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Ecological Impact of Planting Indigenous Plants Instead of Exotic Acacia Trees in Anchal

Arya S Nair[1], Sukanya S Nair[2], Muhammed Anvar Y[3]

[1]Arya S Nair, MTech Student, UKF College of Engineering and Technology, Parippally, Kollam
[2]Sukanya S Nair, Assistant Professor, UKF College of Engineering and Technology, Parippally, Kollam
[3]Muhammed Anvar Y, Assistant Conservator of Forests & Technical Assistant, Chief Conservator of Forest (Southern Circle), Kollam

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Abstract - *Kerala has a wide variety of vegetation and forest types. Plantation forests are expanding rapidly all over the world. There is a global trend of increasing forest plantation to relieve the pressure of deforestation and degradation of natural forests, in addition to meet the demand of timber products and forest services. Mixed-species plantations are growing and becoming more popular, since they have more benefits in biodiversity, economy, forest health and productivity compared with monospecific plantations. Planting the monocultures of fast-growing non-native (exotic) species is one way to slow or reverse deforestation and forest degradation in tropical zones. Acacia mangium has achieved popularity in the private sector plantation programmes in Kerala as a multi-purpose fast growing species. Acacia behaves like a landmine particularly around tropical Western Ghats in India. As mature acacia stands are logged for pulpwood, they will be replaced with indigenous trees. The main aim of this study is to assess the ecological impact of planting fruit bearing plants and other indigenous trees instead of exotic acacia trees. From the study progression of monocultures and mixed-species are compared and the advantages, disadvantages and effects on the surrounding natural ecosystems between the different plantations are noted.*

Key Words: **Monocultures, indigenous-species, deforestation, ecological impact, Acacia mangium.**

1. INTRODUCTION

The state of Kerala is a narrow strip of land, tucked away in the southwest corner of India. Though it covers only 1.18% of the total area of India, it supports about 3.43% of the total population of the country. In Kerala about 28.90% of the total land area is covered by forests. The total forest area covers 11,125.59sq.km which comes under reserve forests, proposed reserve and the vested forest. The forest area in Kerala is near the Western Ghats which lies along the border of the state. From the total recorded forest area, the actual forest area is just 9400sq.km. In Kerala the forest area is spread over the Western Ghats which is one of the world's hot spots of bio-diversity. It is rich in a wide variety of rare and endangered flora and fauna. About 51% of the forest area of Kerala is in the southern districts and the remaining percent is in the central and northern districts. The main districts which are covered by forests are Idukki and Pathanamthitta districts. Alappuzha is the only district with no forest area. Kerala has a wide variety of vegetation and forest types. And the different forest types in Kerala are Tropical Wet Evergreen Forests, Tropical Moist Deciduous Forests, Tropical Dry Deciduous Forests, Mountain Sub Tropical, Rolling Grasslands, Shola Forest, Thorny Scrub Forest, high sholas etc. As there are a wide variety of forest types, it helps in the growth of a rich variety of flora (Vishnu et al., 2017). The trees of the Tropical Dense Evergreen Forests include White Pine, Punnappa, Bhadraksham, Pala, Maravuri, Karimaruthi, Vayana etc. The trees in Moist Deciduous Forest include Teak, Maruthi, Karimaruthi, Rosewood, Venga, Chadachi, Mazhukanjiram etc. Besides these trees there are also many species of flowering, medicinal and nonflowering plants. Acacia mangium is a promising, fast growing, evergreen, leguminous tree and native of tropical rainforests of Australia, Papua New Guinea and Indonesia. In 14 years it grows up to 30 m height and 40 cm in diameter (NRC. 1983). This species is able to grow even in acidic soils with pH as low as 4.2. The trees are useful for shade, ornamental purpose, screening, demarcating boundaries and wind breaks as well as for use in agro-forestry and erosion control (Benard et al., 2018). 2 It is an important raw material in the pulpwood industry. It is also suitable for planting in areas heavily infested with weedy Imperta grass. The leaves can serve as forage for livestock. The tree produces considerable quantity of fallen branches and dead leaves which can be gathered for fuel. The growth rate of Acacia mangium is very high as compared to many indigenous species which are used for similar purposes. Even though Acacia mangium was introduced in Kerala in the early 1980s with the major initiative of His Grace Benedict Mar Gregorius the then Archbishop of Thiruvananthapuram; it was only in the early 1990s that farmers started planting it. However no information is available on the locations planted with Acacia mangium either interplanted with farm crops or as pure plots in Kerala. Although Acacia mangium is described as a multipurpose fast-growing tree species for the humid tropics, the wide variability in growth rates and susceptibility to pests and diseases calls for evaluation of its growth performance and wood properties before large scale planting is done (Barsoum et al., 2016). In order to make wise investments in extensive plantation programmes of this

