



Exotic tree species in India: Problems and prospects

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Abstract

Forests and the plantations have a high potential to mitigate the changes in the environment, preserve the inherent soul of any ecosystem and biodiversity. The introduction of the exotic tree species can take intensive pressure as well as provide for the increasing demand of timber and other forest products, which can reduce the burden on natural forest. Besides Agroforestry, the exotic tree species can also be used in energy plantation, avenue plantation, industrial plantation and wasteland plantation. These tree species are also useful for afforestation of opencast, coal mines and also used for reclamation of saline and alkaline soil. As the exotic species have faster rate of growth as compared to indigenous species so the production and yield is much more in exotic species as compared to the later, but ignorance is one of the reasons for the lesser spread of exotic species. People need to understand about exotic species, their impact, and management. Introducing a non-native species into any region is also ensures focus on ecosystem. The ecosystem and the environment is very much adaptive to the indigenous species. Introduction of a new species may become invasive to that region which can cause an imbalance of the ecosystem. There should be the right amount of species introduction, required for the mitigation of climate change and control on climate variability. This paper focuses on the brighter side of exotic tree species introduction, the problems encountered and steps to mitigate this issues.

Keywords: agroforestry, ecosystem, exotic, invasive

Introduction

The tree species that grows naturally in the country or in the region where the conditions are favorable for their growth is known as indigenous species. On the other hand, exotic species have several definitions, some researchers define exotic species as trees growing in an area different to their natural habitat or species growing in area where they do not naturally occur (Zobel and Talbert, 1984) [24], others use the "exotic" term as a reference to species that are not only able to survive but also able to reproduce outside their habitats where they evolved or spread naturally (United States Environmental Protection Agency, 2003) [21]. The term "Exotic" is also used as synonymous of introduced, foreign, invasive, non-native, naturalized, immigrant, non-indigenous species but some differences among those terms could be found. The difference between the terms exotic species and invasive species is that exotic species is associated with a benefit while invasive is relate to species that have been introduced and become a pest in its new location. Alien species have been moved by humans to areas outside of their native ranges and they often become pests in the areas into which they are introduced.

Afforestation of forest by using indigenous species is the most common practice in forestry. Mostly the indigenous species are favorable to the natural condition where they are growing for a longer period of time. These are less susceptible to pest and diseases in the local climate. These indigenous species are more valuable for its timber value and firewood production. As the origin of species are well known, the cultivation and cultural practices of trees are also known by the local people. Thus it helps the people to manage the forest stand which enhance the forest produce. The Indigenous species does not harm local flora and fauna

thus facilitates conservation measures. The wild animals are adapted well to the vegetation, so that the habitat destruction is reduced. The seed collection, storage and treatment also has no problem. Some indigenous species commonly used for agroforestry purpose are *L-euceanalucocephala*, *Glaricidiasepium*, *Sweteniamicrophylla*, *Tectonagrandis*, *Acacia* species, *Bombaxceiba*, *Bahunia* species. Some indigenous species are also used for the reclamation of mining area and wasteland. These are *Acacia catechu*, *Acacia auriculiformis*, *Acacia mangium*, *Albizialebbek*, and *Casuarina equisetifolia* used for deforestation purpose. The multipurpose tree species are *Albizia lebbek*, *Leucaena leucocephala*, *Azadirachta indica*, *Artocarpus heterophyllus*, *Gliridiasepium*, *Prosopis cineraria* and *Sesbania grandiflora* used for fodder and living fence, shade and nurse tree and for avenue purpose. Some species often grown for industrial uses are: *Pinus* spp, *Tectona grandis*, and *Terminalia* spp. (for sawn timber); *Dipterocarpus* species and *Tectona grandis* (for plywood and veneer); *Acacia* spp, *Leucaena* spp, *Pinus* spp (for pulpwood).

