



## Requirements for Forest Health Management in 21<sup>st</sup> Century

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### ABSTRACT

In view of the global shift in the objectives of forest management, forests in 21<sup>st</sup> century are no longer a timber and plantation management business but ecosystem management. In view of the climate change influencing the species ecology, the forest managers are today intertwined with the challenge of meeting the immediate fuelwood, fodder and timber requirements of the people on a sustainable basis on one hand and required to perform the role of a doctor of the forest ecosystems on the other hand. The present forest management scenario requires to look forest as a single entity and that includes all form of life existing in the forest right from the invisible microorganism to biggest terrestrial animal. The total number of tree species in India are around three thousand and they constitute less than one per cent of the total biodiversity of the country. The rest of the biodiversity yet required to be explored and studied for its role in nourishing and maintaining forest health and wealth. There is need to explore all forms of life other than trees like bacteria, virus, algae, lichens, ferns, herbs, shrubs, climbers, nematodes, earthworms, insects, arachnids, arthropods, fish, reptiles, birds and mammals for their role in maintaining ecological harmony. The forest health management in 21<sup>st</sup> century requires holistic integrated ecosystem management approach of all life forms, especially in light of their response to climatic change.

### Key words:

biodiversity, conservation, plantations, productivity

### INTRODUCTION

For a long time the objective of managing forests was to generate more and more timber. This was because of the fact that until last fifty years or so, the forests were being managed mainly for revenue generation. But over the years, the focus has shifted from production forests to conservation forests and this transition in forest management does not have a long history but only one and half decade (Singh

et al. 2014). The role of algae, cyanobacteria, lichens, bryophytes, thallophytes, pteridophytes was never given much weightage for their role in maintaining a healthy forest. Protection of forest from the pests i.e. insects, fungi, virus, nematodes, snails, slugs, birds, rats, rodents, mammals, etc. could not become a favourite subject of forest managers because sufficient technical knowledge related to the organisms and their management was not available to them. Moreover, each of afore mentioned subject being

highly technical and vast, the deep knowledge of each and every subject is not possible too. If you look for biodiversity of India in books or research papers or the modern information ocean, the internet, the Indian biodiversity includes 350 mammals, 1224 birds, 408 reptiles, 197 amphibians, 2546 fishes, 15000 flowering plants, 30000 number of non-flowering plants ([http://www.vigyanprasar.gov.in/radioserials/indian\\_flora.pdf](http://www.vigyanprasar.gov.in/radioserials/indian_flora.pdf)). Algae, mosses, liverworts, the ferns, nematodes, etc. figure are no where available with certainty.

Forest management today is broadly management of trees and more importantly the commercial species rather than forest biodiversity. That raises a very pertinent question about definition of a forest. Can the forest be considered synonymous to trees in terms of behavior and management? The answer however, is yes in terms of present day forestry in India. According to various estimates, the number of tree species in India ranges from 4000 to 4500 but all forest management (including health) practices in India revolves around two thousand trees only. Within this range of trees also, there is something called LKTS (Lesser Known Tree Species). The activity of forest departments as regards to forest management is to plant the trees, which ensure higher success forgetting the fact that wildlife is also the part of habitat or forest health management. The algae, mosses, hornworts, mosses, bryophytes, pteridophytes, the amphibians, fishes, birds and reptiles are not on the main agenda of management but resultant of their ongoing activities. Always there are targets for coverage of plantation area rather than protection/conservation of plantations. There is need to understand that the objectives of forest management have shifted from the revenue generation to environment and biodiversity conservation. The fact is that all the top officers in the department are conservators. The Union Ministry is Environment and Forest, thus reflecting priority for environment over forest through conservation management. The

