

University of Agricultural and Horticultural Sciences, Shivamogga

M. Sc. (Forestry) theses abstracts produced in the

Department of Silviculture & Agroforestry

1. Assessment of Growth Performance of Agarwood (*Aquilaria malaccensis* Lamk.) Under Different Farming Situations in Karnataka

KARANJIT N SINGH

ABSTRACT

Western Ghats parts of Karnataka are one of the series of mountains and valleys harbouring complex diversity of flora and fauna. Recently, Agarwood (*Aquilaria malaccensis*) is being planted as associated crop in coconut garden, areca garden, coffee plantations and also as monoculture. The spread of agarwood cultivation and the subsequent rise in yield in Karnataka will definitely make the natural products of agarwood easily available to common people. Present study on assessment of growth performance of Agarwood (*Aquilaria malaccensis* Lamk.) under different farming situations in Karnataka generated information on growth performance of the species in different farming situations under different spacing, different ages and at different locations. The results indicated that the spacing, location and different farming situation has a pronounced effect on growth (height, diameter at breast height, basal area, clear bole length, crown width and volume of individual trees) and yield properties (total volume per hectare and MAI) of agarwood. Effect of spacing, farming situations and location was not found to be significant on survival rate in most of the ages. Growth performance of agarwood was found to be superior in areca nut and associated crops in both four and five years after planting. Generally, in recent days, the five year old agarwood trees with 10 cm diameter are subjected to artificial inoculation to get agarwood. In the present study, it was observed that, at the age of five the diameter of trees was ranging from 6.34 cm to 11.27 cm under different farming situations.

Key words: *Aquilaria malaccensis*, growth performance, different farming situation, spacing, location.

June, 2014

(Ramakrishna Hegde)
Major Advisor

2. "Growth and Yield Estimation in *Grevillea robusta* A. Cunn. ex R. Br."

SANJITHA D. P.

ABSTRACT

Traditional shade coffee plantations of Kodagu district, in the Western Ghats of Southern India, harbor a high density and diversity of trees. Local farmers appreciate native biodiversity, but plantation economics and public policies drive them to gradually replace the original diversified cover with exotic shade trees such as *G. robusta*, which grows faster and can easily be traded as timber. Information on growth and yield of silver oak under different farming system with different crops is one of the important aspects of cultivation. Recently, several farmers are marketing their timbers to the traders on tree basis. Many a times, the stumpage prices were fixed arbitrarily resulting in considerable loss to the farmers.

Present study on assessment of growth and yield estimation in *Grevillea robusta* generated information on growth performance of the species in different farming situations under different spacing, different ages and at different locations. The results indicated that the spacing and farming situation has a pronounced effect on growth (height, diameter at breast height, basal area and volume of individual trees) and yield properties (total volume per hectare and MAI) of silver oak in different ages of stands. Effect of spacing and farming situations was not found to be significant on survival rate in most of the ages. Significant difference was evident for the all the growth and yield properties at different locations. In order to determine the stumpage value of standing trees, volume tables were prepared for different farming situation with specific age and spacing.

June, 2014

(Ramakrishna Hegde)
Major Advisor

3. Assessment of Variability for Seed and Oil Traits in *Kingiodendron pinnatum* (Roxb. ex DC) Harms

VINOHARA, V.

ABSTRACT

The present study on *Kingiodendron pinnatum*, an important endemic tree species occurring in Western Ghat region, attempts to assess the variability among the altitudes as well as between candidate trees within altitudes for various pod and seed parameters including seed oil content and biodiesel parameters. Nursery experiment was conducted to evaluate the altitudinal variation in seed germination at College of Forestry, Ponnampet. During the year 2012-13. With respect to pod dimensions, population of altitude-II was found to be superior and this altitude can be aimed in future for identifying CPT's with heavier and thicker pods. The seeds collected from altitude-I were longest, while altitude-II recorded wider and thicker seeds compared to other altitudes. The germination per cent of seeds from altitude-II was highest followed by altitude-III and the least was observed from altitude-I.

