AR-7914
B.Sc. (Forestry) (Sixth semester)
Examination 2013
Agrforestry System and Management
Paper: Second Time allowed: Three hours
Maximum Marks: 60
Note: Answer any five questions.
Question No.1 is compulsory. Question 2-8 carries 10 marks each

Q.1(A) Define the following terms (2x5=10)

- **Farm forestry -:** Farm forestry is the name given to programmes which promote commercial tree growing by farmers on their own land. Farm forestry was defined by NCA (1976) as the practice of forestry in all its aspects in and the around the farms or village lands integrated with other farm operations.

- **Slash and burn system -:** Slash-and-burn is also known as Jhum cultivation which involves cutting and burning of forests or woodlands and raising of agricultural crops for 2-3 years and abandon the land when it is unsuitable for cultivation to retain its fertility by natural means of revegetation. It is subsistence agriculture that typically uses little technology or other tools. It is commonly practiced in north eastern parts of India. It is typically part of shifting cultivation agriculture, and of transhumance livestock herding.

- **Benefit cost ratio -: A benefit-cost ratio (BCR)** is an indicator, used in the formal discipline of cost-benefit analysis, that attempts to summarize the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values. Benefit cost ratio (BCR) takes into account the amount of monetary gain realized by performing a project versus the amount it costs to execute the project. The higher the BCR the better the investment. General rule of thumb is that if the benefit is higher than the cost the project is a good investment.

- **Woody hedge row -:** A hedgerow is a row of trees grown in the form of hedge by repeated pruning. The height of the hedges will be maintained below 1m. In this system, especially fast growing and coppicing fodder shrubs and trees are planted for the purpose of browse, mulch, green manure, soil conservation etc. The following species viz., *Erythrina sp, Leucaena luecocephala, Sesbania grandiflora* are generally used in this system.

- **Competition -:** Each population is inhibited by others use of (above or below ground) growth resources. The competition leads to negative effect on performance of agroforestry system. Two types of competition between trees and crops is generally exists in agroforestry systems i.e. above ground competition generally for light resources and below ground competition for water and nutrients. The severe competition leads the failure of agroforestry system.

Q.1(B) Fill in the blanks (1x5=5)

- Key feature of D&D survey is speed and repetition
- Rank of India in production of rice is 2
- When the negative effect effect exist in both species is known as inhibitory
- The state where India started green revolution is Punjab
- Tree crop interface can be estimated by Simple design

Q.1(C) State whether true or false (1x5=5)

- Pekarangan is also known as Javanese garden –True
- Kancha sytem is practised in U.P – False
- According to time line development the first crop to be sown on earth is wheat -True
- Tea was first discovered by the Emperor of Nepal –False
- National agroforestry research centre is situated in New Delhi - False

Q. 2. Define agroforesty. What are the advantages of agroforestry. And also describe the constraints in adopting agro forestry by the farmers.

Agroforestry is a collective name for a land-use system and technology whereby woody perennials (trees, shrubs, palms, bamboos etc.) are deliberately used on the same land management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence. In an agroforestry system there are both ecological and economical interactions between the various components (Lundgreen and Raintree, 1982).

According to Nair (1979) Agroforestry defined as land use system that integrates trees, crops, animals in a way that is scientifically sound, ecologically desirable, practically feasible and socially acceptable to farmers.

A typical Poplar based Agro forestry system

- **Environmental benefits**

- Reduction of pressure on natural forests.
- More efficient recycling of nutrients by deep rooted trees on the site
- Better protection of ecological systems
- Reduction of surface run-off, nutrient leaching and soil erosion through impeding effect of tree roots and stems on these processes
- Improvement of microclimate, such as lowering of soil surface temperature and reduction of evaporation of soil moisture through a combination of mulching and shading
- Increment in soil nutrients through addition and decomposition of litterfall.
- Improvement of soil structure through the constant addition of organic matter from decomposed litter.
- Carbon sequestration

B) Economic benefits

i) Increment in an outputs of food, fuel wood , fodder, fertiliser and timber;
ii) Reduction in incidence of total crop failure, which is common to monocropping systems
iii) Increase in levels of farm income due to improved and sustained productivity

C) Social benefits

i) Improvement in rural living standards from sustained employment and higher income

ii) Improvement in nutrition and health due to increased quality and diversity of food outputs
iii) Stabilization and improvement of communities through elimination of the need to shift sites of farm activities.