restrictions on green felling by the Hon'able Supreme Court were imposed for intangible benefits than tangible benefits. Material accrued from native forests can be imported from anywhere but clean environment cannot be imported rather has to be generated at our own. Even the emphasis of more forest area in hilly states (60%) than the plain area (20%) in the National Forest Policy was not a territorial discrimination but ecological requirement for sustainable development. In recent years, emphasis has been placed on forests to be managed for mitigating climate change and conserving biodiversity. The requirement of the wood has to be met by encouraging social forestry/joint forest management/ agroforestry interventions outside forest area by planting high yielding short rotation forestry crops. A strong tree outside forest base has to be created to meet domestic as well as industrial requirements and reduce pressure from the traditional forests. We need to understand that forest no longer stands for 5Fs i.e., Forests for Food, fiber, fuel, fodder and fertilizer but . FORESTS has now wider meaning i.e., F: 5Fs, O: oxygen generator, R : Removal of Pollutants, E : Energy provider, S : Soil erosion control, T : Temperature moderation and S : Sustain biodiversity/support wildlife. So, to ensure the optimum forest health, the forests have to be managed with holistic approach integrating all aspects of wildlife, conservation of algae, fungi, lichens, bryophytes, pteridophytes, insects amphibians, fishes, birds, reptiles, mammals, etc. Various aspects of plant and animal kingdoms, which are otherwise vital for the forest health but have been ignored historically have been included in the paper for recognition for their role in forest ecosystem.

### **Bacteria**

The symbiotic relationship between the plants of Fabaceae, Mimosaceae and Caesalpiniaceae with nodule forming bacteria like *Rhizobium* and *Bradyrhizobium* in fixation of atmospheric nitrogen into the soil and making it available to the plant partner is well known. In agriculture, the role of nodule forming bacteria in ensuring good plant health is well developed and

research and understanding had gone upto the stain level association i.e., Bradyrhizobium glyci, B. pisi, B. lensi, B. trifoliae and so on. Dadwal and Jamaludin (2003) recorded better control of different pathogens with Streptomyces sp (self multiplying species in soil) compared to fungicidal treatments. The bioagents are beneficial with minimum chemical residue problems and also safeguard the nursery as well as plantation sites at minimum costs. Similarly there is need to identify specific stain of nodule forming bacteria in forest trees so that it becomes part of regular planting programme. At present, some soil from the rhizosphere of the trees of the aforesaid mentioned families is collected and used at the nursery/plantation sites. This practice disturbs the source areas. If the species and stain of these nodulating bacterium is identified and technique for its culturing is standardized, the application of its culture will become the part of regular plantation programmes and it will ensure lot of ecological and economical benefits. Even there are non-leguminous species (Alnus, Casuarina, Hippophae, Myrica, Correria, etc.), which have association with Frankia to fix nitrogen and cultures are required to be standardized for their effective use. Wuehlisch (2011) also reported that the fast growing species like poplar and willow are expected to fix nitrogen through endophytic bacteria, which through new light on the salicaceae family with respect to sustainability of biomass production at low input energy levels.

### Nematodes

Nematodes are associated with a number of forest species (Morus, Salix, etc.) but the extent of damage caused by them to forest health has not been properly assessed. The role of nematodes in forest health in India has been an un-recognised area due to lack of awareness about nematode damage to forests, and difficulty in survey and sampling; hidden and slower rate of development; resemblance of nematode symptoms with nutrient deficiency, which makes it difficult to differentiate between the two; Untrained nursery and plantation manpower, etc. The nematodes have been associated with

the following tree species:

**Acacias** : *Helicotylenchus dihystra*, *Meloidogyne incognita*, *Tylenchorhynchus brassicae*, etc.

**Sal** (*Shorea robusta*): *Paralongidorus Sali*, *Xiphinema americanum*, *Macroposthonia xenoplax*, *Hemicriconemoides cocophilus*, *Tylenchorhynchus indicus*, *Pratylenchus spp.*, etc.

**Teak** (*Tectona grandis*): *Xiphinema insigne*, *Paralongidorus sali* and *Pratylenchus spp.*

**Sandal** (*Santalum album*): *Rotylenchus*, *Tylenchorhynchus*, *Helicotylenchus*, *Hoplolaimus*, *Trichodorus*, etc.

**Jamun** (*Syzygium cumini*): *Tylenchulus*, *Rotylenchus*, *Tylenchorhynchus*, *Helicotylenchus*, *Fergusobia spp.*, etc.

*Eucalyptus*: *Xiphinema*, *Meloidogyne*, *Pratylenchus*, etc.

**Citrus Ring Nematode**: *Cricone* and *Sheath* nematodes *Hemicycliphora* and *Pin* nematode *Pratylenchus spp.* are sedentary parasites of roots of citrus, oaks and pines.