Exotic forestry

Exotic forestry refers the use of exotic plant and tree for various forestry application. This is inevitable where indigenous species fail to produce the desired quality and quantity of the forest produces. They can sometimes be very competitive and invasive in nature. An invasive exotic plant is a naturalized exotic plant that is expanding its range into natural areas and disturbs naturally occurring native plant communities. The merits and demerits of both types of species have to be considered before selecting trees for planting on farmlands. Khan *et al* (1999) [11]. studied the

growth of exotic species on farmland of Punjab and according to them the most commonly planted indigenous tree species on irrigated farmlands of Punjab are *Dalbergia sissoo*, *Bombax ceiba*, *Melia azedarach* and *Albizia procera*, whereas the common exotic species are *Populus deltoides* and *Eucalyptus camaldulensis*. The exotic species have a faster growth rate than the native species.

It has been concluded from different studies that indigenous trees have better resistance to diseases and pathogens as compared to exotic species while the exotic tree species have faster growth in comparison to the indigenous species as they are very compatible to the site where introduced. A comparative study on the volume produced was done by Muhammad *et al* (2004) [16], conducted on the native species and exotic one at Chichawatni irrigated plantation from 1989 to 2000. According to them, the overall performance is much better in native species than the exotic. Two of the indigenous species (*A.procera* and *B. ceiba*) were suitable for planting on farmlands particularly due to their importance for providing light quality timber and also fuel wood. Although the growth of *D. sissoo* and *M. azedarach* was slower than other species but the importance of these two indigenous species for providing good quality timber increases the feasibility. Planting of *E. camaldulensis* on waterlogged and saline soils is also beneficial for biological amelioration of the land to make it suitable for cultivation of agricultural crops. Exotic plantations are more profitable than native tree plantations in terms of timber and also for short term basis (Sangha *et al*, 2005) [20]. However, for longer term the total benefits from native plantations are far more than the exotic species, where the value of intangible and tangible products and services increases over time. A study by Kumari and Choudhary (2016) [13], was carried out to assess the threat of EIPs to natural forests in Betla National Park (BNP), Palamu in Jharkhand State. Based on intensive field surveys and using quadrat method they identified 142 EIPs in the BNP forest. 21 plots of 20 × 20 m for trees, 5 × 5 m for shrubs and 1 × 1m for herbs were laid randomly adjoining the forest at 10 to 100 m distance from the road and settlement area. Total 14 EIPs were recorded among which *Lantana camara* and *Parthenium hysterophorus* were found to be the most dominant species. The survey revealed that apart from the ecological harm, invasive plants adversely affect the livelihood of all those who are dependent on forests.

Exotic herbs are also dominant in comparison to native herbs. *Pennisetum pedicellatum*, an exotic herb showed maximum importance with comparison to the native herbs. The exotic species like *Eucalyptus* species, Poplar, and *Prosopis juliflora* are mostly used for the agroforestry purpose. These tree are also grown in commercial purpose for their high market value. *Eucalyptus* and poplar are mostly cultivated for paper and pulp production. These species are more dominant in comparison to the native species, as they easily acclimatized to the environment. Wheat and poplar, poplar and turmeric based agroforestry system are mostly practiced in India. Khanduri *et al* (2017) [12], studied the forest invasive species introduced in village forest in Tehri Garhwal area, Western Himalaya. Data were collected through extensive field survey and quadrat method. High invasion was recorded in the shrub and herb layer of the forest. In tree strata native species are dominant. A highest value of ecological indices was evaluated in *Pinus roxburghii* dominated site as compared to the *Quercus*

leucotrichophora dominated site. *Lantana camara*, *Eupatorium glandulosum*, *Clematis gouriana*, *Rosa brunonii*, *Rubusneivus*, *Euphorbia royleana* etc. were recorded as the most destructive Forest Invasive Species (FIS) of both the forest communities. Exotic tree species can have the potential to take intensive pressure, which can reduce the burden of natural forest. Besides agroforestry the exotic tree species are used in energy plantation, avenue plantation, industrial plantation and wasteland plantation. These exotic tree species are also useful for afforestation of opencast coal mines and also used for reclamation of saline and alkaline soil. The exotic tree species can also be used in agroforestry, commercial plantation, road side plantation, reclamation of saline and alkaline soil and also used for the afforestation purpose. (Dutta and Agrawal, 2003) [3]. As the exotic species have faster rate of growth as compared to indigenous species so the production and yield is much more in exotic species as compared to the later (Hafeez, 1986) [6]. Thus, exotics have very high potential in every aspect of forestry.

