Chapter 1

Introduction

M.T. Siddiqui and M.F. Nawaz*

Abstract

A forest is a biotic community of fauna and flora predominated by trees and woody vegetation that covers a large area. Forest have appeared on Earth about 350 million years ago and reached a peak about 270 million to 220 million years ago during the Carboniferous period. Today, forests cover about one third of the earth's land surface. Forests played a vital role in the survival, development, and growth of human society. They not only provide industrial wood, fuelwood, shelter and forage for livestock but also improve the quality and quantity of water, reduce erosion and runoff, store carbon, increase soil texture and fertility, provide habitat, reduce air pollution and surrounding temperature and provide several recreational activities to mankind. Pakistan has only 4.8% of its area under forests which is far behind the country need. Pakistan has natural forest cover only 2.2% and losing its forests at the rate of 1.66% per year, all because of increasing population pressure, land clearance for agriculture, timber mafia, over-exploitation of resources and forest fires. There is urgent need of law implementation and adoption of necessary strategies to protect and improve the forests of Pakistan.

Keywords: Trees; Pakistan; Forest; Degradation; Threats.

1.1. Significance of Forestry

Trees are the oldest companion of man, which provided safety, fuel, food, clothing and shelter when man first moved to the Earth from heavenly abode. In fact, quest

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for wood, which is the principal building material and fuel of the past societies, has triggered large population movements. The discovery of how to keep and use fire, the idea of the wheel, and the concept of lever, are many fundamental civilizing concepts of man that seem to have been developed from wood over a period of many millennia. Actually, wood is indispensable for human existence right from the beginning of life on Earth till to date and associated with human civilization for its multiple uses and properties.

With the advent of modern time in mid- sixteenth century and later during industrial revolution in eighteenth century, importance of forests as a source of wood for industries (iron and bronze manufacture), ship building and protection of river catchments for sustainedsupply of clean water was recognized at a time when forest area began to diminish with increasing population and expansion of agriculture. Wood was used as fuel in locomotives before the discovery of coal: For instance, Changa Manga plantation was established in 1866 to supply fuel for railway engines and some plantations in Punjab and Sindh supplied wood to Indus flotilla at that time. At the close of 20th century, the concept of forest conservation for climatic and environmental stability, sustainable development, control of desertification and conservation of biological diversity is being highlighted in many international forums.

The importance of forests is significant in countries like Pakistan, which has arid and hot climate over more than 70 per cent of its area and where percentage of forest area is very low i.e. 4.8%. In addition to supply of traditional goods and services like wood, fodder, water, wildlife and recreation, forests also protect river catchments in hilly regions and ensure sustained supply of good quality water for irrigation and power generation. Furthermore, sustained agricultural and industrial development in Pakistan is not possible without sustained supply of water in the rivers. Rapid disappearance of forests and reduced tree growth over major part of the country in last two decades has accentuated the problem of aridity, soil degradation, extremes of climate and spread of deserts. There is acute shortage of wood and wood products with concomitant rise in their prices and absence of substantial wood-based industries. It has also adversely affected the programmes of socioeconomic uplift of large population. Annual expenditure on import of wood products, especially, pulp and paper is very high which could be one of the reasons in overall low literacy rate of the country. Pakistan is one of the countries in Asia and Africa, where forests are too meagre to fulfil the needs of the people.

1.2. Distribution of World's Forest Resources

Forest can be defined as land with a tree cover of more than 10% or an area of more than 0.5ha under perennial woody vegetation with a minimum height of *5* m at maturity and this land should not be predominantly used for agricultural purposes. Worldwide distribution of forest area, according to FAO (2001, 2003) is given in Table 1.1. Europe which includes the Russian Federation (27% of world's forest area) has the maximum forest area of the region as compared to any other regions. South America has the highest percentage forest cover and the second highest forest area.

Africa has 22% of its land area as forest, which is below the world average of 30%. Africa has the second largest wood biomass (17%) after South America. Asia has a large area of tropical rainforest in the south-eastern mainland: Indonesia and New Guinea. It also has significant areas of drier tropical forest, subtropical forest, temperate forest and even a small occurrence of boreal forest. Asia has the lowest percentage of the forest cover (18%) of any of the regions. However, it has the largest area of forest plantations, particularly in China, India, Japan, Thailand, Turkey and Vietnam.