Pine Wilt Disease (PWN) disease is caused by a nematode called *Bursaphelenchus xylophilus* (Dwinell 1997; Mota et al. 1999). It is a polyphagous pest and infects conifers i.e., *Cedrus*, *Picea*, *Abies* and *Pinus*. In China, fifty million trees have been killed with a loss of USD 22 billion since 1982 (<http://www.nature.com/news>). PWN is known to be transmitted by a beetle called *Monochamus*, commonly known as "Pine Sawyer" while feeding upon the timber (<http://www.fao.org/docrep/012/al348e/al348e00.pdf>). Upon entry into the host tree, the PWN starts feeding on the epithelial cells which line the resin ducts. When the host is infected, the transmission of water within the plant system is affected. This results into wilt. The symptoms can become apparent within a few weeks after infection as the needles turn brown, and the leaves turn yellow followed by eventual death of the tree. From the time of infection to the death of

the tree, it only takes three months. There is great threat to our Himalayan conifers due to this nematode as it is already killing pines in China. Recent reports indicate that this pest may have already reached India as illegal import of wood is taking place into India via Burma, Nepal and Bhutan. Lot of pines have started dying in Indian Himalayas and reason is still unknown. The presence of PWN in India has to be verified. The nematologists have confirmed the presence of genus *Bursaphelenchus* of nematode and *Monochamus*- the vector insect. However, nematodes can be helpful in controlling some forest insect-pests. DD-136 strain of *Steinernema carpocapsae* is effective against many Lepidopteran, Coleopteran and Dipteran insects (Shannag and Capinera 2000).

### Algae

This term 'algae' was coined by the father of classification, Carolus Linnaeus, which means 'sea weeds'. It is believed that the algae has been inhabiting this universe since the last 2 to 4 billion years. They are the photosynthetic organisms and account for 20 to 30 per cent of photosynthesis on planet earth. They make up the foundation of the food chain and feed the smallest of animals like shrimp and fish, which in turn feed larger animals. Upon their death, algae provide food for fungi and bacteria, which convert them into nutrients for flora and fauna.

The blue green algae (BGA) not only have big share in production of life saving oxygen but they also help in the growth of other plants by processing and fixing the atmospheric nitrogen. Some BGAs are high quality protein source for human beings, i.e., *Spirulina patensis*, which has been given the status of superfood and is particularly so for vegetarians because it is very rich in Vitamin B12, which is rare in vegetarian diet. Many algae like *Gelidium* and *Gracilaria* are the source of phycocolloids like agar. Agar is used as solidifying agent for media in tissue culture of plants. *Nitella* and *Chara* species are the algae of ponds/lakes and largely affect aquatic forest ecosystem. In the present climate change era, which is happening mainly due to increase in atmospheric carbon dioxide, there is need to

explore as to what is happening to these organisms. They can not reverse the process of climate change but definitely they can slow down the process of climate change because they have the capacity of absorbing the atmospheric carbon dioxide and converting it into life saving oxygen. These are essential for overall forest health management but algae is excellent source of bioenergy as well and lot more emphasis is placed on its cultivation for bioenergy (FAO 2009) with the capacity to produce large biomass on unit area basis in marine as well as terrestrial ecosystem.

### Fungi

Fungi are well talked about in forestry, but generally as plant enemy. There are some edible fungi like *Morale (Morchella esculenta)*, mushrooms like Button Mushroom (*Agaricus bisporus*), *Dhingri (Pleurotus sajor-caju)*, *White Milky Mushroom (Calocybe indicus)* and some antibiotic producing fungi like *Penicillium*, which are considered useful. But by and large they continue to be treated as enemies. It is important to mention that the fungi are the nature's factories for the recycling of the nutrients and without the fungi the wood (cellulose) will not rot and there will be no humus production. *Ganoderma lucidum* is regarded a fungi causing huge mortality in *Dalbergia* and *Acacias* (Anon. 2000; Gill et al. 2006). However, it is also called the fungus of immortality. Even *Ganoderma tea* is available in market (<http://www.organogoldreviewz.com/ganoderma-side-effects-and-benefits>) and it has become a multimillion industry in many countries and healthy trees are infected with this fungus for business (Thyagarajan et al. 2007).