Indian tree species introduced to other country

- The exotic tree species like Neem, which is a native to north-eastern India, is a fast-growing evergreen tree that has been introduced and established throughout Australia's tropics and subtropics. Neem is used to produce insecticide, and is planted across northern Australia for this reason. However, in dense stands, it could have adverse effects on native plants and animals.
- Native to tropical and subtropical Asia, bamboo is a tall, woody grass that grows in dense stands. Bamboo was introduced to Australia as an ornamental plant, and today is often used to create shelter belts or for erosion control. Bamboo species have spread into many parts of South East Queensland and northern New South Wales. Where they have broken containment and become invasive, running bamboos have become a problem for landowners and managers of natural areas. Nothing will grow under bamboo, and it crowds out native and other desirable species.

Purpose of exotic tree introduction in India

The ever-expanding human population requires an enormous amount of wood, which in turn, puts intense pressure on the existing forest wealth of India. The production potential of trees for wood generation is restricted to about 0.7 cubic meter/hectare/year in the country as compared to the world average of 2.1 cubic meter/hectare/year. This results in a huge gap between demand and supply. As per the National Forestry Action Program, India's timber requirement in 2006 stood at 82 million cubic meter whereas the domestic availability was just 27 million cubic meter. Moreover, in the past 10 years, the money spent on import of wood has jumped from US \$1 billion in 2001 to more than US \$ 5 billion in 2011. Expansion of farm areas is not possible as land is a limited resource. However, enhancing the efficiency of farms by planting and integrating fast-growing trees under farm forestry and agroforestry is a reasonable and realistic alternative to meet the increasing demand for wood. Planting fast-growing trees outside the forest in the form of farm-forestry or agroforestry is the only way to meet the goal as required by the National Forest Policy, 1988 to increase forest tree cover to 33 per cent from the present

24.01 per cent. (<http://www.fao.org/3/af338e/af338e06.htm>). Short-rotation tree species having faster growth, multiple uses and wider adaptability were deemed desirable for agroforestry/farm forestry plantations. The exotic species are used as an alternative in many places where local indigenous forests cannot produce the quantity and quality of forest products required and its growth rates is much higher than native species; therefore, they produce more wood per unit of area and time. In the tropics, exotic species could grow 5 to 10 times more wood than native species. Many of the exotic species used in forestry plantations can grow in sites with limited edaphological conditions (as pH, nutrient availability, moist content, texture, etc) with better yield than indigenous species. Exotic species usually can adapt to different environmental conditions; nevertheless, is important to test the exotics in the zone where it is needed prior deciding a large-scale plantation establishment. With features as fast growing and wider adaptation, exotic species could be used as source of different type of products and so reduce the pressure over native species (which in general growth less and slower). The yield is higher in exotic trees and augment improved return from a land. Wood is of uniform quality and desirability is obtained. The rotation period is less as compared to the native one. Suitability of the species for involvement as well as biology and reproduction is well

known. Exotic trees are not likely to be effected by their enemy such as pest and disease and many exotic perform well in the introduced country. Moreover, some exotic tree species were introduced to contribute to the success of farm forestry plantations programs. Farmers in India may need to be careful in integrating exotic trees into their agroforestry farms. Besides from looking at market prices, farmers should also consider the trees capability to be efficient and effective suppliers of food, fodder and fuel wood. More importantly, they should also check how the tree of choice complements the other crops, including its maintenance requirements. The introduction of the exotic species, depends on the factors like edaphic, climatic, forest types and environmental condition should also be taken into consideration. The exotics also have some specific role towards the soil and water conservation.

Tree species introduced in India

There are a number of tree species introduced to India which are fast growing in nature and have the potential to meet the need of local people. The tree species like populus, eucalyptus, prosopis are mainly used in agroforestry purpose. The most successful agroforestry practice in India are wheat (*Triticum astivum*) with poplar (*Populus deltoides*, turmeric (*Curcuma domestica*) with poplar (*Populus deltoides*) etc.