species, information regarding its growth rate and wood properties is essential. This will be helpful for evaluating its potential for various end-uses. After planting acacia (an alien species to our natural grasslands and forests) since 1950s, now the officials of Forest Department have started to discourage planting it in reserve forests. Even though these plantations are believed to have created ground water level depletion and sufficient negative impacts in our environment, considering fast growth, sturdy trunks and minimum maintenance, profitability in timber business and external funding, forests departments in different states of the Country overwhelmingly supported this alien species for afforestation during the past. In India timber has an extensive market and it is giving rich dividends too. But mere cutting down of existing trees and zero plantation of new acacia saplings will not restore the ecology. The long plantation of such species of trees restructured the soil and water tables against natural vegetation. It usually takes thousands of years natural process in order to evolve particular vegetation in a locality. Acacia and eucalyptus were seen detrimental to ecology. As mature acacia stands are logged for pulpwood, they are not seen replaced with indigenous trees due to the profuse regeneration of its seedlings in the surroundings (Jonathan et al., 2015).

1.1 Objective

In this study, it deals with the ecological power of implanting fruit bearing plants instead of acacia trees. The objective of my study deals with the following. To assess the ecological impact of planting fruits bearing plants & other indigenous trees instead of exotic acacia trees. To evaluate the benefit of planting fruit bearing indigenous plants & their contribution towards restoration of ecology and conservation of the environment. To assess the ecological and social impacts of monoculture acacia plantations over indigenous trees. To suggest a better option as compared to acacia monoculture plantations, considering its adverse impacts on environment as well as the fringe population.

1.2 Study Area

Anchal is a town in Anchal block in Kollam district of Kerala State, India. It belongs to South Kerala Division. It is located 42 km towards east from district headquarters Kollam shown in figure 1.1. It is a block head quarter in Anchal pincode is 691306 and postal head office is Anchal. Karavaloor (7km), Alayamon (7km), Kelankavu (8km), Elamadu (8km), Chadayamangalam (8km) are the nearby Villages to Anchal. Anchal is surrounded by Chadayamangalam block towards south, Punalur block towards north, Vettikkavala block towards west, Pathanapuram block towards north.

- Forest area of Anchal

The forests of Anchal Range are surrounded by Kallada River on the north and almost a major portion of the eastern side, the rest by Thiruvananthapuram-Shenkotta State Highway up to Madathara, Madathara-Nilamel Road on the south and NilamelAnchal-Punalur Road on the west. The area of Anchal is 143.74150square km in Punalur forest division under Anchal range there are two reserve, Yeroor Reserve 11,797.179Ha and Ayiranelloor Reserve 2,576.971Ha which is shown in figure 1.2 and 1.5. Anchal Range boundaries consists of West: Arabian Sea from Andhakaram Azhi along the seashore upto Thankasseri along Paravur pozhi. North: Southern boundary of Pathanapuram Range from Thankasseri to Vellimala, East: From Edamon 34 thence southwards along Edamon 34 Yeroor road upto Ayiranelloor ferry and thence eastwards to parappar dam along Kallada River. From the South–East point of Kollam district boundary near Kollayil towards west along the common boundary of Kollam and Thiruvananthapuram. The forests of Pathanapuram range are enclosed within the southern boundary of Konni Forest Division passing through Vellappacode, Kaikunnam, Ayiravally and Nagamala ridges, western boundary of Arienkavu reserve forest passing through Nagamala and Nedumpara up to Vellimala Estate and the Punalur-PathanapuramKalanjoor Road. The forests of Anchal Range are surrounded by Kallada River on the north and almost a major portion of the eastern side; the rest by Thiruvananthapuram-Shenkotta State Highway up to Madathara; MadatharaNilamel Road on the south and Nilamel-Anchal-Punalur Road on the west. (Source: Kerala Forest Department in Anchal range).

