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Database of Miyawaki Forest Unit Established at KVK Palakkad: A Green Initiative for Climate Change Mitigation

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ABSTRACT

Miyawaki forest creation, a methodology developed by Japanese botanist Prof. Akira Miyawaki, involves planting trees per square meter which is a promising approach for maximization of green cover and to support biodiversity locally. The present investigation on Miyawaki Model forest unit created at KVK Palakkad was envisaged in preparing a database for 47 different species of saplings that were planted randomly which includes flowering, fruiting, ornamental and medicinal plants. Database prepared represents the native plant species, plant type, life form, tree layer and survival rate that can be used for recommending for a particular locality for further creations of Miyawaki forest. Based on this study, *Ficus racemosa* (T4), *Ficus religiosa* (T5), *Cassia fistula* (T10), *Annona squamosa* (T15) and *Terminalia elliptica* (T9) with excellent and good performance came out as candidates for Miyawaki forest. For forest restoration projects, these plants can be recommended as a suitable and proper species to plant in Palakkad district.

Key Words : Database, Miyawaki forest, forest restoration, green spaces, canopy layer.

INTRODUCTION

Forests form the basic resource for adaptation to climate change owing to their capacity for carbon sequestration, providing means of keeping the carbon trapped in long-term use as wood, harbouring genetic resources, and providing ecological services in terms of soil and water conservation. By promoting agroforestry and urban forestry, we can significantly increase the number of trees outside forests and, consequently, their contribution to climate change mitigation. For augmenting the greenery of the state, social forestry has been given a thrust by introducing innovative programmes in schools, colleges, coastal area, and roadside by labour unions etc. This will also help improving the profile and productivity of the forests.

Haritha Keralam Mission, Government of Kerala has launched a new project called 'Pachathuruthu'on June 5, World Environment Day 2019 which aims to grow “miniature forests”. It just takes a minimum of one cent of land and a love for greenery to set up a 'Pachathuruthu' (an islet of greenery). From five cent plots to huge acres of land belonging to the government, institutions, private parties and puramboke will be used for the project with the help of the Kerala State Biodiversity Board, Agriculture Department, MGNREGA workers, Forest Department and voluntary organisations. The Green Kerala Mission has formed a team in every district to implement the project.

One effective and reliable way to restore forests is to plant native trees in the area, following the principles of plant ecology developed by Professor Miyawaki (Padilla and Pugnaire, 2006). This approach was first used in Japan during the 1980s. This method comprises of layers of a forest like shrubs, trees and canopies which are laid on small plots of land, turning them into tiny forests (Khouzami, 2015). The Miyawaki model is successfully implemented in about 550 locations around the world, including Japan, Southeast Asia, Chile, Malaysia, Brazil and some parts of China where the method has helped to quickly restore damaged environments (Schirone *et al*, 2011).

The effective adaptation strategies as well as proactive steps to protect our communities and

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ecosystems can be developed by understanding the interconnectedness of climate change, vulnerability, and risk since climate change is a significant driver for environmental destruction (Das, 2023). Knowledge of the composition of species and the diversity of tree species is significant not only for understanding the structure of Miyawaki forest community but also for planning and implementing community conservation approaches. This has prompted to come-up with a database with authentic list of tree species describing tree species diversity of Miyawaki forest demo unit established at KVK Palakkad so as to support conservation and development initiatives in this district. Hence the present investigation was undertaken with the objective of preparing a database in Miyawaki model forest unit created at KVK Palakkad and hopes to develop such green spaces in Palakkad district.

MATERIALS AND METHODS

The experimental material was young Miyawaki model forest unit created at KVK Palakkad aged 1.8 years which was planted as per Miyawaki method (Miyawaki *et al*, 1998). The experiment plot area is 871.2 Sq.ft. In the Miyawaki forest unit, 47 different species of tree saplings were planted randomly which includes flowering, fruiting, ornamental and medicinal trees. No two trees of the same kind are placed next to each other. Totally 188 saplings were planted very closely at a distance of 1 x 1 m^2.