Constraints in adoption agro forestry by the farmers

Major constraints are as follows:

Small land holding size: Farm sizes of small and marginal farmers are too small to allow for the integration of trees.

Gaps in technical knowledge about spatial and temporal integration of trees and crops.

Long gestation period of trees: Trees are perennials and generally have long gestation periods do not allow poor farmers to practice them under agroforestry systems since the economic benefits are usually realized after a long period. Small and subsistence farmers could not afford wait for such longer period due to their poor economic conditions.

Tree-crop management: The practice of agroforestry is complex, which needs a thorough understanding of biophysical interactions to exploit the benefits of agroforestry. A lot of skill and knowledge is required for achieving sustainable production.

Tenure of trees: Most farmers were not aware of ownership right concerning the growing of trees on farms and so were not willing to plant trees. Agroforestry depends on people right to plant and use trees and these rights in turn depend on the prevailing system of land and tree tenure.

Insect-pest infestation: The trees under agroforestry harbour a variety of pests, which are harmful for crops. The animals interfere frequently on functioning agroforestry system.

Lack of adequate credit facilities and insurance of crops: The agroforestry venture needs greater financial requirement than sole cropping system. At instances, the crops get damaged due to excessive shade, insect pests and also logging. Lack of proper credit support and insurance facilities prevent the farmers in adoption on large-scale.

Marketing and transportation facilities: The lack of adequate marketing and transportation facilities creates problems and further discourages the farmers to practice of agroforestry.

Inadequate availability of quality planting material: The availability of quality planting stock is a biggest snag in adoption of agroforestry especially by small and marginal farmers.

Q3. Differentiate between

- **Lopping and pruning**

Lopping	**pruning**
Lopping is the cutting of large woody branches to stubs that are not large enough to assume the terminal (main growth point) role. It is usually done by lopping shears, axes and saw.	Pruning is defined as the elimination of tiny lateral branches to suppress lateral growth, It is usually done with pruning knife/saw or secateurs.
The main purpose of lopping is to reduce the canopy size of a tree.	The purpose of pruning is to obtain trees with clean bole.

The process of lopping can remove up between 50% to 100% of the foliage (leaf) bearing crown of a tree. Because leaves are the food factories of a tree, removing them can temporarily starve a tree.	On the other hand there are different prunings Fixed lift pruning - is the complete pruning of all the branches. Variable lift pruning - is a pruning of all branches below a prescribed variable point on the stem Tip pruning- is the pruning of a branch at a point other than at its junction with the stem.

RECOMMENDED PRUNING METHOD

PROPER REMOVAL OF BRANCHES

FIRST CUT

UNDER CUT TO PREVENT STRIPPING OF BARK

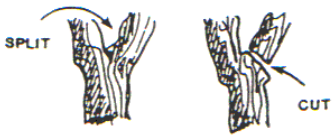
SECOND CUT

REMOVE LIMB BY MAKING DOWNWARD CUT

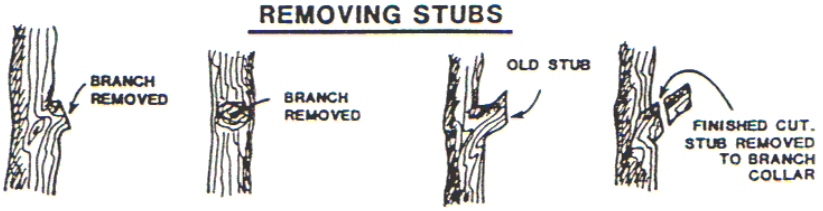
THIRD & LAST CUT

REMOVE STUB BY DOWNWARD CUT FROM TOP SIDE

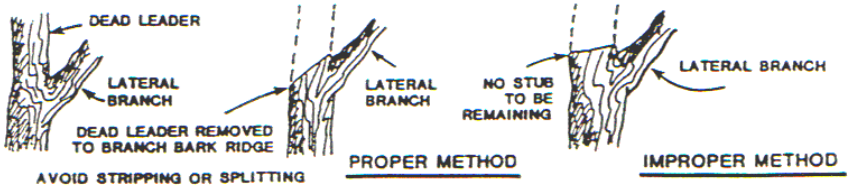
PROPER CROTCH TREATMENT

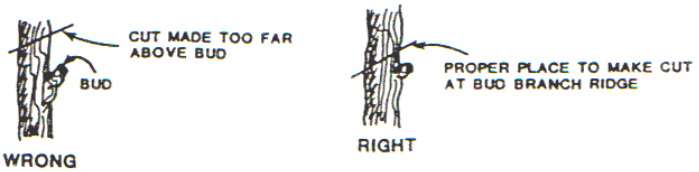


REMOVING STUBS



PART OF LEADER OR BRANCH TO BE REMOVED





SHARP TOOLS ARE IMPORTANT

- **Wind break and shelterbelt**.