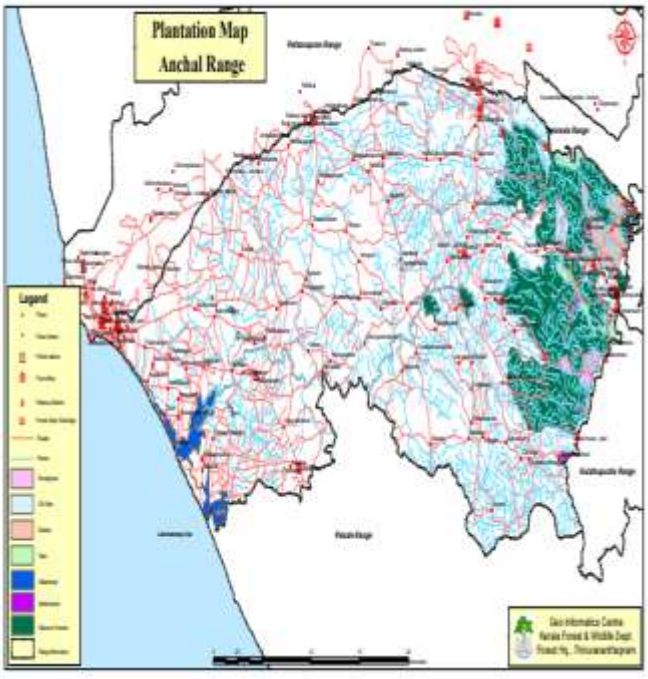

Fig 1.1: Plantation map of Anchal (Source: Kerala Forest Department)

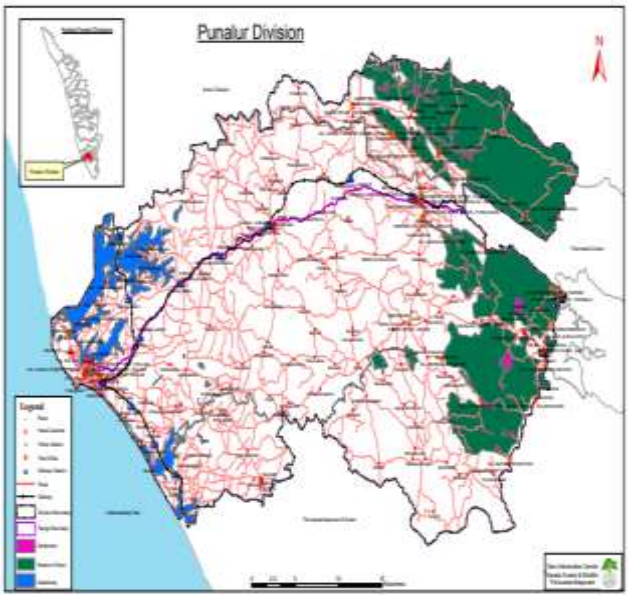

Fig 1.2: Punalur Division Map (Source: Kerala Forest Department)

2. Methodology

The places selected for the comparative study of monocultures and mixed-species.

1. Acacia mangium in Maravanchira, Anchal range, Yeroor reserve, Punalur division.
2. Miscellaneous Plantation in Onthupacha, Anchal range, Yeroor reserve, Punalur division.
3. Melia dubia plantation in Onthupacha, Anchal range, Yeroor reserve, Punalur division.
4. Natural Forest in Aanapalayam, Anchal range, Punalur division.

A description of the study area is provided followed by the methodology of the work. It comprises of data collection from the field, from the fringe population through a questionnaire and analysis of the data collected by suitable method to assess the impacts of acacia plantations as compared to miscellaneous fruit bearing tree species on the environment as well as on the population.