As part of the study, a database was created with an updated checklist of all plant species native to the Palakkad district identified for establishment of Miyawaki forest demo unit at KVK Palakkad. The data base prepared on plant species gives an overview of the composition, plant group, plant life form, tree type, layer and survival percentage.

RESULTS AND DISCUSSION

Database is the cornerstone for ensuring sustainable and efficient forest sector planning and management. This authentic database is a systematic documentation on tree diversity, habit (deciduous/evergreen) and abundance of plant species across life-forms in Miyawaki forest demo unit established at KVK Palakkad. In this database, baseline information on tree and shrub diversity have been prepared and this document can be useful for diverse stakeholders as 'Miyawaki forest' envisages to grow “miniature forests” in every vacant space available in every local body in a systematic and useful manner.

The data base prepared on plant species gives an overview of the composition, plant group, plant life form, tree type, layer, advantage and survival percentage. The parameters studies were tabulated in Table 1.

Tree species composition

Forty seven plant species belonging to 26 different family and 39 genus are exhibited in the species composition, which compete to each other, prevent extinction and increase their diversity. Similar results were reported by Shankar (2001). Fabaceae (6 species), Moraceae (5) and Rutaceae (5) were the families recording highest species number.

Plant group

All plant species present in the Miyawaki forest was Angiosperms. The angiosperm diversity in Miyawaki forest was divided into dicotyledons and monocotyledons. Among the total of 47 species, 25 families, 38 genera, 45 species are dicotyledons and the remaining 1 family, 1 genera and 2 species are monocotyledons.

The most abundant plant species in the Miyawaki forest were *Mangifera indica, Ficus benghalensis, Syzygium samarangense, Saraca indica, Annona squamosa, Bambusa vulgaris, Pongamia pinnata,Polyalthia longifolia, Allamanda cathartica* and *Hydnocarpus pentandrus*. The variability in the floristic composition of the different forests could be attributed to the nature of the geological substrates and climatic variability. The limitations in use of species which are native include uncertainty with respect to growth rates, lack of genetic improvement as well as adaptability to various soil conditions and variability in performance.

Plant life form

Forest comprises of a community of plants having trees, shrubs, herbs and climbers. With regard to representation of various life forms, 36 species form framework tree species. 7 species are shrubs, 2 taxa are climbers and 2 taxa are herbs. Life form analysis shows that 76.59% are trees, 14.89% are shrubs, 4.25% are herbs and 4.25% are climbers. Hence this model forest is achieving a multi layered structure because vegetation is luxuriant with plant life forms of all kinds. Among the climbers, golden trumphet and garlic vine are fast-growing which survived and flourished during the past 20 months after planting.

Economic importance of Plant species

The use value of plant species of study area was also incorporated and they are identified in the demo unit with medicinal, industrial and economical values. Out of 47 plant species, 26 are medicinally important and can serve as the feedstock for many drugs. Four species are timber yielding plants. In addition to above economics there are plant species that give pleasure by providing us flowers and fruits. Thirteen species are fruit yielding and four species are flowering respectively. Mathur (2017) reported that in JIET college, Jodhpur, Rajasthan, above 150 plant species were found having environmental, medicinal, economical, ethical and industrial values.

Tree type

Out of 47 plant species in Miyawaki forest 25 species are evergreen (53.13%), 14 species are deciduous (29.78%) and 8 species are perennial (17%). Evergreen trees are dominant in Miyawaki forest. According to ecologists, long-lived evergreen leaves potentially have longer photosynthetic period than deciduous leaves. This state reduces quantity of nutrients to be absorbed from soil every year. Several reports are there regarding association of leaf habit with seasonal drought, tolerance as well as avoidance (Givnish, 2002; Markesteijn and Poorter, 2009; Ackerly, 2004). Tolerance to drought can be linked with evergreen types because leaves are retained through out dry season. This activity helps them to be active at transition phase between dry and wet period, otherwise proceed at lower activity in dry period.