Australia- a prominent region of Oceania is famous for having tropical dry forests predominate. It has moist tropical rainforest in the north, subtropical humid forest in the east and temperate oceanic forest in the south —east and subtropical dry forest in the south- west. New Zealand-another prominent country of the Oceania has subtropical humid (warm temperate) forest in the north island and temperate oceanic forest in the South Island.

Table 1.1. Worldwide distribution of forests

Regions	Forest area (10^6 ha)	land area (%)	world forest area (%)	world woody biomass (%)	Plantation area (10^6 ha)	Forest area Change (%/year) 1990-2000
Africa	650	22	17	17	8	-0.8
Asia	548	17	14	11	116	-0.1
Europe	1039	46	27	14	32	+0.1
North & Cent. America	549	26	14	12	18	-0.1
Oceania	198	23	5	3	3	-0.2
South America	886	51	23	43	10	-0.4
World	3869	30	100	100	187	-0.2

Source: Sands (2005)

North and Central America have all kinds of forest types varying from tropical rainforest to boreal tundra woodlands. The region is dominated in area by the USA and Canada. Both countries have almost equal forest area and both about the same percentage of forest cover (Canada 27% and USA *25%).* The forests are mainly subtropical and temperate in the USA, and temperate but mainly boreal in Canada. Consequently, the wood biomass is greater in the USA (24.4 billion tonnes) than Canada (20.2 billion tonnes).

1.3. Forest Spectrum in Pakistan

A forest is a biotic community of fauna and flora predominated by trees and woody vegetation that cover a large area. It supports an array of complex flora and fauna, and forms a distinctive microclimate as compared to other land uses. Each forest type has specific species composition, size, diversity, and density, due to specific temperature and precipitation. No matter what type the forest is, the plant sizes,

canopy density, litter floor, and root systems are significantly taller, greater, thicker, and deeper respectively than other vegetation types. These characteristics enable forests not only to provide several natural resources, but also to perform a variety of environmental functions.

Forest resources may include timber, water, soil, wildlife, vegetation, minerals, and recreation. Except for minerals, all these resources are greatly affected by forestry activities. Some resources can be destroyed, depending on the intensity and extent of the forestry activity. Environmental functions performed by forests may include control of water and wind erosion, protection of headwater and reservoir watershed and riparian zone, sand dune and stream-bank stabilization, landslide and avalanche prevention, preservation of wildlife habitats and gene pools, mitigation of flood damage and wind speed, and sinks for atmospheric carbon dioxide. Many established forests have been managed to achieve one or more of these environmental functions, while others are preserved to prevent loss in biodiversity and degradation of the ecosystem.

The forests of Pakistan reflect great physiographic, climatic and edaphic contrasts. Pakistan is an oblong stretch of land between the Arabian Sea and Karakoram mountains, lying diagonally between 24° N and 37° N latitudes and 61° E and 75° E longitudes and covering an area of 87.98 million hectares (Siddiqui 1997). Topographically, the country has a continuous massive mountainous tract in the north, the west and the south west and a large fertile plain: the Indus plain. The northern mountain system, comprising of the Karakoram, the great Himalayas, and the Hindu-Kush, has enormous mass of snow and glaciers and 100 peaks of over 5400 m in elevation including K-2 (8, 616 m according to Desio (1988) that is the second highest peak in the world. The mountain system occupies one third area of the country. The western mountain ranges, not as high as in the north, comprise the Sufed Koh and the Sulaiman while the south-western ranges form a high, dry and cold Balochistan plateau. Characteristically, the mountain slopes are steep, even precipitous, making fragile watershed areas and associated forest vegetation extremely important from hydrological point of view. The valleys are narrow. The mountains are continuously undergoing natural process of erosion. The nature of climate with high intensity rainfall in summer and steep slopes in the northern regions are prone to erosion and landslides.