2.1. Acacia mangium in Maravanchira

• Extent of Acacia mangium planting in Anchal

From the acacia mangium plantation in Maravanchira, Anchal range, Yeroor reserve, Punalur division the datas were collected by manual inventory method. The plantation has the total area of 11.50Ha and effective area of 11.17Ha. The total number of seedlings planted in the area is 17600 Nos which has the espacement of 2.5m x 2.5m (1600 no/ha). The seedlings were planted in 05.06.2014 to 12.06.2014 and the seedlings were collected from the Central nursery, Kulathupuzha. We select a plot of 20m x 20m and details of trees were collected by measuring using tape (Source: Manual Inventory of inside forest).

• Growth rate

From the details collected by manual inventory the age, year of planting, growth rate, extent of Acacia mangium planted in Anchal region can be noted. As interest in planting Acacia mangium developed in Kerala far years ago. There were only very limited number of plantations now due to its adverse effects, that too in the form of small blocks. More of these are in private sector. There are only limited plantations of this species in the Government sector (Forest Department). As it was possible to collect the details of plantations in a systematic way for the studies, a survey was conducted on Acacia mangium plantations available. The collection of the growth rate data of trees of same ages growing at Anchal region. Girth at breast height (GBH) (1.37 m above ground level) was recorded for all trees in selected sample plot. In sample plot, height measurements were recorded on sample trees representing the height range. GBH of trees were collected and mean was calculated and mean heights were recorded. The GBH and height data from a plot established in Anchal in 2014 was used to study the growth pattern during the initial 5 year period of the crop. In the plantation no other plants or grasses are present. The Acacia mangium donot allow other plants to grow.

• Water table depletion observed during past years, collected through questionnaire

Acacia is naturally found in arid conditions which are why the people of Kerala sometimes refer to it as alien trees. It consumes water in excess in the tropical conditions which reduces the ground water level. Acacia behaves like a landmine particularly around tropical Western Ghats in India. It is naturally made to exploit water as much as possible if not it cannot survive in water short arid regions. Plus it reduces the fertility of soil. A mature tree will disperse their seeds even to farthest locations through wind. Thus acacia ensure the destruction of local eco systems. If one acacia is there in the vicinity, no other species will survive in the entire surrounding area within some years; that's why it became the dominant invasive tree species in the world ecology. Plants like Acacia show nutrient depletion from soil faster than other slow growing plants. The reason is acacia is an efficient biomass producer; it can produce more biomass than many other tree species. As a result of its fast growth and high biomass production acacia consume more water than other less productive species. Growing acacia in low rainfall areas may cause adverse environmental impacts due to competition for water with other species, which has been widely accused of triggering asthmatic allergy in nearby resident population and depletion of ground water levels. A survey was conducted with the nearby locality of Acacia mangium plantation and the people are against the

plantation due its harmful effects. They are suffering from lack of water even in rainy season also. The pollen grains of Acacia mangium cause their body itching and allergic. And also it causes asthma and other respiratory problems. Even infants also affected by this plant. In younger stage the plant does not cause any problem as it grows the problem arrives. It requires enough water for its fast growth and time passes the pollen grains moves through the wind and causes diseases.