Trees by layer

Forest stratification refers to different layers of plants in forest. Distinct vegetation layers starting from forest floor to tree canopy can be observed in mature forest. Clear separations of layers cannot be found in young forests. Formation of layering can be found visible only when the forests become aged and tall canopy created by growth of trees.

Trees in Miyawaki forest were grouped into 4 layers namely shrub layer, sub-tree layer, tree layer as well as canopy layer. Canopy layer represents top layer in Miyawaki forest model and this layer contains trees above 40 feet in height. The layer is composed of 25 species out of 47 species. Tree layer is within the height range of 20-40 feet and it includes 8 species. Sub tree layer contains trees about 6-12 feet in height which is having lowest number of species and is composed of 5 species. Shrub layer contains trees about 6 feet in height. This layer is composed of 9 species. Canopy layer has highest number of plants whereas minimum number of plants were noted in sub tree layer with 53.191% and 10.63% respectively (Figure 1).

The structure of forest canopy differs among forests due to factors like tree arrangement, availability of nutrients and difference in biological species. So plants must be selected from potential native vegetation of respective region so that restoration of multi layer natural or quasi-natural forests can be done.

The distribution of plant life forms is regulated by micro environmental features such as soil moisture, light and nutrients in their habitat. As trees grow into tall canopy, they block sunlight almost completely, preventing weeds and shorter plants from growing. Baruah and Ramakrishnan (1989) considered shade stress as fatal factor for determining whether plants can establish themselves in a given habitat of forest. Plants with perennial leaves dominate in habitat with high shade intensity and in this study, perennials occupy 17% of the plant type population survived.

Percent Survival rate

Table 1. Database description of plant species present in Miyawaki forest unit at KVK Palakkad