The Indus plain have two distinct features; the alluvial plain and sand dunal desert. The country is drained by five rivers; namely, Indus, Jhelum, Chenab, Ravi and Sutlej. Of these Indus arising in snow covered northern mountain ranges flows towards south through the Punjab and Sindh plains into a wide delta before entering Arabian Sea. Other rivers join it on the way, together feeding one of the largest irrigation systems in the world. The great river system of Indus in Pakistan derives a part of their water supply from sources which lie in the high lands beyond the Himalayas and the western mountains, and part from countless valleys which lie hidden within the mountain folds. Much of the silt of the alluvial plain is from natural geological erosion of mountains in the north brought down by rivers. Thal desert lies between the rivers Indus and Jhelum, while Cholistan and Thar Desert occur on the south-east of the country.

A great variety of parent rock types occur in Pakistan, which exert considerable influence on the properties of soil. The rocks found in Pakistan can be classified into three major groups, *viz*., the igneous rocks, the sedimentary rocks and the metamorphic rocks. In the Himalayan regions, the common rock types are metamorphic which are gneisses, schists, slates and phyllites with some quartzite and marble. In the northern part of Indus plain, between Sargodha and Shahkot small outcrops of phyllites and quartzites occur. Granite, syenite, diorite, gabbro, dolerite and peridotite are more common types of igneous rocks, which occur in Dir, Swat, Chitral, Gilgit, Zhob, Chagai, Las Bela and Nagarparker.

According to FAO (2010), Pakistan has the natural forest cover of only 2.2% or 1,687,000 ha and losing its forests at the rate of 1.66% or 42,000 ha per year (Data from 1990 to 2010). Pakistan's forests contain about 213 million metric tons of carbon and Pakistan has some 4950 species of vascular plants of which about 7.5% are endemic, meaning they exist in no other country. It is also worth mentioning that major needs for industrial wood (72%) and fuelwood (90%) of the country are fulfilled by the wood from farmland (Rahim and Hasnain 2010). Between 1996 and 2000, the average roundwood production and industrial roundwood production per year in Pakistan was 31.66 million m^3 and 2.35 million m^3 respectively. However, the big bucks were spent to import about 5,32,000 m^3 per year of industrial roundwood (FAO 2002). According to FAO (2002), Pakistan's forests, in spite of having very small forest per capita (only 0.05 ha/capita against world average of 1.0 ha/capita) providing employment to 500,000 workers and contributing 0.3 percent to GNP. Furthermore, Pakistani forests including farm-forests are supplying 32% of Pakistan's total energy needs in the form of fuelwood, providing forage for one third of Pakistan's 86 million head of livestock and saving Pakistan's agriculture, which contribute about 26% of GDP, by ensuring good quality irrigation water in river based gigantic irrigation system.

1.4. Benefits of Forests

Forests have appeared on Earth about 350 million years ago, and reached a peak about 270 million to 220 million years ago during the Carboniferous period. Today, forests cover about one third of the earth's land surface. They are the most distinguished type of vegetation community and provide many resources and environmental functions that far exceed those of other vegetation covers. Accordingly, forests have always played a vital role in the survival, development, and growth of human society since prehistoric times. Healthy forests always improve the quality of environment. Before discussing the benefits of forest, it is important to understand the four categories of functional forests: Production forests, protection forests, preservation forests, and public forests. The functions for which a forest is managed are directly related with site and environmental conditions. However, the ownership, economic constraints, and prospective value of the forest play an important role in determining management objectives.

Production forests: The main purpose of production forests is to obtain financial profit from the forest by producing timber, pulpwood, fuels, wildlife, forest and

agricultural by-products, livestock, and recreation services. In rural areas of the tropical regions, a sizeable population lives in and around forests. They grow crops in the forest for food and harvest branch and litter for fuel. India has started a social program in which people plant and grow trees in back yards and community woodlots for fuel and other purposes. Many feasibility studies have shown that power stations could be operated and liquid fuel ethanol could be produced by growing trees in "energy plantations" (Fung 1982). Forest grazing is also a common practice that often damages trees, destroys litter floor, and compacts soils. These exploitive adverse practices interrupt nutrient cycling in the forest, increase soil and water erosion, deplete land productivity, and eventually cause the disappearance of forests or reduction in the forests production. In the pursuit of maximum economic gain from a forest, exploitive uses of its resources should be avoided. Best management practices should be incorporated in all forestry activities so that land productivity can be maintained and water quality should not be impaired.