Wind break	Shelterbelt
Wind break are strip of trees/ shrubs planted to protect field, home from wind and blowing sand or soil.	A shelterbelt is a The extensive form of wind break is known as shelterbelt. This are belt of several rows of trees, shrubs established at right angle to prevailing wind
Wind break are also known as wind breakage and narrow belt of trees/shrubs usually one or few rows.	Shelter belt is also known as protection belt comprising wide belt of trees/shrubs planted in multiple rows to protect crops from direct sun, wind and snowdrift.
It covers small area (Farm)	It covers extensive area usually extends in Kms.
The scope and benefits are limited.	The scope and benefits are more compared to wind breaks

Q4. Write short notes on

- **Multipurpose tree species**

Multipurpose trees are those trees that are deliberately grown and managed for more than one product. They may supply food in the form **of fruit, nuts, or leaves** that can be used as a vegetable; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs.

Some common multipurpose trees of the tropics are:

- Moringa *(Moringa oleifera)* – edible leaves, pods and beans, commonly used for animal forage, shade, and adding nitrogen to the soil.
- Coconut palm – used for food, purified water (juice from inside the coconut), roof thatching, firewood, shade.
- Neem - limited use as insect repellent, antibiotic, adding nitrogen to the soil, windbreaks, biomass production for use as mulch, firewood.

Desirable characteristics of species

- **Easily established:** require minimum labour for planting and maintenance.
- **Fast growing:** benefits become available to the farm family as soon as possible.
- **Good sprouting:** hedgerows continue to grow regularly after pruning.

- **Nitrogen fixing:** leguminous (nitrogen-fixing) species can contribute to crop nutrition.
- **Heavy and palatable foliage**: provide more green manure and acceptable fodder.
- **Deep root system:** nutrients and water are drawn from lower soil layers.
- **Easy to propagate:** generally, growing hedgerows from seed requires less labour than vegetative propagation.
- **Adaptable to close spacing:** hedgrows require dense planting

- **Shifting cultivation**

Shifting cultivation is commonly known as slash and burn agriculture, is believed to be originated during the Neolithic period around 7000 B.C. It was a remarkable innovation during primitive culture and regarded as the first step in transition from food gathering to food production. Yet this system of farming is still practiced in different parts of the world. It has been estimated that about 200 million people, 7% of mankind of the world is still practicing this type of cultivation in about 300 million ha. of various land i.e. 5% of cultivated soil throughout the world. In India around two million tribal people cultivated approximately 11 million hectare of land under shifting cultivation. In North-East India over a 100 of tribal ethnic minorities are practicing shifting cultivation and in certain parts of this region it is practised not only by the tribal minorities but also by the landless people and lowland migrants. According to the report of National Commission on Agriculture (1976), 49 ,2000 tribal families of this region are involved in Jhumming and the total area affected by this practice is 26,94,000 ha.

Technology -Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily, then abandoned and allowed to revert to their natural vegetation while the cultivator moves on to another plot. The period of cultivation is usually terminated when the soil shows signs of exhaustion or, more commonly, when the field is overrun by weeds. The length of time that a field is cultivated is usually shorter than the period over which the land is allowed to regenerate by lying fallow.

. **Implements** –stick, knife

Main crop- paddy, potato, millets

Common name-kurwa,podo.dahiya

Effect-

The longer a field is cropped, the greater the loss of soil organic matter, the reduction in the cation-exchange-capacity and in nitrogen and phosphorus, the greater the increase in acidity, the more likely soil porosity and infiltration capacity is reduced and the greater the loss of seeds of naturally occurring plant species from soil seed banks. In a stable shifting cultivation system, the fallow is long enough for the natural vegetation to recover to the state that it was in before it was cleared, and for the soil to recover to the condition it was in

before cropping began. During fallow periods soil temperatures are lower, wind and water erosion is much reduced, nutrient cycling becomes closed again, nutrients are extracted from the subsoil, soil fauna increases, acidity is reduced, soil structure, texture and moisture characteristics improve and seed banks are replenished.