Treatment No.	Botanical Name	Vernacular Name in malayalam	Common English Name	Family	Type	Advantage	Layer	Survival rate
T1	*Mangifera indica* L.	Maavu	Mango tree	Anacardiaceae	Evergreen tree	Fruiting	Canopy	100
T2	*Phyllanthus emblica* L.	Nelli	Indian Gooseberry	Phyllanthaceae	Deciduous tree	Fruiting	Canopy	50
T3	*Artocarpus heterophyllus* Lam.	Plavu	Jack	Moraceae	Evergreen tree	Fruiting	Canopy	75
T4	*Ficus racemosa* L.	Atthi	Cluster Fig	Moraceae	Deciduous tree	Medicinal	Sub Tree	50
T5	*Ficus religiosa* L.	Arayal	Peepal tree	Moraceae	Semi-evergreen tree	Medicinal	Canopy	75
T6	*Ficus benghalensis* L.	Peral	Banyan Tree	Moraceae	Evergreen tree	Medicinal	Canopy	100
T7	*Wrightia tinctoria* R.Br.	Dhanthappala	Pala Indigo	Apocynaceae	Deciduous tree	Medicinal	Canopy	50
T8	*Tamarindus indica* L.	Puli	Tamarind tree	Fabaceae	Evergreen tree	Fruiting	Canopy	50
T9	*Terminalia elliptica* Willd.	Matti/ Karimaruthu	Indian laurel	Combretaceae	Deciduous tree	Timber	Canopy	50
T10	*Cassia fistula* L.	Kanikkonna	Indian Laburnum	Fabaceae	Deciduous tree	Flowering	Tree	50
T11	*Syzygium samarangense* (Blume) Merr. and L.M.Perry	Panineer Chamba	Java apple	Myrtaceae	Evergreen tree	Fruiting	Sub Tree	100
T12	*Madhuca longifolia* (J. Koenig ex L.) J.F. Macbr.	Ilippa	Indian Butter Tree	Sapotaceae	Deciduous tree	Medicinal	Canopy	75
T13	*Syzygium cumini* (L.) Skeels	Njaval	Indian Blackberry	Myrtaceae	Evergreen tree	Fruiting	Canopy	75
T14	*Saraca indica* L.	Ashokam	Ashok tree	Fabaceae	Evergreen tree	Medicinal	Canopy	100
T15	*Annona squamosa* L.	Seethapazhm	Custard apple	Annonaceae	Semi-evergreen tree	Fruiting	Sub Tree	100
T16	*Mimusops elengi* L.	Elenji	Asian bullet wood	Sapotaceae	Evergreen tree	Medicinal	Canopy	75
T17	*Azadirachta indica* A.Juss.	Aryaveppu	Neem tree	Meliaceae	Deciduous tree	Medicinal	Canopy	50
T18	*Strychnos nux-vomica* L.	Kanjiram	Strychnine Tree	Loganiaceae	Deciduous tree	Medicinal	Canopy	50
T19	*Citrus medica* L.	Ganapathi narakam	Citron	Rutaceae	Perennial	Fruiting	Shrub	50
T20	*Bambusa vulgaris* Schrad.	Mula	Common bamboo	Poaceae	Evergreen herb	Timber	Canopy	100
T21	*Zanthoxylum brachyacanthum* F. Muell.	Kazhani	Thorny yellow wood	Rutaceae	Thorny evergreen tree	Timber	Canopy	50
T22	*Pongamia pinnata* (L.) Pierre	Ungu	Indian beech tree	Fabaceae	Evergreen tree	Medicinal	Tree	100
T23	*Polyalthia longifolia* (Sonn.) Thwaites	Aranamaram	Mast Tree	Annonaceae	Deciduous tree	Medicinal	Tree	100
T24	*Simarouba amara* Aubl.	Lekshmi tharu	Paradise tree	Simaroubaceae	Evergreen tree	Medicinal	Canopy	50
T25	*Citrus limon* (L.) Osbeck	Cheru narakam	Lemon	Rutaceae	Perennial	Fruit	Shrub	75
T26	*Pimenta dioica* (L.) Merr.	Sarvasugandi	Allspice	Myrtaceae	Evergreen tree	Medicinal	Tree	50
T27	*Garcinia gummi-gutta* (L.) Roxb.	Kudam puli	Malabar tamarind	Clusiaceae	Evergreen tree	Fruiting	Tree	50
T28	*Bambusa tuldoides* Munro	Budha mula	Buddha belly bamboo	Poaceae	Evergreen tree	Medicinal	Sub Tree	50
T29	*Murraya paniculata* (L.)	Mara mulla	Orange jasmine	Rutaceae	Evergreen tree	Flowering	Shrub	50
T30	*Citrus maxima* (Burm.) Merr.	Babloos naranga	Pummelo	Rutaceae	Perennial	Fruiting	Shrub	50
T31	*Justicia adhatoda* L.	Adalodakam	Malabar nut	Acanthaceae	Perennial	Medicinal	Shrub	50
T32	*Myristica fragrans* Houtt.	Jathi	Nutmeg	Myristicaceae	Evergreen tree	Fruiting	Tree	50
T33	*Allamanda cathartica* L.	Kolambi	Golden trumpet	Apocynaceae	Perennial	Flowering	Shrub	100
T34	*Spondias pinnata* (L. f.) Kurz	Ambazham	Hog plum	Anacardiaceae	Deciduous tree	Fruiting	Canopy	50
T35	*Hydnocarpus pentandrus* (Buch. -Ham.) Oken	Maroti	Jangli almond	Achariaceae	Evergreen tree	Medicinal	Tree	100
T36	*Vitex negundo* L.	Karinochi	Chaste tree	Verbanaceae	Perennial	Medicinal	Sub Tree	50
T37	*Gardenia jasminoides* J. Ellis	Gandaraja	Cape jasmine	Rubiaceae	Perennial	Flowering	shrub	50
T38	*Cinnamomum verum* J. Presl	Karuvapatta	Cinnamon	Lauraceae	Evergreen tree	Medicinal	Canopy	50
T39	*Mansoa alliacea* (Lam.) A.H. Gentry	Veluthulli chedi	Garlic vine	Bignoniaceae	Evergreen vine	Medicinal	Shrub	50
T40	*Couroupita guianensis* Aubl.	Nagalingam/ Nagapoomaram	Cannon ball tree	Lecythidaceae	Deciduous tree	Medicinal	Canopy	75
T41	*Dalbergia latifolia* Roxb.	Veeti	Black rosewood tree	Fabaceae	Deciduous tree	Timber	Canopy	50
T42	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	Neermaruth	Arjun tree	Combretaceae	Evergreen tree	Medicinal	Canopy	50
T43	*Helicteres isora* L.	Edampiri - Valampiri	East-Indian screw tree	Sterculiaceae	Perennial	Medicinal	Shrub	50
T44	*Carallia brachiata* (Lour.) Merr.	Vallabham	Corkwood	Rhizophoraceae	Evergreen tree	Medicinal	Canopy	50
T45	*Magnolia champaca* (L.) Baill. ex Pierre	Chembakam	Champaca	Magnoliaceae	Evergreen tree	Medicinal	Canopy	50
T46	*Ficus tsjahela* Burm. f.	Kaaral	Karal Fig	Moraceae	Deciduous tree	Medicinal	Canopy	50
T47	*Pterocarpus santalinus* L.f.	Raktachandanam	Red sandalwood	Fabaceae	Deciduous tree	Medicinal	Tree	50