### Mycorrhizae

It is a perfect union between a fungus and a tree. The symbiotic relationship between the plants of *Pinaceae* and *Eucalyptus* with its fungal partner is well known. The pines and *Eucalyptus* are known to absorb two to three times more potassium, nitrogen and phosphorus than in the absence of its fungal partner (Manoharachary et al. 2009). Even many tree species do not grow

without inoculum and usually the soils from respective species is used as inoculum for raising nursery and plantations. The inoculum of ectomycorrhizal fungi is also available. This needs to be popularized in forest departments for their effective use.

### **Lichens and bryophytes**

Lichen is the classical example of mutualism between two organisms i.e. fungus and algae. They play very important role in nutrient release and are vital for forest health. They are very sensitive for pollution and are first to go as the pollution increases. That is the reason why lichens are not seen in urban areas and they act as indicators of pollution. They are pioneering organisms for the weathering of rocks. If the fungi are the nature' factories for the recycling of nutrients, the lichens are the nature's pioneers. They are the first organisms to colonize the bare rock and thus they initiate the process of soil formation. When they die and decompose they release acids which helps in soil formation. They also serve food for insects, wildlife, deer and even human beings. Moss and other innumerable species of microorganisms grows on rocks . All that is completely destroyed when the rock surface is painted. About twelve years back, Hon'able court directed the governments not to paint advertisements on the rocks to conserve these small plants and other biological life inhabiting on the rocks. The extensive damage to the eco-fragile mountain area cannot be reversed.

The bryophytes, ecologically the mosses are organisms which colonize the bare rocks, retain the moisture and start the process of soil formation. The information about their present status is limited and we need to explore them more. The peat moss or the Sphagnum is known because it is a multi million dollar industry. It is over exploited but we need to explore the possibilities of its conservation and judicious use.

### **Pteridophytes (Ferns)**

It is estimated that there are over 1000 species of ferns in India, out of which many are

endangered but cannot be identified by common man for want of knowledge (Chandra 2000; Chandra et al. 2008). Ferns have ecological, economical and ornamental value. The tree ferns of Darjeeling are world famous for their beautiful look and they are the part and parcel of the ecosystem. Similarly, lotus fern is an attraction of Himalayas. The fiddle wood fern (*Diplazium esculentum*) is edible fern (vegetable/pickle), known by the name lingadu/kasrod, its tender stem is cooked into tasty recipes and pickle as well. With change in climate and over exploitation, its availability is decreasing every year. Lot of awareness is required to protect the habitat and make their judicious use.

### **Gall Wasp**

All Eucalyptus growing countries of the world have now become familiar with Gall Wasp (*Leptocybe invasa*). All of sudden, it caused havoc to Eucalyptus plants in the nursery and new plantations upto 2 years. It all changed the impression that Eucalyptus is a pest free species (Jacob et al. 2007; Chander 2011). However, another Gall Wasp called *Ophelimus maskeli* is more serious than *L. invasa*. It is more serious than *L. invasa* and is sitting on the border for making entry. It affects Eucalyptus plants of all ages. During 2006, along with *L. invasa* this pest multiplied in millions in Israel and it caused so much nuisance to school going children that schools had to be closed for sometimes because the wasps had started entering their eyes and ears (<http://www.haaretz.com>). Similar is the case of gall insects of *Alstonia scholaris*, *Terminalia arjuna*, *Terminalia chebula*, *Pongamia pinnata*, etc., which have serious affect on the health of the species (Chander 2014).

### **Termites**

Termites or white ants are treated as enemy insects that destroy the trees and plantations. But they play very important role in the decomposition to become part of food chain. They are the organisms, which create the conditions favourable for other organisms to follow the path of decomposition and ultimately recycling of nutrients back into the ecosystem.

They have protozoans in their gut, which help them break cellulose into lower forms of sugar. It is important to mention that they do not eat the green plants but the remnants in forest are decomposed to make way for the new vegetation to appear and grow by making use of decomposed nutrition, which may not have been possible without decomposing agent like termite.

### **Spiders, mites and ticks**

The spiders act as predators of insects. On the other hand, some mite species are beneficial and preying on aphid eggs and nematode worms. People in some states like Chhattisgarh collect and sell Red Velvet Mite, Rani Keeda (*Trombidium grandissimum*). It is a beautiful mite and it earns its name because of its skin, which looks like red velvet. It appears during rainy season and is predatory in nature. It preys upon insect-pests, but no information is available as to which insects are preyed upon by it. It is used in traditional system of medicines for treatment of diseases including malaria, urogenital disorders and paralysis, etc (George et al. 2010). Local healers buy this mite from the tribes for about 50 rupees for one hundred mites. But the arachnids are poorly described and understood and so is their role in forest ecosystem.