The maximum seed oil content was recorded from seeds collected from altitude-II and altitude-III while it was low in altitude-I. Based on the values recorded for seed morphology, weight and oil content within each altitude, it is apparent that CT1, CT2, CT7 and CT4 from altitude-II; CT4, CT5, CT6 and CT8 from altitude-I; CT5, CT3, CT7 and CT8 from altitude-III have topped in their performance. Therefore, these CTs may be focused for further identification and selection of plus trees which could be used in the future tree improvement programme. Biodiesel was produced through transesterification of oil using Methanol and NaOH and yields 75% conversion, fuel properties like viscosity (5.7 cSt at 40° C), density (890 kg/m³), copper strip corrosion test (class 1), flash point (178° C) and fire point (184° C) were found to be on par with ISO standards for fossil diesel.

June, 2014

(G.M. Devagiri)
Major Advisor

4. Impact of Moisture Status and Shade Tree Management on Performance of Coffee Based Agroforestry

CHONDAMMA M P

ABSTRACT

Coffee based agroforestry systems cover one third of the land area in Kodagu district and accounts to one third of the total Indian coffee production. Coffee is grown under the shade of diverse trees under multi-strata agroforestry systems and hence the shade trees play a major role in biodiversity conservation and ecosystem services. The present study on impact of moisture status and shade tree management on performance of coffee based agroforestry, has generated information on the performance of coffee grown under different management and moisture regimes. The study was carried out in coffee plantations of Kodagu district with three management practices *viz.*, conventional with native shade, organic with native shade and *Grevillea robusta* management practices. Impact of moisture status and shade tree management on different growth performance of coffee plants and Chlorophyll content of leaf was assessed. The results revealed that there was no significant influence of moisture stress and shade tree regimes on different parameters during the study period. But however it was observed that the per cent retention of berries were higher in moisture stress coffee plants than the control, hence the yield being higher in moisture stress coffee plants. The *Grevillea robusta* shade management had higher retention of berries; hence the yield was higher than conventional with native shade and organic with native shade. This could be mainly due to the higher rainfall during the study period, which favoured higher yields under moisture stress conditions.

Key words: Coffee based Agroforestry, Moisture stress, Shade tree, *Grevillea robusta*

June, 2015

(N. A. Prakash)
Major Advisor

5. Effect of Shade Trees on Bee Pollination Services in *Coffea Canephora* Pierre Ex A. Fr.

ABSTRACT

The region of Kodagu, Central Western Ghats, South India, is dominated by coffee plantation comprising diverse native shade trees. The current study investigates the impact of shade trees within the coffee plantation on bee abundance and pollination success in coffee. The study was carried in 25 coffee plantations by considering three different management regime viz., coffee under native shade with organic, native shade with conventional and *Grevillea robusta* (Silver Oak) shade with conventional management system. The results revealed that bee abundance in coffee did not differ significantly between management regimes, but irrespective of management regime bee abundance in coffee increased significantly with the density of bee pollinated co-flowering shade trees and also differed significantly between irrigated and rainfed coffee plantations.

Comparatively irrigated plantation had higher bee abundance. An interaction effect of bee abundance at coffee and flowering initiation (irrigated/rainfed) showed significant positive effect on pollen tube development in coffee. It was found that initial fruit set in coffee reduced significantly with the density of Silver Oak trees. The results suggest planting important bee foraging shade trees which helps in attracting bee into coffee plantations. Flowering initiation by irrigation is a good option to enhance bee abundance. However planting Silver Oak has several advantages to farmers and hence the study suggests the farmers to plant Silver Oak along the fence and retain the diverse native shade trees in the center of the plantation which helps in conserving bees and other insect diversity.

June, 2015

(C.G. Kushalappa)
Major Advisor

6. Selection of Candidate Plus Clumps of *Dendrocalamus brandisii* (Munro) Kurz. in Kodagu district

ABSTRACT

An investigation on *Dendrocalamus brandisii* was carried out to select Candidate Plus Clumps (CPC) and assess the variation in phenotypical and wood characters among three different rainfall zones in Kodagu. Growth parameters were divided into clump parameters and culm parameters, clump parameters such as clump height and clump girth demonstrated higher values in high rainfall zone followed by medium rainfall zone and least was found at low rainfall zone. Whereas, average number of culms found to be utmost at high rainfall zone. Culm length which was found to be maximum at high rainfall zone and minimum at low rainfall zone. Rest of culm parameters were recorded at three different portions viz., bottom, middle and top. Culm girth and internodal length all showed higher value at high rainfall zone for bottom portion of the culm.