Q5. What do you mean by tree architecture? Explain the importance of high density short rotation plantation system.

Tree architecture is a dynamic concept the ultimate architecture of design of tree is based on the ratio of growth of leader axis vs lateral branches. Bud dynamics, pattern of production of branches, birth and death rate of leaves born on them and the final display of the branches and leaves on them. Such a dynamic concept would be determined by micro environmental changes that occur around tree grow the adoptive strategy of tree. Tree architecture is thought to allow species to partition horizontal and vertical light gradients in the forest canopy. Tree architecture is closely related to light capture, carbon gain and the efficiency with which trees reach the canopy. There is great diversity in the form shape and architecture of trees due to multiplicity of species and environmental condition in which they grow. On the basis of architectural form trees are classified in to (a) mono axial trees (b) poliaxial trees.

Monoaxial trees :

- Monoaxial trees with terminal inflorescence- e.g., Agave, Corypha
- Monoaxial trees with lateral inflorescence e.g., Coconut, Arecanut, Borassus, Phoenix species

Poly axial trees:

- Polyaxial trees with vegetative axis all equivalent and orthotropic basal branches
- Trees with repeated development of equivalent orthotropic basal branches e.g., Banana, Date palm
- Trees with orthotropic or plagiotropic stems e.g., Hyphaene spp., Nipa fruticans
- Sigmoid stem originating from basal branching having plagiotrophic branches e.g., Bamboos
- Poly axial trees with vegetative axis differentiated into stem branch
    - Vegetative axis orthotropic or plagiotropic e.g., Jatropha, Ricinus
    - Trees with axis orthotropic e.g., Ailanthus, Alstonia sp.
    - Trees with two distinct types of modules e.g., Alstonia, Euphorbia
    - Trees with orthotropic monopodial trunk. e.g., Terminalia bellirica
    - Trees with orthotropic monopodial trunk with rhythmic growth e.g., Arucaria, Agathis

(C) Trees with all orthotropic e.g., Mangifera indica, Anacardium , Cassia

(D) Trees with mixed axis e.g., Emblica, Bauhinia, Cassia

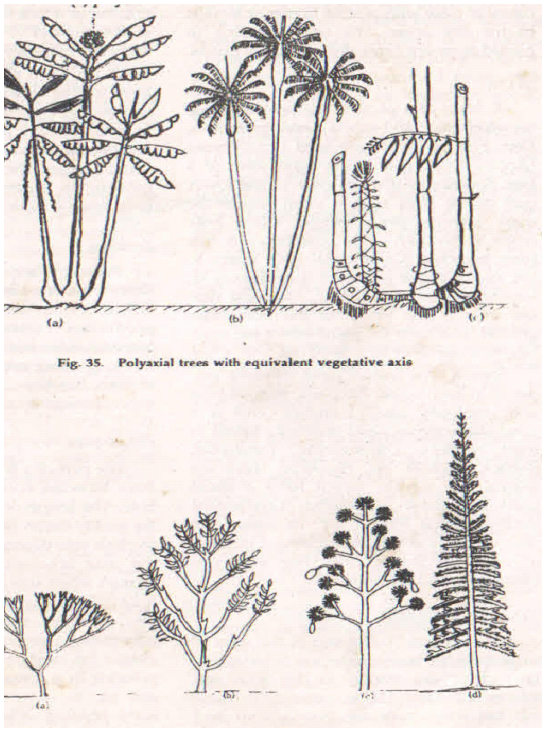


Fig. 35. Polyaxial trees with equivalent vegetative axis

Poly axial trees

High density short rotation plantation system

Lack of wood is common in many countries – particularly for forest industries in developed countries and for fuel in developing countries. Greater attention to short-rotation forestry on agricultural land and on non fertile forest soils could offer a way to provide forest industries with enough wood resources and people in the developing world with enough fuel, while conserving natural forests.