Table 1: List of some common exotic tree and its impact on climate

SI No	Scientific Name	Native from	Family	Positive Impact to environment	Negative impact
1.	<i>Populus deltoides</i> :	United States of America.	Salicaceae	The benefit rendered to the environment in terms of adsorption of carbon dioxide, production of oxygen, conservation of soil and water, and amelioration of climate is beyond calculation (Chander, 1998) [2].	Due to its straight bole and height it is very much susceptible to lightning and it capture fire easily.
2.	<i>Eucalyptus tereticornis</i>	Australia	Myrtaceae	Plants commonly show flexible acclimation of leaf photosynthesis to temperatures that relate to the thermal regime in which they are grown (Yan, 2012) [22].	Growing Eucalyptus in low rainfall area may cause adverse environmental impacts. Heavy competition for water with other species and increase the incidence of allelopathy.
3.	<i>Prosopis juliflora</i>	South America	Fabaceae	They are capable of transferring fertile land into dense thickets of impenetrable tree stands (Pasicznik <i>et al.</i> 2004) [17].	More water consumption can lower the ground water table. With its thorns and many low branches it forms impenetrable thickets which prevent cattle from accessing watering holes. It also takes over pastoral grasslands and uses scarce water. Livestock which consume excessive amounts of seed pods are poisoned due to neurotoxic alkaloids
6.	<i>Araucaria heterophylla</i>	Norfolk Island, Pacific Ocean	Araucariaceae	Tolerance to salt and wind so ideal for planting in coastal zone.	Canker and needle blight are observed.
7.	Cryptomeria	Japan	Cupressaceae	Tree withstand to stagnant water condition and grows well in moist soil.	Toxic to human and other animal.
8.	<i>Taxodium distichum</i>	Southeastern United States	Cupressaceae	Gives structural support and stabilization. Can grow in flood prone area.	Brown pocket rot is very common. It attack and destroy sapwood of another tree. Cypress flea beetle, leaf roller infestation is common.
9.	<i>Acacia mellifera</i>	Ethiopia	Fabaceae	trees is important particularly in arid and semi-arid areas for regulating microclimate, improving conditions for survival of associated plant and animal species (Attum & Mahmoud, 2012) [1].	It is invasive and cover large area of farmland.
10.	<i>Jatropha curcas</i>	Central American	Euphorbiaceae	Use of jatropha biodiesel reduce the global warming potential and the non-renewable energy demand as compared to fossils diesel.	The jatropha bioenergy is not climate friendly because it disturb the greenhouse gas balance and increase the acidification, eutrophication and water depletion.

Problems due to exotic tree species

The plantation of exotic species should be selected carefully, after introduction to a site if the provenances and seed sources of the exotic species are not appropriate, the plantation could result in a disaster. Therefore, it is important to test the species in the area where it is to be grown before it is planted at commercial scale. The delayed failure, in some cases creates a problem during afforestation in later stage. In some case, The introduced species is performed at substandard level. Sometimes growth may become unsatisfactory. The exotic are considered ecologically less valuable than indigenous species. The use of exotic species could be associated with new pests and diseases and affect native species e.g. pink disease *eucalyptus grandis*. Therefore, it implies new or stricter disease and pest controls. The exotic may bring new insect and pest to be introduced at the region. Experimentation with exotic is time consuming and may not serve the purpose of immediate needs.

The use of exotic species has many opponents, not only ecologists but also politicians, who are against the use or modification of natural forests and their biodiversity. Some ecologists point out that “once established, some exotic species have the ability to displace or replace native plant and animal species, disrupt nutrient and fire cycles, and cause changes in the pattern of plant succession” (Jeff Lovich, 2003) [14]. The exotic may have physiological distribution and problem of seed production. e.g. *Araucaria bidwillii*, in spite of their faster rate of growth in many areas these are not producing the viable seed. Due to this reason large scale propagation is not possible. For e.g. Previously in India they promoted wide-scale plantations of exotic *Eucalyptus tereticornis* mainly for the short-term visible gains from timber because of its straight bole, fast growth rate, high productivity per unit area, and minimal requirement for post-plantation care. However, the merit and demerit of this tree is a very controversial from the view point of scientific community, private growers, and the public. One reason for this is that our current accounting system considers only the economic gains from wood and fails to consider the cost of lost ecological services when comparing exotic vs. native trees. Instead, we compared the total value of exotic *E. tereticornis* plantations in comparison with native *Dalbergiasissoo* plantations.