2.2. Miscellaneous Plantation in Onthupacha

From the Miscellaneous Plantation in Onthupacha, Anchal range, Yeroor reserve, Punalur division the datas were collected by manual inventory method. The plantation has the total area of 102Ha. The total number of seedlings planted in the area is 35000 Nos. The seedlings were planted in 2017 and the seedlings were collected from the Central Nursery, Kulathupuzha and from Nursery in Alappuzha. The plot was divided into 20m x 20m area and all the details were collected. The number of plants in the area which are planted and which are produced naturally are noted. The species which are produced naturally and growth rate of species are noted. Each category of species are noted and their height are measured. Many other species are also growing in the area. A natural forest is restoring by providing these plantations. The plantation is treated 3 years after that it naturally grows. The weed etc. is destroyed. Each 5m distance a fire line is provided and 3 step protections is done. The height of plants ranges from 3 to 4 feet (Source: Manual Inventory of inside forest). From the miscellaneous plantation we can analyse that all species are present. Planted species as well as naturally produced ones. Plantations which are diverse in genotypes, species, structures and functions are acclaimed as more environmental friendly and sustainable plantation systems over monocultures, especially in case of mixing indigenous species. There are prolific evidences that planting multiple species can gain numerous economic, environmental and social benefits. First of all, species mixtures can maximize the use of resources and consequently increase stand-level productivity and carbon sequestration. In comparison with monocultures, several studies have found that mixed-species plantations are more productive. Mixtures of fast-growing and slower-growing species can produce timber and more valuable wood products and some species can act as nurse to other tree species. While reducing risks of soil erosion and providing shelter and protection against frost or pests. The smaller species are under the shade of the taller species in mixtures, resulting in less branching of the smaller ones, which may eventually improve the wood quality. Moreover, mixed-species plantations could be more efficient in filtering of atmospheric pollutants (eg. sulphur and chlorine) in the areas with heavy precipitation. There is a potential of using more complex mixtures with five to seventy species for restoration of degraded lands. For ecological benefits, proved that spruce-birch and spruce-pine polycultures did not only simply support aesthetic and recreational values, but they also increased avian diversity with special composition of bird species.

2.3. Melia dubia plantation in Onthupacha

From the Melia dubia plantation in Onthupacha, Anchal range, Yeroor reserve, Punalur division the datas were collected by manual inventory method. The plantation has the total area of 12.48Ha and effective area of 12.05Ha. The total number of seedlings planted in the area is 13388 Nos consists of Cloned root trainer seedling 500, Cloned basketted seedlings 1800, Basketted seedlings 4500 (Agricultural University Tamil Nadu), Basketted seedlings 6588 (unknown source). The seedlings were planted in 2018 and the seedlings were collected from the Agricultural University, Tamil Nadu. We select a plot of 20m x 20m and details of trees were collected. The height of plants varies from 2.5 to 3.5 feet (Source: Manual Inventory of inside forest). It is planted in a sequence and our area 49 Melia dubia plants are present. It consists of miscellaneous plants such as rambuttan, vattayila, maruthi, vayana, mangium. The mangium is not naturally occurring it is because the land is early mangium plantation. As a result mangium is growing here and it is weeded at its younger stage itself. Other small plants, grasses are also present here.

2.4. Natural Forest

A natural forest is a protected area which is reserved and managed for conservation. Biodiversity refers to the variety of organisms, including microorganisms, plants, and animals in different ecosystems, such as deserts, forests, coral reefs, etc. The most commonly used representation of ecological diversity is species diversity, which is defined as the number of species and abundance of each species living within a certain location. Many species are interconnected and dependent on one another for survival. They perform important ecosystem functions and offer different ecosystem services to support life on Earth and human economies, for instance, water quantity and quality, seed and pollen dispersal, soil formation, nutrient cycles, regulation of pests and human diseases, carbon storage and climate regulation, waste management and cultural services. Ecosystems with higher species diversity can be more efficient and are generally more stable and resistant to disaster than those with fewer species, as a substantial number of species consist of many different traits, which can contribute to various functions. From the natural forest in Aanapalayam reserve under Madathara region, Anchal range in Punalur division the datas were collected by manual inventory method. There are so many trees and plants with bird's chirpings. Forests help in purifying the atmosphere, aid in climate control and act as natural watershed. We select a plot of 20m x 20m and noted the trees present in that area.