Whereas, for middle and top portion of the culm the values varied in different rainfall zones. Wood parameters such as culm wall thickness, modulus of rupture (MOR), modulus of elasticity (MOE), wood moisture content (MC) and specific gravity (SG). Culm wall thickness followed a linear trend that is, culm wall thickness decreased with the increase in height. Both MOR and MOE exhibited higher values for bottom and middle portion at high rainfall zone. With respect to MC, at all three portions of culm highest values were found in high rainfall zone. Whereas, SG values were found to be highest in low rainfall zone and least at high rainfall zone. CPC were identified using index selection method developed, each trait of candidate clumps was assigned score based on its phenotypic performance based on this two plus clumps from each rainfall zones were selected.

June, 2016

(N.M. Poonacha)
Major Advisor

7. Studies on Seed and Vegetative Propagation Techniques in *Melia dubia* CAV.

VARSHA K JAYANANDAN

ABSTRACT

The gap between demand and supply of wood is a problematic situation prevailing in the global market which needs an urgent attention. Identification of tree species, indigenous to the country, which satisfies different market requirements and establishment of industrial plantations could be the best possible measures for resolving the problem. *Melia dubia* Cav. or Malabar neem wood is a fast growing tree species which has demand in the plywood and pulpwood industries. Poor seed germination is one of the hurdles for the production of quality planting stock for large scale planting. An effort was made to study the effect of storage and pre-sowing seed treatments on seed germination and to develop macropropagation techniques for the species using stem cuttings. Ripe fruits were collected from seedling seed orchard and were stored in plastic containers for seven storage periods after de-pulping and drying. The seeds were subjected to nine pre-sowing seed treatments at the end of each storage period. It was revealed that the seeds stored for one year gave better germination than other storage period. Among all the pre-sowing treatments, relatively higher germination was found for the seeds exposed to microwave radiation for 10 minutes over different storage periods except 12 month storage period. Soaking of seeds in cow dung slurry for 96 hours had higher germination (6.41%) among all the pre-sowing seed treatments after 12 months of storage. It is prudent to mention that all the pre-sowing seed treatments did not considerably improve the seed germination which could be linked to the presence of combined dormancy. Study on macropropagation through stem cuttings collected from healthy trees revealed that treating stem cuttings with 4000 ppm IBA resulted in better success (27.15 %) and more promising than propagation through seeds.

June, 2016

(Ramakrishna Hegde)
Major Advisor

8. Studies on Distribution, Natural Regeneration and Seed Propagation in *Chrysophyllum roxburghii* G. Don.

Poornesh, K.A

ABSTRACT

Chrysophyllum roxburghii belongs to family Sapotaceae, commonly called as 'Kappale' or 'Hannale' and 'Pallehpann' in Kodava language. It grows as a tree up to 30 m (100 ft.) tall, with a trunk diameter of up to 40 cm and its habitat is lowland forests from sea-level up to 700 m (2,300 ft.). This is a canopy tree in wet evergreen forests. The fruits of this species have been found to possess nutritionally rich components. The fruits are used to prepare salads, jams and jellies. The fruits can be eaten raw and are also used in medicine preparations.

The present investigation on distribution, natural regeneration and seed propagation in *Chrysophyllum roxburghii* was carried out in both natural forest and sacred groves of Kodagu. The results revealed that the distribution was restricted to evergreen and semi evergreen patches of the study locations in Kodagu. When the regeneration pattern is considered the more regenerates were observed in class I and Class II compared to class III and Class IV. Natural regeneration shows reverse J curve, this indicates the natural regeneration is good. Among multiple regenerates the seedlings attaining the pole stage is very minimum, it may be due to various biotic and abiotic pressures.

Viability of seeds was reduced with increased storage period, the germination per cent was seen to be dropping as the storage period increased. The results on pre sowing treatment revealed that seeds sown without any treatment and seeds treated with cold water is performing better than other pre sowing treatments. Acid treatment and hot water treatments showed very poor germination. Number of days taken for initial germination had direct effect on the seedling parameters like the number of leaves, collar diameter and height of seedlings and the recorded values were higher with the early germination.