Protection forests: On rough terrain, steep slopes, streambanks, water resource areas, wind prone regions, or potential landslide sites, forests are often established to reduce soil erosion, increase sand stability, improve water quality, retain reservoir capacity, mitigate flood damage, and attenuate air pollution. Forests are also managed to protect habitats for birds, fish and other animals. Protection forests ensure environmental functions; economic income is insignificant or even totally ignored. Since protection forests are there to protect a specific site and environmental condition, species used are more restrictive, and management activities need to assure the sustainability of the forest. Protection forests are usually in areas sensitive to environmental problems; clear cutting, grazing, cropping, and litter harvesting should not be practiced. A clear-cut in these sensitive areas would make artificial regeneration very difficult or too long to establish. It can consequently make the destruction of forests in the protected area devastating. Thus, legal enforcement is required to preserves the protection forests any kind of damage due to cultivation, harvesting, grazing, and other impairing activities. In fact, all forests can be considered protective in view of their function as sinks of atmospheric carbon dioxide, and their effective role to control or reduce global warming. An estimate of potential carbon sequestering in the tropical closed-forest landscape is about 1 .*5* to 3.2 Pg C per year (I Pg= 10^{15} g or 1 Gt) or 31 to 58%of the current CO_2 emission by fossil fuels (Brown and Lugo 1992). A sustainable forest-management plan should be developed that can provide simultaneously both a profitable income from the forest and an inexpensive way to reduce accumulation of CO_2 in the atmosphere.

Preservation forests: It has been estimated that about 30% of Earth's surface vegetation has been damaged since farming began. According to another estimate, between 1981 and 1990, about 12% or l68 × 10^6 ha of the highly bio-diversified tropical forests in 62 tropical countries were lost due to deforestation (FAO 1990). Loss of forests leads to the loss of many plant and animal species from the genetic and pharmaceutical pools of the world. The nature and ecosystems of managed forests are different from those of the virgin forests. Impacts on the hydrological

cycle, soil and nutrient losses, and climate changes are highly significant and well documented.

Public forests: Forests that are developed and managed for the public to provide recreation are referred as public forest. They may include parks, botanic gardens, zoos, and wildlife refuges. Most public forests have been declared as national, state, and city parks. The national parks are dedicated to preserve vegetation, wildlife, natural wonders, cultural heritages, and historical monuments for people's pleasure and health. They also provide educational and awareness programs through forest trails and on-site boards about environment and biodiversity.

1.4.1. Environmental Functions

The physical environment of Earth is composed of three phases; atmosphere, hydrosphere, and lithosphere. Which form the so-called geosphere of Earth. The interface of these three phases is life, or biosphere, and the combination of geosphere and biosphere is called ecosphere. Forests are largest and biggest system in the biosphere and with profound impacts to the environment. Major functions of forests can be divided into hydrological, climatological, mechanical, biological and societal.

1.4.2. Hydrological

Forests affect both water quantity and quality. Firstly, the amount of precipitation that reaches the mineral soil is reduced by canopy interception. Secondly, a great amount of soil moisture is transpired to the air through the roots- stem-leaf system. Finally, the root systems, organic matter, and litter floor increase the infiltration rate and soil moisture-holding capacity. Combine effect of these processes makes overland runoff less, runoff timing longer, and water yield cleaner in forested watersheds than in nonforested watersheds.

A reduced amount of runoff carries less sediment and debris to the stream. This reduced runoff, combined with the shielding and shading effects of canopies, the binding effect of root systems, and screening effect of forest floor, makes stream flow from forested watersheds have less sediment, lower dissolved elements, cooler temperature, and higher dissolved oxygen. The importance of forests to purify water can be recognized by the fact that about a third (33 out of 105) of the world's largest cities obtain a significant proportion of their drinking water directly from protected areas and other 13 cities are managing forests at high priority to obtain good quality water (Dudley and Stolton 2003).