Short-rotation plantation (SRP) is defined as the silvicultural practice under which high-density, sustainable plantations of fast-growing tree species produce woody biomass on agricultural land or on fertile but degraded forest land. SRPs usually have a rotation cycle ranging from 3 to 6 years, in some cases even 1-2 years. They involve fast growing tree species planted at very high density with up to 10,000 trees per hectare. Trees are grown either as single stems or as coppice systems, with an annual woody production of at least 10 tonnes of dry

matter or 25 m^3 per hectare. The practice should optimize the use of natural resources, environmentally and economically, through the application of biological, physical, theoretical and practical knowledge .The biomass produced is used for construction, pulp and paper, fodder and energy. Wood from short-rotation forestry may replace wood from tropical forests and from protected forest areas and thus help conserve valuable natural forests for future generations.

High-density, short-rotation mixed plantations including some fast-growing nitrogen-fixing tree species have been found suitable for site amelioration and biomass production for fuel and fodder. Examples include *Leucaena leucocephala* with *Melia azedarach* and *Eucalyptus* spp. hybrids in subtropical foothills and *Robinia pseudoacacia* with *Acacia mollissima* and *Morus*spp. in the subtemperate middle hills of the north-western Himalaya. *Prosopis juliflora* and *Acacia nilotica* (with 9- to 14-year rotations) are suitable for fuel wood and site amelioration in the northern and north-western plains.

Wood production, agroforestry and site amelioration in India

As a result of restrictions on green felling in natural forests imposed by the Indian Government, fast-growing, short-rotation forest plantations are emerging as a major source of raw material for Indian wood-based industries. Forest plantation activities have been emphasized since the Indian Government recognized, as early as 1961, the gap between supply and demand for all types of wood. In a review of Indian industrial plantations cultivated under various schemes, highlighted a need for plantation of short-rotation species, e.g. *Eucalyptus*, *Casuarina* and *Populus* species, to meet the growing demand for raw material for wood-based industries. In response to recent commercial plantation activity in central and southern India, there is also renewed interest in growing teak (*Tectona grandis*) on short rotations. Research on teak wood quality is focusing on heartwood production and timber strength from plantations with relatively low-input management. *Gmelina arborea* has been grown successfully on short rotations for pulp and paper in the north-eastern humid tropics. Besides economic benefits, Short rotation plantations provide several ecological e.g., amelioration of degraded environments, C sequestration, soil and water conservation etc. and social benefits e.g., meeting the requirements of firewood and small timber.

Q6. Classify the Agroforestry system on the basis of socio economic and functional basis.

Agro forestry system are highly diverse and complex in character and function. To evaluate understand and seek to improve them through some action plan of research requires their classification. The objective of classification of agro forestry should be

- Logical grouping
- How system is managed
- Flexibility
- Easily understood

On the basis of function and socio economic, the agroforestry systems are classified as

Functional classification

A) **Productive agroforestry systems**- the objective is to maximise production of tree and crops by enhancing timber, firewood, fodder and food production. e.g., Home gardens, plantation crops

B) Protective systems- the objective is provide protection by ameliorating climate, reducing wind and water erosion, improving soil fertility, providing shelter and other benefits. e.g., wind breaks and shelterbelts.

C) Multipurpose systems- These agroforestry systems provide both benefits of production and protection. E.g. Silvipasture systems, multipurpose trees on farm lands

A) Productive functions

The Productive functions are:
I) Food
II) Fodder
III) Fuel wood
IV) Cloths
V) Shelter
VI) NTFPs

B) Protective functions

The Protective functions are:
i) Wind breaks
II) Shelterbelts
III) Soil conservation
IV) Soil improvement

2.S socioeconomic criteria -as scale of production and level of technology input and management, agroforestry systems have been grouped in to three categories.
A) Commercial Agroforestry systems (AF)

B) Intermediate Agroforestry systems

C) Subsistence Agroforestry systems

A) Commercial AF systems:
The term commercial is used whenever the scale of the production of the output is the major aim of the system.

Examples:

a) Commercial production of plantation crops such as rubber, oil palm, and coconut with permanent under planting of food crops, pastures

b) Commercial production shade tolerating plantation crops such as coffee, tea and cocoa under over storey of shade trees

B) Intermediate AF systems:

Intermediate systems are those between commercial and subsistence scale of production and management.

Examples:

Production of perennial cash crops and subsistence food crops undertaken on farms wherein the cash crops fulfil the cash needs and the food crops meet the family's food needs.

C) Subsistence AF systems:

Subsistence AF systems are those wherein the use of land is directed towards satisfying basic needs and is managed mostly by the owner and his family.

On the basis of technology

A) Low technology

Low technology agro forestry systems are those which based on primitive technology. e.g shifting cultivation with low or no inputs.