June, 2016

(N. M. Poonacha)
Major Advisor

9. Variability Studies in *Dalbergia latifolia* Roxb.

NAVEEN R

ABSTRACT

Dalbergia latifolia Roxb. (commonly known Rose wood) is one of the most valuable timbers of the world with its rich purple brown to deep purple colour used for decoratives. Tree to tree variability is especially wide, with differences within species, often being strongly influenced by environmental and genetical factors. Because of its diverse utility, limited distribution and overexploitation, the population of rose wood is shrinking. Identification of variation existing in the natural population of *D. latifolia* could help in identifying the individuals with most desirable traits. The present investigation was carried out to study the variation in growth and wood traits in natural populations of *D. latifolia* and further to assess the growth performance of half sib progenies at nursery stage. Based on the natural population, various locations were identified in districts of Karnataka viz., Belagavi, Uttar Kannada, Shivamogga, Chikmagalur, Hassan, Kodagu, Mysuru and Chamrajnagar districts. The results revealed the existence of considerable variation between the trees in different regions and within the region in all growth traits (height, diameter at breast height, clear bole height, basal area, and volume) and wood parameter (basic density, moisture content, oven dry specific gravity, fresh specific gravity and wood colour).

Among the different wood traits, basic density of individual trees in the entire study site varied from 0.45 g/cc to 1.05 g/cc. Wood colour of different trees varied from very light colour (purple grey) to very dark colour (Deep purple brown). Seed parameters like weight of 100 seeds were found to be significant different from different location. Average seed weight of individual trees varied from 2.79 g to 7.41 g. Seed germination of different seedlots varied from 0 per cent to 22.22 per cent. Seedling traits such as height and collar diameter varied significantly. Average height of seedling of different seedlots varied from 1.17 cm to 12.07 cm and mean collar diameter of seedlings of different seedlots varied from 0.25mm to 2.13mm. The Seedling survival rate of different seedlots varied from 3.84 per cent to 100 per cent. Heritability values of different traits were low to moderate. Significant relationship between seed weight and height of seedling was observed (0.31). Seedling height and collar diameter of seedlings had significant positive correlation with seed germination ($r=0.78$) and seedling survival ($r=0.78$) at nursery.

June, 2016

(Ramakrishna Hegde)
Major Advisor

10. Studies on Population Structure and Nursery studies of *Diospyros ebenum* J. Koenig

BOPANNA C D

ABSTRACT

Diospyros ebenum is a slow-growing medium-sized tree grows up to 20-25 meters tall, which belongs to the family Ebenaceae commonly known as “Kari mara” which is native to India and Srilanka. It is known for its black coloured wood since ancient times. Timber of *D. ebenum* is said to produce the best commercial black ebony. It is resistant to insect attack and fungi and highly durable. Due to high exploitation of this species for its timber it is listed as a rare and endangered tree species. Lack of quantitative data on the baseline information on the population status of this tree species in natural forest is a barrier plan for the future conservation and management hence the present investigation carried on density, population structure and regeneration of *Diospyros ebenum* were carried out in the natural forest of Kodagu. The result revealed that the density and basal area was found to be higher in Makutta. The overall regeneration showed a reverse J shape curve but in regeneration of *D. ebenum* showed lack of regenerates in Class I and in higher classes which may be due to various biotic and abiotic pressures in the natural forest. The effect of fertilizer imposed on seedling growth of *D. ebenum* affected on seedling growth. Maximum seedling height was observed in both seedlings treated with NPK (1g/seedling) and VAM (0.9g/seedling) followed by the treatment Cow dung slurry. The maximum collar diameter was found in NPK (2g/seedling) and the maximum leaves showed in NPK (2g/seedling) which was on par with Cow dung slurry treatment. The Influence of fertilizer on Maximum dry shoot weight, dry root weight and maximum total dry weight was recorded in VAM (0.9g/seedling) and the minimum was recorded in control (T1). The Comparison of the effect of different treatment on seedling quality parameters revealed that sturdiness quotient is maximum in Treatment VAM (0.9g/seedling).