1.4.3. Climatological

The Earth's surface characteristics such as topography, water, land, and vegetation, play an important role in the atmosphere near the ground. These conditions modify water and energy exchanges between Earth and the atmosphere and affect the local and regional patterns of the atmospheric circulation. This is especially true in the forest because of its height, canopy density and depth, and area covered. Solar

radiation is the major energy source that affects the climate of Earth. In a forest, canopies usually receive more incoming solar radiation than pasturelands or the bare ground because of its dark colour and great roughness, but only a fraction of the received energy is transmitted to the ground surface. On the other hand, the emission of long wave radiation from the ground surface to the sky is reduced due to the shielding effect of forest canopies and less wind movement in the heat transfer processes. Thus, the forest can cause net radiation to be greater and air and soil temperatures to be cooler in summer and warmer in winter. The most significant effect of forests on precipitation is canopy interception, which reduces the net amount of radiation reaching the soil and delays snowmelt. Perhaps the largest-scale climatological functions of forests are carbon storage and the release of oxygen by photosynthesis. The world's forests have been estimated to contain 358×10^{15} g or 80% of all above-ground carbon and 787×10^{15} g or 40% of all below ground (soils, litter, and roots) terrestrial carbon. Estimates for annual emissions of CO_2 by fossil-fuel and land-use change for 1980-1989 were $5.4 \pm 0.5 \times 10^{15}$ g of carbon per year (Dixon et al. 1994).

1.4.4. Mechanical

Forests are the most efficient means of controlling soil water erosion by:

1) Reducing overland runoff through canopy interception and transpiration.
2) Increasing soil porosity through the organic horizon and root systems.
3) Slowing down overland flow velocity through litter coverage.
4) Reducing the terminal velocity of raindrops through canopy interception.
5) Enhancing soil aggregates and binding through root reinforcement.

As a result, the soil erosion rate from a forested watershed can be 1000 times less than that of a bare-ground watershed (Patric 1976). Forest clearing along a stream bank often causes severe channel erosion and even stream bank collapse. Like raindrops and streamflow. Wind has energy to detach and transport soil particles. The detachment, rate of soil movement, and transport capacity grow with the second, third, and fifth powers of wind's drag velocity (Eimern et al. 1964). In addition to protecting against water and wind erosion, a forest can also protect against avalanches if it occupies the zone of potential occurrence areas. The shadow cast by shelterbelts along with the retardation of wind speed has a great impact on soil evaporation and soil moisture conservation.

1.4.5. Biological

Forests provide habitats for an array of fauna and flora that live and properly develop in a particular environment. They not only are genetic pools for life on earth, but also play a crucial role in the stability and viability of the biosphere. The biosphere is a large-scale life-support system with all components mutually interactive in a state of equilibrium. Large scale alterations of forests or destruction of habitats can lose species of potential importance to human health, medicine, food production, and other uses. Most important, a chain reaction and the cumulative

effects, if not corrected in time, may lead to a collapse of food chains and to a biological disaster.

1.4.6. Societal

Cool and shaded forests, with their vast area, wilderness setting and fresh air are ideal places for people to relax from tension, pressure, and hectic activities. Green canopies with blue sky and white clouds are a natural beauty to our eyes, and the environmental tranquillity relaxes our ears and minds. Thus, many recreation and leisure-time activities- picnicking, sightseeing, bird watching, hiking, camping, and canoeing- take place in forest areas. Psychologists have even used "forest bath", a mental solace in the forest environment, as a treatment for persons with depression. Cardiologists have also discovered that frequent forest bath can support the proper heart functioning and decrease the chances of heart attack. Furthermore, retreating from hectic cities to wilderness even at higher costs has become a part of lifestyle in modern cities of developed countries. The presence of forests can benefit the health of people living in their vicinity. This may be attributable to the continuous replenishment of oxygen and reduction of dust and air pollutants in forested areas. City and traffic noise can be attenuated and ill looking scenes can be blocked by a greenbelt of trees. Wilderness areas serve as field laboratories for various research and educational purposes. They provide opportunities for the public to study and appreciate forest ecosystems, ecological processes, landscapes, and natural resources conservation.