A tick called *Babesia bigemia* is a parasite of blood of red blood cells of cattle. It is transmitted by a tick called *Boophilus annulatus*, which acts as intermediate parasite. The asexual stages occur in the blood of cattle and the sexual stages in the hind gut of animals. Now as the wildlife habitat are getting fragmented and the wild animals being in constant exposure with the domesticated animals, it remains to be seen as to how wild animals are being affected by this tick infection.

### **Secrets need to be revealed**

It is in the interest of the forest fraternity that the forest secrets should not remain a secret rather we need to explore the mysteries of nature for the sustainability of ecosystem, which can happen only by studying all types of organisms and relationship among them. We have already moved from deforestation to afforestation to

conservation mode of forest management. Lack of proper knowledge, results in the exploitation of a species. For example, Shilapushpa or rock flower (*Parmelia perlata*), which is used for adding a particular essence to the spice. We have no records as to how much and since how long they have been exploiting this lichen. It is only about a decade back that we came to know of this all and it has already gone into danger zone due to overexploitation. The forest health studies should not be restricted to trees or the medicinal plants only but to all types of organisms. Entomophagy is another area of concern, since insects are a source of food in many countries including tribes in India (Das and Hazarika 2012). Proteins, vitamins and minerals requirements can sustainably be afforded, since the natural resource (water, soil, etc.) requirements for rearing insects is very little in comparison to regular food crop cultivation and livestock rearing. Collecting and farming insects could provide a diversified employment strategy and multiple income-earning chances in developing countries.

### **Vanishing honey bees and declining yields**

The honey bees including bumble bees and butterflies account for about 70 per cent pollination in cultivated crops and wild plants. But the honey bee hive and yields in forests are decreasing continuously. Honeybees are absolutely crucial to the chain of life on planet Earth, and they are dying in record numbers. Particularly in the case of *Apis dorsata*, which inhabits tall trees, abandoned buildings and water tanks; the number of bee colonies are decreasing year after year. The possible reasons for the death of honey bees are the infection by *Nosema apis*- a fungus affecting the alimentary canal, *Acarapis woodi* choking the trachea, the modern day mobile towers fragmentation, developmental disturbance in habitat, fluorescent light, pesticides, etc. There are reports that upon reaching the mobile towers, the bees when get exposed to the electromagnetic radiations and lose their sense of smell and become blind (Warnke 1976; Greenberg et al. 1981; Sainudeen 2010; 2011). There is failure of central nervous system and the message is not

passed by acetyl choline esterase and the choline gets deposited on the ganglia. The bees get confused and die. These aspects need thorough investigations. The declining population will certainly affect the reproductive biology and regeneration of species in the forest. Honeybees and major agent for pollination and without them, the global food supply may crash and forest resources may also face colossal d e p l e t i o n .

#### **Animals and forest health**

Wildlife and forest are inseparable and so is the health of forests. The biggest threat to the wildlife is from the domestic animals, which can transmit diseases to their wild counterparts. For this situation, we have to be ready with the solution. The biggest problem to forest health is from the Rhesus monkey (*Macaca mulata*), which has become a big nuisance not only for human beings and agriculture but for the forest health as a whole. They are eating away the fruits and seeds of plants and eggs of birds like red jungle fowl to affect the next generation. Habitat destruction is vital to the animals. Infestation of forest by lantana/parthenium, etc. have resulted in reducing the food resources and restriction in their movement.

Deaths in some animals like chinkara (*Gazella gazelle*) are occurring due to strongyles. It is spreading to black buck (*Antelope cervicapra*) as well. The conditions favouring the spread of these organisms in the forests have to be studied. The cattle movement inside forests affects the growth of grass. There is a risk of habitat degradation because of grazing competition among herbivores. The cattle are let in groups, which results in shortage of food and water for the wild animals and affects their health. The wild animals have no immunity against Foot and Mouth Disease (FMD) and Anthrax, which could be spread by the cattle during grazing in the forests. Concern over illegal cattle grazing in forests, which could spread FMD and Anthrax among wild animals is essential. It should be mandatory for every cattle to undergo vaccination for FMD and other diseases before the permit is issued. There is

need to create awareness among grazers. Even sometimes, it lead to poaching risk of wild animals as well.