April, 2017

(N. A. Prakash)
Major Advisor

11. Studies on Seed Storage Technique and Germination in *Lophopetalum wightianum* Arn.

RASHMI DESAI

ABSTRACT

The most convenient methods of *ex-situ* conservation of plant germplasm is by storage of seeds under conditions which maintain its viability. In case of orthodox seeds, this can be achieved by storing it in the dry state under ambient temperature and low relative humidity but desiccation sensitive nature of recalcitrant species act as a hurdle for its storage. *Lophopetalum wightianum* is an important riparian tree with commercial prospects and very little information is available regarding the storability of seeds. To overcome this problem investigation on seed storage technique and germination of *L.wightianum* was conducted by collecting the seeds from a natural population of the species and storing the seeds in three different containers for four storage periods after imposing the seven different storage chemical treatments on seeds. The study reveals that among the different storage containers, the earthen pot was found to be the best storage container, as it could store the seeds and maintain the viability up to two months with maximum germination of 38.23 per cent. Different chemical treatments applied to the seeds helped to maintain the seed viability for a longer period (90 Days), in that seeds treated with Chlorpyrifos (0.89 %) exhibited maximum (30.31 %) germination but there was a gradual decrease in germination with an increase in storage period. Among all the combination of treatments, seeds stored in an earthen pot (M1) treated with Carbendazim (0.25 %) + Chlorpyrifos (0.89 %) (T5) stored for 60 days (S3) exhibited maximum (64.61 %) germination.

June, 2017

(Ashok B. Divatar)
Major Advisor

12. Studies on Population Status and Propagation of Bee Forage Trees of Coffee based Agroforests

BASAVARAJAPPA

ABSTRACT

Coffee based agroforest in Kodagu is one of the most diverse agroforestry system in terms of biodiversity and ecosystem services offered. Shade trees in coffee based agroforests provide additional forage and refuge to pollinators, which ensures the presence of bees in the landscape throughout the year. To assess the population status of bee forage tree species in coffee based agroforests, six locations were selected in Virajpet Taluk and 36 circular plots of 30 m radius were laid such that the sampling intensity in each plantation was 10 per cent. Besides, study on feasibility of vegetative propagation for two important bee forage tree species viz. *Cinnamomum malabattrum* and *Persea macrantha*, was also conducted after treating the semi-hard wood branch cuttings with IBA and NAA at different concentration (2000 ppm, 3000 ppm and 4000 ppm). In the study area a total of 100 tree species (194 trees ha⁻¹) were recorded and richness ranged from 37 to 50 among study locations. Out of total shade tree species recorded, 74 (177 trees ha⁻¹) were found to be bee forage (Range: 30 to 40). Most of the dominant tree species (based on IVI value) were found to be bee forage such as *Artocarpus heterophyllus*, *Dalbergia latifolia* and *Grevillea robusta* etc. The flowering calendar of bee forage species shows that the blooming of different floral species throughout the year and it was highest from January to April. Twenty seven RET tree species were recorded, of which 81 per cent were bee forage tree species listed in IUCN red data book with high conservation value. The average canopy cover within the coffee agroforests was 44 per cent (Range: 29.5 to 57 %). Spearman's correlation analysis showed that the species richness of shade and bee forage tree species was significantly and negatively correlated with crown percentage. Hence, there is a need to advise the farmers to ensure sustainable forage resources and increase the availability of suitable nest locations within coffee based agro-forests by maintaining diverse native bee-preferred trees without pruning. Vegetative propagation of the two important bee forage tree species was not successful. Therefore, there is a need to undertake detailed studies for multiplication of these trees to supply quality planting materials. The results indicate that coffee based agroforests still host large density and diversity of bee forage trees and there is a good opportunity to integrate apiculture in the production system contributing both for ecological and economic sustainability.

Key words: Coffee based agroforests, Bee forage trees, *C. malabattrum*, *P. macrantha*

June, 2017

(C. G. Kushalappa)
Major Advisor

13. Seed Germination and Seedling growth of *Calophyllum inophyllum* L. under elevated Carbon dioxide condition

SUPRIYA K SALIMATH

ABSTRACT

Global climate change induced by the anthropogenic activities is the major challenge faced by the world in this 21st century. The daily average concentration of CO₂ in the atmosphere rose above 400 parts per million for the first time on record in 2013, up from 280 ppm. The acclamatory responses of plants to the rapidly changing environment and understanding the potential impacts of multiple interacting factors have become a subject of debate over the past two decades. Hence, it is prudent to understand the response of tree species in the initial stages, as seed and seedlings, to the elevated carbon dioxide conditions. *Calophyllum inophyllum* one of the important biodiesel yielding tree species distributed widely in the coastal area, which are more vulnerable to climate change. Thus, seeds of these species were collected and germinated under the Carbon dioxide elevated condition and its germinating behavior and growth performance was analyzed. Elevated carbon dioxide condition was created by the decomposition of organic matter in a poly tunnel. The seeds were allowed to germinate under both open as well as elevated CO₂ conditions. The three month old seedlings were subjected to Nitrogen, Phosphorous and Potassium (NPK) treatment at two levels (0.5g and 1g per plant) to understand the growth of species under elevated CO₂ condition in nutrient non deficit condition. Results revealed that, the elevated Carbon dioxide negatively affected the germination of the species to the extent of 40.60 per cent. When supplemented with nutrients, the positive response growth of the seedlings were observed in terms of collar diameter, seedling height, biomass, volume index and their relative growth rates. Thus, the elevated CO₂ condition has the potential to increase the productivity of the seedlings under nutrient rich conditions.