1.5. Threats to Forests

The most serious threats to the forests, such as deforestation, over cutting, over lopping grazing, forest fires, and air pollution is a result of human activities. Naturally induced insects, disease, tornadoes, volcanic eruptions, and storms can cause substantial damage to forests; but these are considered as a little threat to forests. Weakened trees created by overcrowding, age, or other agents are less resistant to insect and disease attacks. Their populations build up easily in these weakened trees and then spread to the entire forest. In many cases, poor forest management can cause a massive wind-throw of timber in forested areas. Unless active salvage actions are taken, there are more chances for insect infestations and wildfire outbreaks.

1.5.1. Deforestation and Grazing

In the lower latitudes, because of population and economic pressures, deforestation and grazing caused a net loss of tropical forests of 167.8×10^6 ha in the 1980s. These forests were lost in most cases due to shifting cultivation. In the middle latitudes, however, reforestation and conservation programs have increased temperate forests and other woodlands. Thus, deforestation and forest grazing are more a regional and global issue in the lower latitudes, and a local issue in the middle latitudes.

1.5.2. Forest Fires

Like precipitation and wind, wildfire is a natural phenomenon, which is very dangerous to forests, but it occurs less frequently than any other weather events. From the management point of view, fires can cause on-site and off-site as well as detrimental and beneficial effects to soils, water, nutrients, vegetation and wildlife. The intensity and duration of these effects depend on the type of vegetation, the severity and frequency of fires, the type of burning (ground, surface, or crown fires), season, slope, aspect, soil texture, and climatic conditions. Virtually all terrestrial ecosystems have been affected by fire at one time or another. Foresters consider forest fires a great threat because they can destroy the forest and its protective functions, reduce the value of existing timbers, induce insect or disease infestation, damage the recreational and scenic value, and delay forest regeneration.

1.5.3. Air Pollution

Air pollution is the concentration of certain chemicals or particles in the air at levels that can cause harmful effects on humans, plants, animals, structures, soils, and water. Pollutants originate from natural events such as ocean splash, wind erosion, forest fires, and volcanic eruptions, or from human activities such as fuel and industrial emissions. These pollutants can react with the chemicals and moisture present in the air to form induced pollutants. Air pollutants, including acid deposition, gaseous sulphur oxide, ozone, and heavy metals, have adverse impacts on forest vegetation.

Acute vegetation damage caused by smelters, power plants, and other sources of air pollution have been reported frequently. However, the most widespread effects of air pollution on the forest are probably due to acid deposition. Acid deposition can adversely affect forest vegetation either directly by damaging protective surface structures (cuticles) of the canopy or indirectly through the acceleration of soil acidification. The damage of cuticle layer can lead to malfunction of guard cells, alteration of leaf- and root-exudation processes, interference with reproduction, water stress, and leaching of minerals from the canopy. The soil acidification can lead to leaches of basic nutrient ions, alterations of nutrient availability; slow down of microbiological processes, reduction of microbial populations and variety, and increases in ion toxicity level to plants. These combined effects on soils and plants can ultimately result in leaf discoloration and abscission, and in reduction of forest growth, productivity, and species diversity.

1.6. Deforestation Causes in Pakistan

Deforestation remains one of the most intractable environmental problems of today. About one third the size of the original forest cover has disappeared so far. Despite continuous efforts by the world community, deforestation continues unabated in most parts of the world, with serious consequences for the human abodes, ecosystems, and global climate. Pakistan also faces serious problem of depletion of its forest reserves. Approximately 39000 ha of forest are being cleared every year

in Pakistan (FAO 2001). If deforestation continues at this pace, it is feared that Pakistan will lose most of its forests within the next thirty to forty years.