3. Results and Discussions

In India, this low elevation species was probably introduced in the eighties. However, it was only in the early 1990's that farmers had started planting them, either interplanted with farm crops or as pure plots. In 1997, trees up to an age of 13 years are present in some plots. There is still plantation of this species at State Government level, particularly by the Kerala Forest Department. The extent of both these plantations amounts to a few hectares only. Acacia mangium has been introduced in all the districts of Kerala. The details of variation of GBH with age as recorded from plantation. The GBH gradually increased as the age increased and reached a mean value of 74 cm at the age of 5 years. The slightly low value of GBH observed for the 5-year-old trees may be due to the limited number of trees available for measurement and that too, from only one plantation is shown in table 3.1 and figure 3.1. The influence of soil factors on growth may be another reason for the slightly low growth observed in this case. After 5 years, again the mean GBH was found increasing. The variation of estimated tree height with age is observed. It can be seen that at the age of 2 year the mean height of the trees is about 3-5 feet. This slowly increases to an average value of around 19-25 feet at the age of 5 years. Despite the many reported benefits of Acacia mangium in agricultural, agroforestry and forestry systems, there is increasing evidence that because of its invasive properties, this species can exert profound negative impacts on soil, biodiversity and human wellbeing. Commercial forestry plantations are mostly established in large open areas which are highly susceptible to invasions of alien trees argued that it can easily invade disturbed and degraded forests, especially those that experienced drought and fire. They found that Acacia mangium have a wide range of impacts on ecosystems that increase with time and disturbance and frequently transform ecosystem functioning, thereby altering and reducing the delivery of ecosystem services. The accumulation of massive stores of long lived Acacia mangium seeds in the soil ensures persistence of the invader even with frequent and severe disturbance. It changes the functional diversity of soil microorganisms inhibited the growth of the native tree species. Acacia mangium is a fast growing species which absorb more water than other species which reduces the water table level. Acacia cannot survive in water short arid regions since it is naturally made to exploit water as much as possible. Plus it reduces the fertility of soil. Soil fertility is created by the presence of micro-organisms in soil for which water and other bio-degradable elements are required. It is provided by leaves and other parts of plants. Presence of phenolic and lignin in acacia leaves are high which makes them slow in decaying. In the next stage these components makes soil more acidic which destroys other micro-organisms. More worrying is the colonizing nature of this tree. A mature tree will disperse their seeds even to farthest locations through wind. Thus acacia ensure the destruction of local eco systems. If one acacia is there in the vicinity, no other species will survive in the entire surrounding area within some years; that's why it became the dominant invasive tree species in the world ecology. Plants like Acacia show nutrient depletion from soil faster than other slow growing plants. The reason is acacia is an efficient biomass producer; it can produce more biomass than many other tree species. As a result of its fast growth and high biomass production acacia consume more water than other less productive species. Growing acacia in low rainfall areas may cause adverse environmental impacts due to competition for water with other species, which has been widely accused of triggering asthmatic allergy in nearby resident population and depletion of ground water levels. In the plantation no other plants or grasses are present. The Acacia mangium donot allow other plants to grow. There is an ecological point of view too. Each plant has its own natural environment and they can contribute environmental disasters if planted elsewhere. In Australia, Acacia is one of the best plants for arid region condition. Acacia behaves like a landmine particularly around tropical Western Ghats in India. Acacia cannot survive in water short arid regions since it is naturally made to exploit water as much as possible. Plus it reduces the fertility of soil. Soil fertility is created by the presence of micro-organisms in soil for which water and other bio-degradable elements are required. It is provided by leaves and other parts of plants. Presence of phenolic and lignin in acacia leaves are high which makes them slow in decaying.

Table 3.1: Details of Acacia mangium plantation in Maravanchira, Anchal.

Sl.No.	No: of trees counted	Mean girth at base (cm)	Mean GBH (cm)	Mean height of tree (feet)
1	8	56.5	51.37	25
2	8	46.2	40.25	21
3	9	48.1	42	22
4	9	49	42	23
5	9	51.6	45.22	25
6	9	57.8	52	27
7	9	62.3	55.55	26
8	9	64.5	55.44	24
9	9	59.6	54.33	27

Fig 3.1: Acacia mangium plantation in Kulathupuzha.