#### **Nanotechnology in forest Health Management**

Nanotechnology is the technology of 21<sup>st</sup> century and it has the potential to revolutionize the forest scenario globally (Agarwal et al. 2006). It has a number of applications in forestry and provide a road map for ensuring the proper forest health. Nanosensors will also be utilized in the future to monitor forest health and enable us to maintain better health of forest ecosystems. Nano sensors incorporated into wood based material could provide an early warning of disease and pest damage in the forest and act as an early warning of mold or termite damage. So much so that it will be possible to facilitate self-healing in plants in response to environmental or biological damage. Nano particle pesticides will need very less pesticide to cover a very large area. This will ensure environmental protection besides keeping the pest under check. This will improve the overall health of the forest as the life of the wood products will be enhanced and the requirement of new wood will be delayed. However, human and environment aspects have to minutely considered as it is feared that nano-particles can enter human body and create complications.

#### **REDD and PES**

On-going CDM (Clean Development Mechanism) projects in our country is a kind of PES (Payments for Ecosystem Services), which could not be realized in Indian forests because of certain limitations. However, outside forest plantations have benefitted and seven afforestation/reforestation project were registered under CDM for carbon payments. REDD (Reducing Emissions from Deforestation and Forest Degradation) is yet to start in our country. In CDM the standing forests were not included which will happen in REDD. It has been estimated that deforestation and forest degradation including forest fires account for about 20 per cent of global glass house gas emission. Reducing Emissions from Deforestation and Forest Degradation (REDD) is

an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. REDD<sup>+</sup> goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. Government of India played significant role for REDD<sup>+</sup> to take advantage of forest conservation and sustainable management. It is time that we now start talking about REDD<sup>+</sup> and offer actual forest stocks rather than overestimates (Gilbert 2012; Dhyani 2014), strategy/policy, safeguards, benefit sharing, etc. The current mode of monitoring and reporting of forest stocks are inadequate to meet the international requirements (Ravindranath et al. 2012; 2014). In spite of continuous annual afforestation and reforestation, the increase in forest/tree cover is very low indicating under-reporting of felling in the forest. To meet the international obligations for financing under REDD<sup>+</sup>, there is need for realistic acceptable picture of forest and tree cover. Undoubtedly Forest Survey of India, Dehradun is making concerted efforts to report the state of Indian forests after every two years but still there are technological limitations to record the selective felling, which affect the appropriate acceptable reporting, which would be mandatory under REDD<sup>+</sup>.

## CONCLUSION

The global assault on forest carries a disaster potential equal to the better known crisis in food supplies and fuel, and no one will escape the effects of balding earth, whether through shortage of paper and plastics or at worst through climatic change. It was reaction and subsequent awareness of the disaster of forest destruction that the birth of scientific forestry took place to bring an equilibrium between deforestation and restocking to meet objectives of maintaining ecological balance and meet demands of stakeholders. It is becoming important to equip the current state of knowledge on all aspects for judicious practical utility to address the thematic areas of

sustainable forest management i.e., forest resources and their productive/protective functions, biological diversity, forest health/vitality, socio-economic functions, legal, policy and institutional framework. Forest Officers/Scientists may be well informed about the latest updates but the field functionaries are poorly equipped and their knowledge upgradation is essentially important in terms of changing forest management scenario from tangible benefits to intangible significance. Development activities will continue but we have to make judicious choice between economics and ecology for livelihood of future generation. Sustainable forest management, environmental amelioration, biodiversity conservation/judicious utilization, poverty alleviation, participatory approach, agroforestry, bioenergy, carbon stocks, wood utilization, etc. are important areas of current concern. Farmers, NGOs, private sector, etc. have to play a major role with the support of State Forest Departments in re-greening awareness mission i.e., involvement of communities with defined responsibilities and benefit sharing. Forestry education in last two decades have extended in all four corners and presently sixty two institutions are offering technical forestry and this human resource is still at crossroad to translate their rich skills in environment/forest management. The communication gap between the policy makers, the forest managers and the researchers on the one hand and the user communities on the other will have to be bridged through appropriate extension strategies. Current Government initiative of forest management planning to integrate multiple functions of forestry in the country with the application of modern tools and techniques is a welcome step for forest health management.

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