Factors responsible are:

1) A population of 180 million people for meeting their needs (fuel, timber, shelter, forage for livestock, raw material for wood based industries and agricultural implements etc.)
2) Population pressure for urbanization and industrialization.
3) Land clearance for agriculture, infra-structure development for example residential areas, roads, dams, official buildings, etc.,)
4) Grazing pressure of forest/range inhabitants by over-exploitation of resources.
5) Forest fires also result in quantum loss of forest cover.
6) Timber mafia is an alarming threat for deforestation e.g., in 2010 flood, wood worth Rs. 12 billion was confiscated at Chashma Barrage. Such incidents are common in KP and AJK.
7) Market forces which have seen soaring timber prices for many years
8) Ill equipped Forest department; it lacks human and financial resources, and relevant technical expertise.

The general perception among planners is that over population is the primary culprit behind forest degradation. Moreover, people living close to forestlands, and using it for their needs, show an imprudent behavior towards these forests and use it in an unsustainable manner. Since most of the forests in Pakistan are state owned/managed, and responsibility for the protection/conservation of these forests rests with the state, therefore, any inquiry into the causes of forest degradation in Pakistan must analyse the state's role in it. Putting the entire burden of deforestation on 'other factors' shifts attention away from more important causes (namely, failure of government to manage forests), and leads to wrong policy conclusions.

1.7. Strategies for future

1.7.1. Training of Foresters and Forest Management

Forest department is using traditional methods to manage the forest resources. In fact, before the division of subcontinent, we had more than 25% forest area and policy of the British Government was also to protect the forests. So, foresters were given a complete training like in military services and they were even equipped with weapons against timber mafia. But after the independence of Pakistan and India, most of the forests went to India and a meagre forest area was given to newly born state of Pakistan. However, instead of changing our policies from the protection of forests to increasing the forest area, we continued the same policies. Even today, all the foresters in the PFI (Pakistan Forest Institute) are trained in the similar way. Now we need research oriented officers in the field and not merely the

persons with military like trainings. It is strongly recommended that the lower forestry staff like Forest Guard and Forest Block Officer should be given a real hard training because they spend the most of their time in the field but all the officers should be competent professionals and trained researchers. Other option is that to recruit the trained foresters (officers) in a competitive way from all the academic institutions of the country and then give them a training of 6 month in a selected institution as the practice for CSP officers.

1.7.2. Promotion of Participatory Approach

Forest Department rarely involves the local people to plant the trees in forest areas. In many foreign countries, on special events, local people are invited to plant the trees on their name and take care of them throughout their lives. Globally, the concepts of social forestry, agro-forestry, community forestry and urban forestry are more prudent than state forestry. It is recommended that foresters should be trained to involve local people in planting and post planting operations. This will result in protecting and promoting trees through participatory approach.

1.7.3. Strong Collaboration Among Forest Department, Universities/Colleges and Research Institutes

In Pakistan, poor collaboration exists between Forest Department and other Forestry universities/research institutions. A strong collaboration between Forest Department and research universities and institutions is mandatory for solving the current problems of forests and deficiency of forest resources.

1.7.4. Provision of Funds and Facilities

Adequate facilities and funds are essential for afforestation and protection of forests, so, Govt. should provide basic facilities to protect and promote forests.

1.7.5. Concept of High Conservation Value Forest (HCVF)

Forests contribute directly to the purification of the air we breathe in and the water we drink; protect river basins from erosion, regulate the flow of water courses and reduce the risk of floods. Forests also help to control the excess carbon dioxide in the world's atmosphere; it is estimated that they can absorb more CO_2 from the atmosphere than is emitted by natural phenomena and industrial activity. Nowadays the classic principle of the single-use forest has been replaced by the idea of multiple use, an idea that is being expressed with increasing persuasiveness. Apart from wood shortage, such phenomena also cause loss of soil fertility, reduced ecosystem diversity and the destruction of habitats. The foundation of Conservation Value Forests (HCVF) lies in managing and protecting these forests. In Pakistan, there is a urgent need of defining the HCVF at spatial level and declaring their HCVF status to protect them at maximum level.

