: Fertilizers are available in the form of mono calcium phosphate or ammonium phosphate. E.g.: single super phosphate, double super phosphate and triple super phosphate.

ii) Containing citric acid soluble phosphoric acid: These fertilizers contain citrate soluble phosphoric

acid or dicalcium phosphate. E.g.: Basic slag, Di-calcium phosphate.

iii) Containing phosphoric acid not soluble in water or citric acid: E.g.: Rock phosphate, raw bone meal, steamed bone meal.

c) Potassic fertilizers: These are those which contain and supply only the 'K'. Potassium in the fertilizer is expressed as K2O (Potassium oxide). The conversion factor to express in elemental factor (K) is 0.83 and oxide form is 1.2.

These are grouped in two as:

a. Chloride form: - E.g. Muriate of potash or pot. Chloride.

b. Non chloride form: - E.g. Potassium Sulphate, Potassium Magnesium sulphate, Potassium nitrate.

2) Complex or Compound fertilizers: These are those which contain two or three primary plant nutrients of which two primary nutrients are in chemical combination. E.g.: Diammonium phosphate, Nitro phosphates, Ammonium phosphate, Potassium nitrate, Ammonium Sulphate phosphate, Ammonium Nitrate phosphate, Ammonium Potassium phosphate.

a. Fertilizer mixtures/Mixed fertilizers: These are physical mixtures of straight fertilizers containing two or three primary plant nutrients.

These are made by thoroughly mixing the ingredients either mechanically or manually. Fertilizer grade refers to the guaranteed minimum percentage of N, P2O5 and K2O contained in fertilizer materials. E.g.: 20:20:0, 28:28:0, 18:18:10, 14:25:14, 17:17:17, 14:28:14 and 18:8:9, etc.

b. Micro nutrient fertilizers: These are the nutrients which supply the nutrients required in smaller quantities. These are the chemicals which supply the elements required by the plant in very small quantity. E.g.: Copper Sulphate, Zinc Sulphate, Borax, Sodium Borate,

Manganese Sulphate, Sodium Molybdate, Ammonium Molybdate, Ferrous Sulphate, etc.

c. Soil amendments: These are those which improve the soil by correcting its acidic or saline, or alkaline conditions and neutralizing the injurious effects that may result from improper use of fertilizer. E.g.: Lime, Gypsum, Sulphur, and Molasses. These are the substances that influence the plant growth favourably by producing the soil one or more of the following beneficial effects:

1. Changing the soil reactions i.e. making the soil less acidic (Lime) or less alkaline (Gypsum).
2. Changing the plant nutrients in the soil from unavailable forms.
4. Improving the physical condition of soil (Molasses).
5. Correcting the effects of injurious substance.

d. Bio-fertilizers/Microbial inoculants: It may be defined as preparation containing live or latent cells of the efficient strains of N fixing, phosphate solubilizing or cellulytic micro organisms.

These are used for application to seed, soil or decomposing areas to increase the no. of such certain microbial process to make the nutrients in available form to plants such as Rhizobium, Azotobacter, Azospirillum, Blue-green algae and Azolla.