Instead of Acacia mangium now the government is introducing a new method that is planting miscellaneous trees which includes fruit bearing plants and trees. As it is in developing stage it creates a positive impact on ecosystem. Many species are interconnected and dependent on one another for survival. They perform important ecosystem functions and offer different ecosystem services to support life on Earth and human economies for instance water quantity and quality, seed and pollen dispersal, soil formation, nutrient cycles, regulation of pests and human diseases, carbon storage and climate regulation, waste management and cultural services. Ecosystems with higher species diversity can be more efficient and are generally more stable and resistant to disaster than those with fewer species, as a substantial number of species consist of many different traits, which can contribute to various functions. There are prolific evidences that planting multiple species can gain numerous economic, environmental and social benefits. First of all, species mixtures can maximize the use of resources and consequently increase stand-level productivity and carbon sequestration. In comparison with monocultures, several studies have found that mixedspecies plantations are more productive. An example from Chomel et al (2014) demonstrated that mixing hybrid poplar and white spruce increased wood production of poplar and sequestrated more carbon than monocultures of either poplar or white spruce. Mixtures with stratification can also enhance individual-tree growth rates and stem quality of species in upper canopies, whilst minimizing the proportion of taller species that can reach the highest production. Mixtures achieving greater productivity than monocultures have remained many uncertainty. Forrester et al (2006) expressed that several examples of mixing eucalyptus and nitrogen-fixing species increased productivity and nutrient cycling rates, and they had better results than monocultures. The benefit of mixed-species over monocultures is the promotion of diversifying production under different rotation periods. Mixed-species plantations are more resistant to damage caused by storms, insects or diseases. Mixtures of fast-growing and slower-growing species can produce timber and more valuable wood products and some species can act as nurse to other tree species. While reducing risks of soil erosion and providing shelter and protection against frost or pests. The smaller species are under the shade of the taller species in mixtures, resulting in less branching of the smaller ones, which may eventually improve the wood quality. Moreover, mixed-species plantations could be more efficient in filtering of atmospheric pollutants (e.g., sulphur and chlorine) in the areas with heavy precipitation. There is a potential of using more complex mixtures with five to seventy species for restoration of degraded lands proved that spruce-birch and spruce-pine polycultures did not only simply support aesthetic and recreational values, but also they increased avian diversity with special composition of bird species. Correspondingly, agroforestry systems have been well recognized as an improvement on monocultures and being closer to native forests. They can provide a wide variety of goods which increase carbon storage, enhance soil fertility and improve water and air quality. Growing trees with agricultural crops can also produce high-value wood products and bioenergy, minimize the risk of pest outbreaks and enhance biodiversity. There are several successful agroforestry examples. Pelleri et al (2013) presented a mixed plantation of walnut, poplar and some other nurse trees, which had favourable impacts on the growth of both walnut and poplar, farm economics and landscape quality and also this plantation was less prone to disturbances. Mutanal et al (2007) showed that mixed-species of fast-growing tree species and tamarind had higher yields and better growth performance in comparison with monocultures, as well as having the capability to prevent soil erosion and increase biodiversity. The evaluated risk factors included climate impacts, stability, human impacts, insects, diseases, wild game and fires. Mixed forests had the lowest scores in total among all the management strategies, and contrastingly, spruce monocultures had the highest. This implies that mixed-species plantations are certainly less susceptible to biotic and abiotic disturbances. The challenges facing planted forests will come from population growth and climate impacts, but also other issues such as Governance which can affect forest investment and management. The major factor affecting future expansion is the competition of land. Well managed planted forests usually have higher yields of wood than natural, unmanaged forests, with commercial plantations in the tropics having annual growth rates more than natural forests. This categorises the benefits/services of ecosystems as: Supporting Services such as primary production, soil formation, nutrient and water cycling which provide the basic infrastructure of life; Provisioning Services which are the goods such as food, fuel and fibre; Regulating Services such as climate and hazard regulation (prevention of erosion, carbon storage, water

regulation, avalanche protection, etc.) and Cultural Services such as recreational use, benefits to health and spiritual well-being. Relative to other land-uses, and particularly when compared to food production, the benefits from planted forests especially their protection functions are often uncosted and may be enjoyed by stakeholders other than those who own the land. It has become recognised that land-use policies focussed solely on agriculture or wood production, give lower overall benefits relative to policies which consider the full range of ecosystem services. This study we have shown that planted forests will continue to be a major source of timber and other forest products that on an area basis far outweigh production from natural forests. A recent paper noted that planted forests reduced harvesting from natural forests globally by 26% and had significant ecological benefits. We have also shown that in some regions, expansion rates of planted forests are decreasing and that climate impacts and population pressures on land availability will have an impact on planted forests in the future. The miscellaneous plantation is shown in figure 3.2.