B**) High technology**

High technology agro forestry systems are those which depend on modern technology with high inputs e.g. tea coffee plantation

C) Inter mediate technology

Inter mediate technology are those in between two systems discussed above. Most of the system followed in India is of this category.

On the basis of technology

a) Extensively managed e.g shifting cultivation

b**) Intensively managed** e.g. home garden

Q7. Chhattisgarh is classified in to how many climatic zones. Enlist the agro climatic zones of India.

Agro-climatic zone is a land unit in terms of major climate, superimposed on length of growing period (moisture availability period). The prime objectives of agro-climatic regional planning are to optimize agroforestry production, increase farm income and create more employment opportunities through the scientific utilisation of agricultural and allied resources.

The potential for growth and diversification would be fully exploited taking a holistic view of the climate, soil type, topography, water resources and irrigation facilities and relating them to the requirements of output and employment. A break up agro forestry has been outline to increase the area fro 7.45 m/ha to 25.36 m/ha by two decades. ICAR R&D programme has started All India Co-Ordinated AICRIP project in 36 centres to enhance the productivity as well as area under agro forestry system.

Out of 137.00 lakh hectares geographical area of Chhattisgarh, 43 % area comes under cultivation. On

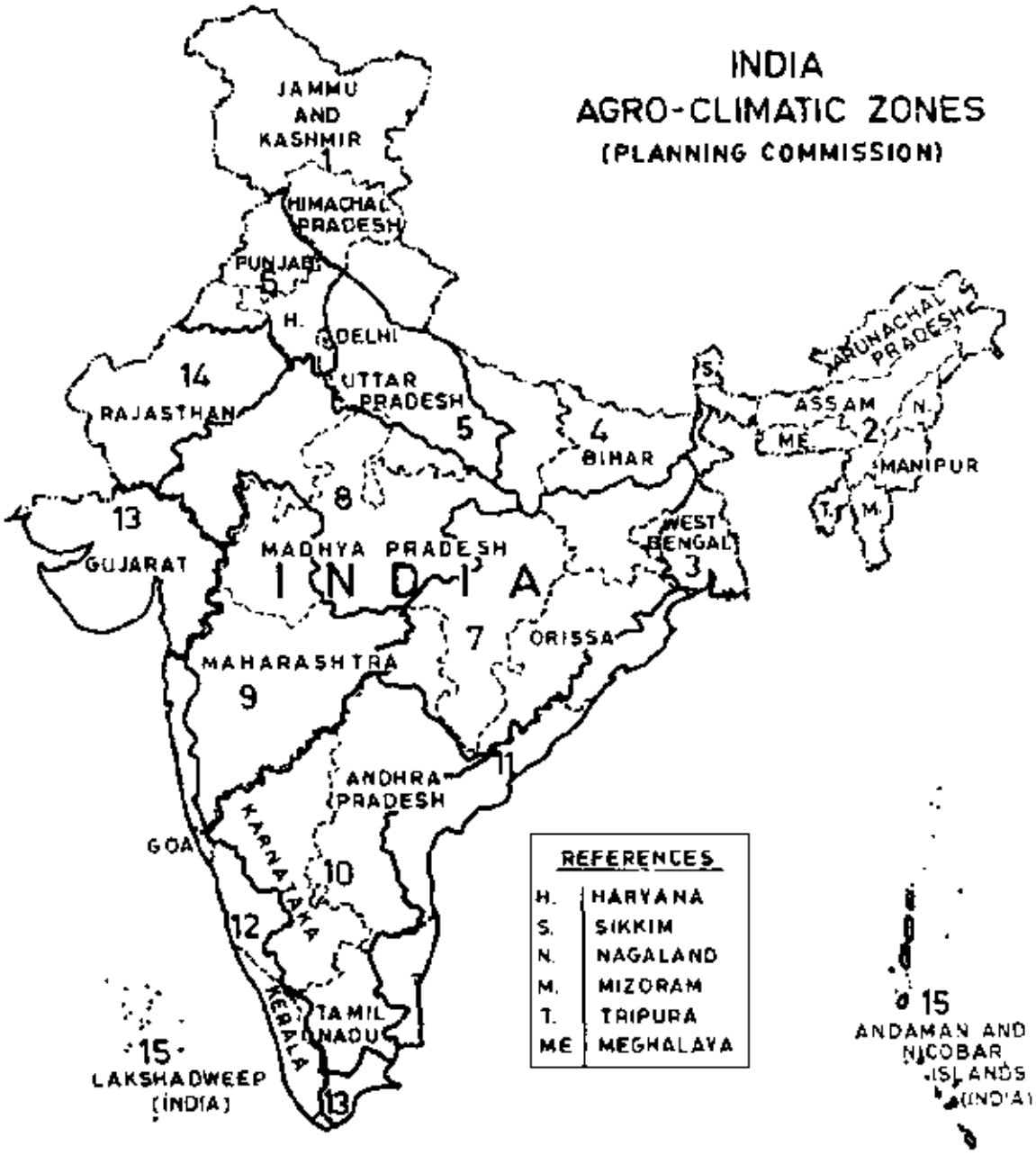
the basis of climate & topography the state is divided into 3 agro climatic zones. The Bastar Plateau comprises of Bastar, Dantewada, Beejapur & Narayanpur districts and a part of Kanker (excluding Charama, Narharpur & Kanker Blocks). Northern parts of the state comes under "Northern Hilly Region" which comprises of Sarguja, Koriya & Jashpur Districts. Bilaspur, Raipur, Janjgeer-Champa, Raigarh, Rajnandgaon, Kawardha, Durg, Mahasamund, Dhamtari, Korba and parts of Kanker come under "Plains of Chhattisgarh".