Table 2. Survival rate of plants in Miyawaki forest after 6 months and 20 months

Treatment No.	No. of plants survived after 6 months	Survival rate (%) after 6 months	No. of plants survived after 20 months	Survival rate (%) after 20 months
T1	4	100	4	100
T2	3	75	2	50
T3	3	75	3	75
T4	2	50	2	50
T5	4	100	3	75
T6	4	100	4	100
T7	2	50	2	50
T8	2	50	2	50
T9	2	50	2	50
T10	3	75	2	50
T11	4	100	4	100
T12	3	75	3	75
T13	3	75	3	75
T14	4	100	4	100
T15	4	100	4	100
T16	3	75	3	75
T17	4	100	2	50
T18	3	75	2	50
T19	4	100	2	50
T20	4	100	4	100
T21	2	50	2	50
T22	4	100	4	100
T23	4	100	4	100
T24	4	100	2	50
T25	4	100	3	75
T26	4	100	2	50
T27	4	100	2	50
T28	2	50	2	50
T29	4	100	2	50
T30	3	75	2	50
T31	4	100	2	50
T32	3	75	2	50
T33	4	100	4	100
T34	3	75	2	50
T35	4	100	4	100
T36	4	100	2	50
T37	3	75	2	50
T38	3	75	2	50
T39	2	50	2	50
T40	3	75	3	75
T41	2	50	2	50
T42	2	50	2	50
T43	2	50	2	50
T44	3	75	2	50
T45	2	50	2	50
T46	2	50	2	50
T47	2	50	2	50