July, 2017

(Ramakrishna Hegde)
Major Advisor

14. Spatial distribution of Soil Organic Carbon pool under Different Land use Systems in Kodagu and Chamarajanagar Districts

ANAND N

ABSTRACT

In the present study spatial distribution of soil organic carbon pool under different land use systems in Kodagu and Chamarajanagar districts was analysed. This study generated information on the effects of different land use systems on the magnitudes and directions of soil organic carbon and soil parameters within and among land use systems and soil depths. The current study utilizes the Land Degradation Surveillance Framework (LDSF) protocol, developed by ICARAF, Nairobi, Kenya, which is spatially balanced, hierarchical field sampling methodology. Based on the reconnaissance survey, topographical and satellite images of districts, different land use systems such as natural forest, teak plantation, coffee agroforest with native trees, coffee agroforest with silver oak, agriculture land and fallow land were selected. The results revealed that statistically significant difference in soil organic carbon (SOC) content, stock, physical and chemical properties among different land use systems and different soil depth at both Madikeri and B.R.Hills sites. The highest SOC content was recorded in natural forest (2.80 %) followed by coffee agroforest with native trees (2.11 %), coffee agroforest with silver oak (1.76 %) and lowest SOC content was recorded in agriculture land (0.86 %) and fallow land (0.73 %). Similarly, SOC stock was found to be highest in natural forest (77.70 t ha⁻¹) followed by coffee agroforest with native trees (61.02 t ha⁻¹), coffee agroforest with silver oak (53.32 t ha⁻¹), agriculture land (29.32 t ha⁻¹) and lowest in fallow land (25.40 t ha⁻¹). Similar trend was also observed at B.R. Hills site. The highest mean values of soil nutrients like N, P, K, Ca, Mg and S were observed under tree based land use systems as compared to the agriculture and fallow land which may be due to presence of higher amount of litter. Soil organic carbon showed positive and significant correlation with N, P, K and Ca.

Key words: Carbon sequestration, natural forest, teak plantation, coffee agroforest, agriculture land, fallow land, SOC, soil physico-chemical properties

August, 2017

(G. M. Devagiri)
Major Advisor

15. Assessment of Tree Diversity and Above Ground Carbon Stock in Natural Forest, Teak Plantation and Coffee Agroforests of Kodagu

NAGAMANI, N.

ABSTRACT

Tropical landscapes are biologically very rich harboring the diverse flora and faunal as well with high productivity. Understanding the patterns of diversity and biomass distribution in such landscapes is essential for conservation planning and sustainable utilization of the natural resource. Hence, it is prudent to understand the diversity of different land use systems which help in planning the strategy for sustainable management. In this study, diversity and species composition under three different land use systems *i.e.* natural forests, teak plantations and coffee agroforests were studied in Thithimathi, Southern part of Virajpettaluk, Kodagu. In each land use type, 20 quadrats of 20 x 20 m size were randomly laid which approximately accounts for 0.001 per cent sampling intensity. Tree species were identified and their height and girth were measured. Non-destructive sampling method was used for estimation of above ground tree biomass using allometric equation developed by Chave *et al.* (2005) for tropical forest region. The results revealed that, Coffee agroforests recorded higher number of species (29 species) and diversity ($H' = 2.58$) which resembled natural forests. Similarly, these landscapes also recorded highest tree density (415 trees ha^{-1}) with basal area of 39.06 $m^3 ha^{-1}$. The above ground biomass was highest in coffee agroforests followed by teak plantation and lowest in natural forest which might be attributed to different degree of disturbances. Based on these results it may be concluded that human managed landscapes such as coffee agroforests are equally important as that of natural forests for conserving biodiversity and ecosystem services, while providing economic opportunity and essential natural resources.

February, 2018

(M. N Ramesh)
Major Advisor