Agroclimatic zones of Chhattisgarh

S. No	Agro climatic Zone	Districts
1	Chhattisgarh Plains	Raipur, Mahasamund, Dhamtari, Durg, Rajnandgaon, Kabirdham, Bilaspur, Korba, Janjgir and part of Kanker district (Narharpur & Kanker
2	Bastar Plateau	Jagdalpur, Dantewada and remaining part of Kanker district.
3	Northern Hills	Surguja, Koriya and Jashpurnagar and Dharamjaigarh Tehsil of Raigarh

Agroclimatic zones of India and suitable Agroforetry practices

S. No	Agro climatic zone	Agro forestry system
1	Western Himalayan Region	Silvipasture , Agro-horticulture
2	Eastern Himalayan Region	Agri silvi culture, Silvipasture
3	Lower Gangetic Plains Region	Agri silvi culture, Silvipasture
4	Middle Gangetic Plains Region	Agri silvi culture, Silvipasture
5	Upper Gangetic Plains Region	Agri silvi pasture
6	Trans-Gangetic Plains Region	Agri silvi culture, Agri silvi pasture
7	Eastern Plateau and Hills Region	Agri silvi culture, Silvipasture
8	Central Plateau and Hills Region	TBO'S , Agri horticulture
9	Western Plateau and Hills Region	Agri silvi culture, Silvipasture
10	Southern Plateau and Hills Region	Agri silvi culture, Silvipasture, TBO'S
11	East Coast Plains and Hills Region	Agri silvi culture
12	West Coast Plains and Ghat Region	Agri horticulture, Agri silvi culture, Silvipasture
13	East Coast Plains and Hills Region	Agri silvi culture, Silvipasture, TBO'S
14	West Coast Plains and Ghat Region	Agri silvi culture, Silvipasture
15	Gujarat Plains and Hills Region	Agri horticulture, Silvipasture



1. Western Himalayan Region
2. Eastern Himalayan Region
3. Lower Gangetic Plains Region
4. Middle Gangetic Plains Region
5. Upper Gangetic Plains Region
6. Trans-Gangetic Plains Region
7. Eastern Plateau & Hills Region
8. Central Plateau & Hills Region
9. Western Plateau & Hills Region
10. Southern Plateau & Hills Region
11. East Coast Plains & Hills Region
12. West Coast Plains & Ghats Region
13. Gujarat Plains & Hills Region
14. Western Dry Region
15. The Islands Region

Q8. How agro forestry helps in improving the industrial growth of India. Explain

India encounters a critical disequilibrium in its natural resource pool. Half of the country's legal forest is deplorably degraded and deforestation occurs at alarming rate of 1.5 million ha $year^{-1}$ till the recent past. These have ushered in not only a total mismatch between supply and demand of both domestic and industrial wood requirements but also leads to degradation of the land surface. The forests have very low growing stock at 74 m^3 ha^{-1} compared to the world average of 110 m^3 ha^{-1}. Similarly, the mean annual increment is very low at less than 1 m^3 ha^{-1} $year^{-1}$ compared to the world average of 2.1 m^3 ha^{-1} $year^{-1}$. The shortfall in forest area coupled with poor productivity resulted in dwindling supply of raw material requirements of various wood based industries. This has necessitated the exploit the potential agro forestry. The agro forestry has immense potential and scope, provide diverse products and full fill the needs of Industrial raw material in India. Agro forestry does not convert agricultural land to forests or forested lands to agriculture. Rather, it is an approach to land management that spans the breadth of the industries of each, integrating with current land management practices to produce both familiar and novel crops.