1.7.6. Sustainability in Utilization of Forests

In all developed countries, sustainability of forest yield is given more priority than maximum forest yield occasionally. It means extracting the yield of a forest that doesn't damage that forest. For maintaining the sustainability of Pakistani forest, an urgent research is required at spatial level to determine the forest yield potentials and pertinent management tools by considering the local climatic and soil conditions. Judicious working plan is the key to successful management of the forest as well as ensuring its sustainability.

1.7.7. Forest as Industry

Forests do not mean only an aesthetic land but in many countries, they are dealt as an industry which not only generates revenue but also provides employment to local people. For example, in Canada it was estimated in 1997 that forests provided about 830, 000 direct and indirect jobs and added about $60 billion in Canadian economy each year. Therefore, economic analysis of our forests at national level will help us to devise the policies for a profitable investment.

1.7.8. Involvement of Local People (Participatory Forestry)

Successful stories of many countries revealed that they attained the goals of reforestation in the country by involving the local people, private owners, industrialists and city governments. A good example of it is agroforestry in Pakistan, farmers are earning much more by selling the trees after completion of their rotation as compared to revenues generated by Forest Department. Government should provide helping hand to agroforesters by regulating timber market and establishing wood based industries.

1.7.9. Optimum Land Use of Marginal Lands

At international level, every inch of soil available is used in a productive way. In Pakistan, it is estimated that about 6.5 million hectares of soil is degraded either due to salinity or waterlogging and can not be used for regular cultivation. However, trees have the great diversity and potential for survival in these problem soils. Suitable species of trees can be planted on these soils by involving the owners of these lands. Planting of suitable trees on these lands will provide the wood and economical benefits to the land owner as well by improving the soil and providing other environmental benefits.

1.7.10. Introduction of New Species

Introduction of exotic tree species play a vital role in greening the Earth. For instance, New Zealand remained successful to stop the deforestation by introducing the new fast growing species (*Pinus radiata*) from California to fulfil the demand of local industries. Research is required to introduce the new species in Pakistan which have the potential to survive in the arid and semi arid climatic conditions of Pakistan and produce a good quality wood.

1.7.11. Mechanization and Use of Advanced Tools

In modern countries, all the silvicultural operations from sowing to harvesting are carried out by machines. Mechanization of forests avoids delay in operations and brings sustainability in products. In Pakistan, mechanization can bring revolution in forest production by adequate release of funds. Similarly, advance management equipments and monitoring tools like GIS, advance communication systems, mobility and weapons can help a lot Forest Department to cope with illegal cutting or theft of trees.

1.7.12. Modelling of Forest Yield

Prediction of forest yield and the effects of different environmental factors (like climate change) on the forests models are frequently used in advanced countries. If there is a fire out break in a forest, the destination of the fire is predictable through the developed models. To develop or to validate he models, excessive data are required. In advanced countries, all the data acquired by Forest Department is online and can be used to conduct research. But in Pakistan, data about forests or tree growth is rarely acquired or kept secret. Researchers in the Forest Department are few, so, data are rarely used. It is therefore recommended that data on forest growth acquired by Forest Department should be displayed and used by collaborating with any research institution to prepare models or to validate the foreign models under Pakistani climatic conditions. These models can be largely helpful to predict about outputs from a forest.

1.7.13. Implementation of Laws

Formation of new laws that can be implemented and complete implementation of existing laws is the key to success of all developed countries for managing the forests. But in Pakistan, the case is with other departments and laws; same is with the Forest Department and Forest, there are well written clear laws about every aspect of forest management and protection but their implementations are hardly 10%. For example, the major factor involved in illegal cutting and theft of trees in irrigated plantations of Pakistan is the presence of saw machines just near the forest area. Labour or other residential persons cut and sell the trees to these saw machines. By law, there could be no saw machine in 5 kilometres periphery of a forest. So, if all these saw machines are pushed out of 5 kilometers, all the saw machines are compelled to maintain their buying and selling record and if these records are checked on regular basis; half of the illegal theft of wood from irrigated plantation can be stopped. Similarly, making the Forest Check Post functional and increasing their numbers can reduce the theft and illegal cuttings of trees. So; if implementation of forest laws can be ensured, we can bring the deforestation rate to its minimum level.

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