Exotic plantations are more profitable than native tree plantations only over the short-term basis and in terms of timber, which is at the cost of many ecological services (Sangha, K. and R.K. Jalota, 2005) [20]. However, the long term the total benefits from native plantations are far greater where the value of intangible and tangible products and services increases over time, and adds to the continuum of services and sustainability of a system. Invasive exotic plant species (IEPS) threaten the environment, reduce biodiversity, replace economically important plant species and increase the investment in agriculture and silviculture practices, prevail vegetation dynamics and alter nutrient cycling (Richardson & Higgins 1998) [18]. They can promote hazards like forest fire. Plant invasions dramatically affect the distribution, abundance and reproduction of many native species (Sala *et al.* 1999) [19]. IEPS intrusion is severe in edges of forests, agricultural land and wet lands. However all ecosystems that are susceptible to invasion and effected with a higher level of human interventions (e.g. forestry, agriculture, wetland and rangelands) are likely to

pose greater susceptibility. Introducing an exotic species can result in undesirable side effects. One possible problem is that the species will adapt so well to its new environment that it will become a weed and take over crops that are important to farmers' livelihood. For example, *Prosopis juliflora*, native to Central America and the West Indies, was introduced to India as a fodder and fuel wood tree. It grows so well in its new environment that it inhibits the germination and growth of other plants that are more valuable to the farmer. Invasive plants that have usually been brought in as exotics, but are so well adapted to their surroundings that they spread uncontrollably, pushing out indigenous plants, and consuming precious resources at the same time.

Strategies to overcome the problem

The successful growth of exotic tree species depends on selection of the most appropriate species. To perform well the, farmers or forest personals must have a clear idea of purpose to grow exotic trees and the tree crops match the needs of their particular farming system and local agro ecological conditions. People grow trees for different purposes: to obtain timber, fuelwood, fodder, or food; to conserve the soil or a combination of these and also be grown in different land use systems, such as alley cropping, home gardens, farm woodlots, or industrial plantations. These different purposes and growing systems determine the criteria that farmers must consider when selecting which species to grow. People need to understand about exotic species, their impact, and management of it. The balance of nature by introducing non-native species into any region is also ensuring the focus on ecosystem.

Conclusion

The over exploitation of forests leads to damage the environment and biodiversity. If the process continues there will be no forests left by 2050. The condition of forest-based industries is also not healthy in India. Therefore, promoting large-scale farm forestry/agroforestry plantations is essential. The National Forest Policy (1988) directed the wood-based industrial units to meet their future raw material requirements by developing partnerships with farmers. Some progressive industrial units have promoted farm forestry/agroforestry plantations through the supply of planting stocks, technical extension services and buy-back arrangements with varying degrees of success.

These exotic trees have the potential to take intensive pressure and can mitigate the timber demand of huge population. From various study it is concluded that the exotic trees can give more outcomes per unit area as compared to the indigenous species as the rate of growth is faster in exotic trees. But the indigenous species has better resistance to disease and pest as compared to the exotic. The exotic tree species have various advantages in agroforestry and commercial plantation, apart from these advantages, there are various negative impacts of exotic trees *viz.*, allelopathy, liable to attack by pests and disease, use of excess water and effect on soil and invasive nature. These risks can be reduced by taking some precautions before introduction of an exotic species. Introducing material through proper evaluation before mass plantation, keeping wide genetic base, etc must be taken into consideration at the time of selection. When introducing an exotic species it is important to determine whether the soil, rainfall, and

other requirements of the species match the conditions of the planting site. If the suitability of the species in the introduced area are not known indigenous species as well as local species should be considered first. Exotic species are those found in botanic gardens, on farms, in parks or along road sides have survived easily in local agro ecological conditions.

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