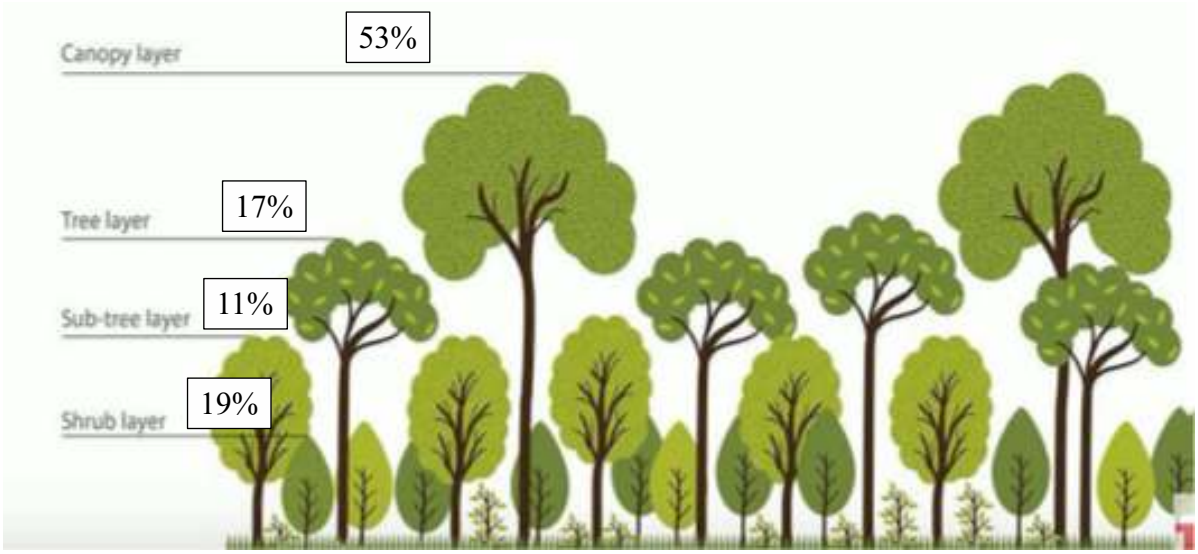

Fig.1. Tree layer stratification in Miyawaki forest unit

Ensuring the survival of the plant is critical for Miyawaki forests and steps to be taken to increase the survival rate are selecting the right species and sapling size in right site with availability of sustainable water source. Miyawaki method has reflected in better survival of plants as compared to the traditional method, improved density and growth without maintenance. Bhuyan et al. (2021) reported that diverse plankton and favorable hydrological conditions in a Himalayan region indicate a healthy water body, supporting snow trout and nutritional security for local communities.

The percent survival rate of 47 plant species in Miyawaki forest (Table 2) after 6 months of plantation observed that 20 species have showed 100% survival rate. These species include *Mangifera indica, Ficus religiosa, Ficus benghalensis, Syzygium samarangense*, *Saraca indica*, *Annona squamosa*, *Azadirachta indica, Citrus medica, Bambusa vulgaris, Pongamia pinnata*, *Polyalthia longifolia*, *Simarouba amara, Citrus limon, Pimenta dioica, Garcinia gummi-gutta*, *Murraya paniculata*, *Justicia adhatoda, Allamanda cathartica, Hydnocarpus pentandrus* and *Vitex negundo*. About 14 species showed 75% survival rate and 13 species have lower survival rate (50%).

The percent survival rate after 20 months of plantation noticed that 10 species of plants have 100% survival rate. It includes *Mangifera indica, Ficus benghalensis, Syzygium samarangense, Saraca indica, Annona squamosa, Bambusa vulgaris, Pongamia pinnata, Polyalthia longifolia, Allamanda cathartica* and *Hydnocarpus pentandrus*. Seven species have survival rate of 75% and the remaining 30 species of plants have showed only 50% survival rate.

According to Dhanorkar *et al* (2023), survival percentage of 1,060 plants belonging to 58 different species planted in two plots at afforestation site exhibits 100 percent survival and follows natural pattern in growth performance. Pareliussen et al (2006) investigated survival rate of seedlings of five native tree and shrub species which was planted in grass land at various distance from forest within the RS Ambohitantely. The results showed that species survival ranged from 40 % to 51 % during time span of fifteen months after planting.

CONCLUSION

Miyawaki model forest unit created at KVK Palakkad represents habitat or biome with high tree density. Most of native tree species planted in study area were in good health and growing fast. Twenty months after planting, reduced diversity of flora species initially was observed because canopy of planted trees get closed, resulting in shading and this decreased its opportunity for development of some herbs and trees among flora.

Selection of inappropriate trees at wrong places may trigger situations such as erosion, landslide, monoculture and in long run may neither provide biodiversity as well as ecological nor economic outputs to society. So dynamic strategy which has to be updated at regular time intervals based on research works and ground level validations is necessary. Hence the preparation of database representing the native plant species, plant type, life form, tree layer and survival rate can be used for recommending for a particular locality for further creations of Miyawaki forest.

Based on this study, *Ficus racemosa* (T4), *Ficus religiosa* (T5), *Cassia fistula* (T10), *Annona squamosa* (T15) and *Terminalia elliptica* (T9) with excellent and good performance came out as candidates for Miyawaki forest. They can be recommended as suitable, proper species to plant for forest restoration projects throughout Palakkad district.

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