Fig 3.2: Miscellaneous plantation in Onthupacha.

The details collected from the miscellaneous plantation is shown the presence of trees such as Thembavu, Aatha, Thanni, Cashew, Vattayila, Maruthi, Vallabham, Perumaram, Rambuttan, Vayana, Jackfruit, Mangium, Kanikonna, Nelli, Mysore thembavu. By analyzing it is clear that certain trees and plants of wide variety is growing in the field. The plantation is greenish wide variety and of useful plants. The mixed-species plantations are certainly less susceptible to biotic and abiotic disturbances.

Another plantation of Melia dubia is introduced in the plantation forest by the government of Kerala. By analyzing the Melia dubia plantation in Onthupacha we can see that enormous plants and trees are growing in that area. Ecosystem is greenish than earlier plantation. The *Acacia mangium* in that area is replaced by Melia dubia and it is widely increasing in the plantations. Other fruit bearing plants and certain plants & trees are naturally occurring in those plantations. Many species are growing in that area which provides more and more species to grow, thus the restoration of ecology and conservation of the environment. An area of 20m x 20m is considered and analyzing it we can clearly note that all the seedlings planted is growing and other species are also present here such as maruthi, vattayila, vayana, aatha etc. shown in figure 3.3.

Fig 3.3: Melia dubia plantation in Onthupacha.

Natural forest consists of wide variety of plants and animals. In Kerala the forest area is spread over the Western Ghats which is one of the world's hot spots of bio-diversity. It is rich in a wide variety of rare and endangered flora and fauna. From the natural forest in Aanapalayam reserve and the number of species present there are noted shown in table 3.3. An area of 20m x 20m is selected and the species there is identified. The forest area in madathara region is shown in figure 3.4 and 3.5.

Table 3.3: Details of trees in natural forest.

Sl No.	Name of trees present in natural forest	No.of trees
1	Kambakam, Malampunna	2
2	Cane stick,Pulivaka	1
3	Vetti	8
4	Thembavu, Pala	5
5	Kadamaram	4
6	Unnam, Edana, Aanjili, Thanni	2
7	Maruthi	13
8	Kanikonna, Kattu nelli, Mango tree	1
9	Eetti, Vayana, Charu, Mayila	2

Fig 3.4: Natural forest in Madathara region.

Fig 3.5: Natural forest in Madathara region.

4.CONCLUSIONS

To gain abundant knowledge and sustainable use of mixed-species, many researchers keep exploring the potential benefits for the future of forestry and agriculture. Forest plantations cannot completely replaced by natural forest. Cultivated forest ecosystems established through planting or seedling of native or introduced species under the process of afforestation or reforestation. Diverse types of plantations have different purposes and they are expanding steadily all around the world. It is interesting and important to establish and explore the type of diversified plantation system. Mixed-species planation consists of two, three or even four species of plants, but it is possible to have more diverse and complex mixtures. It could be more efficient in filtering of atmospheric pollutants and they are less susceptible to biotic and abiotic disturbance.

From the study we can conclude that mixed-species plantation is beneficial than monoculture plantation. As part of the study four areas were compared and results from the site is analyzed. It is clear that mixed-species is more beneficial to ecosystem services and ecological gains. They are creating a new ecosystem which is surrounded by pure atmosphere different species and plants are growing naturally in the region of mixed-species and thus it creates a natural environment. More birds and organisms are present in these areas gradually and we can create a forest. The benefit of planting fruit bearing indigenous plants and their contribution towards restoration of ecology and conservation of the environment. We can suggest a better option as compared to acacia monoculture plantations, considering its adverse impacts on environment as well as the fringe population. That is instead of acacia we can plant mixed-species which increases the benefit of ecosystem and conservation of the environment.

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