Most of the wood based industries like pulp, paper, match and veneers are largely dependent on forest department supply but due to government policies and the promulgation of Forest Conservation Act, 1980 restricted the supply of raw material to the wood based industries which necessitated massive import of sawn timber, pulp and even newsprints. Substantial improvement in productivity of forest resources on sustainable basis and large scale expansion of industrial linked agroforestry plantations are critically important for meeting the industrial raw material requirements besides achieving the national goal of 33 per cent forest cover. The Indian Paper Industry accounts for about 1.6% of the world's production of paper and paperboard. The estimated turnover of the industry is Rs 35,000 crore (USD 7 billion) approximately and its contribution to the exchequer is around Rs. 3000 crore (USD 0.6 billion). The industry provides employment to more than 0.37 million people directly and 1.3 million people indirectly. The industry was started effective from July, 1997 by the Government of India; foreign participation is permissible. Most of the paper mills are in existence for a long time and hence present technologies fall in a wide spectrum ranging from oldest to the most modern. The mills use a variety of raw material viz. wood, bamboo, recycled fibre, bagasse, wheat straw, rice husk, etc.; approximately 35% are based on chemical pulp, 44% on recycled fibre and 21% on agro-residues. The geographical spread of the industry as well as market is mainly responsible for regional balance of production and consumption. The operating capacity of the industry currently stands at 12.75 million tons. During this fiscal year, domestic production of paper and paperboard is estimated to be 10.11 million tons. As per industry guesstimates, over all paper consumption (including newsprint) has now touched 11.15 million tons and per capita consumption is pegged at 9.3 kg. Demand of paper has been hovering around 8% for some time. So far,

the growth in paper industry has mirrored the growth in GDP. India is the fastest growing market for paper globally and it presents an exciting scenario; paper consumption is poised for a big leap forward in sync with the economic growth and is estimated to touch 13.95 million tons by 2015-16. The futuristic view is that growth in paper consumption would be in multiples of GDP and hence an increase in consumption by one kg per capita would lead to an increase in demand of 1 million tons.

Agroforestry systems are capable of meeting the demands of raw materials of several agricultural and forest based industries. Some of the industries, e.g., paper and pulp mills, sports goods, furniture, saw mills etc. are located in Haryana, Punjab, Uttar Pradesh etc. are meeting their raw material requirements from agroforestry produce. *Eucalytypus* hybrid grown by farmers on large scale is now been used for a variety of purposes. Poplars has been widely cultivated in the Tarai area of U.P. and is been used by several industries e.g., Match splints, plywood, packaging cases etc. Some industries have started buy back guarantee scheme for planting specific tree species required by the industry. A similar system which yielded good result was initiated by the paper industries, corporation of Philippines.

WIMCO Ltd., India also operates in a temperate zone - at locations both in Uttar Pradesh and elsewhere in northern India. The company raises fast-growing poplars as raw material for its mills, which produce matches, veneer, pulp and paper, fuel, lumber, pencils, packaging, joinery and light furniture. Trees are bred for narrow crowns and early leaf-fall to facilitate capture of sunlight by crops. This type of cooperation with local landowners has generated an immense amount of good will for the company and has significantly increased the income level of local farmers and meets the industrial needs of raw material. Similarly, the ITC Bhadrachalam paper mills also encouraged contracting farming of improved *Eucalyptus* and *Causirina* clones in agroforestry systems in southern India to meet the Industrial requirements of paper and pulp wood. The demand for raw materials for sports goods are increasing day by day, the practice of mulberry, salix, celtis, acer and poplar trees in agoforestry practices in northern India helped in decreasing the gap in demand and supply. Similarly, the ply wood and packaging industries are facing acute shortage of raw materials, the practice of fast growing species like *Eucalyptus, Casuarinas*, poplars, acacia, bamboos, kadam, albizias in agroforestry by and large meeting the demands of industries.