



Green Tamil Nadu Mission

Mission Document

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INTRODUCTION

- (i). India is one of the 17 mega-diverse countries in the world, which collectively account for 60-70% of the earth's biodiversity. India, a country with a high species variety, endemism, and agrobiodiversity, supports an incredible 8.1% of the world's biodiversity despite having just 2.4% of the world's landmass. Additionally, 16% of the world's population of humans and 18% of the world's population of cattle live in India. According to estimates, 70% of India's population relies on local natural ecosystems for subsistence resources like food, water, fuel, housing, and health security.
- (ii). Tamil Nadu has a geographical area of 130,060 sq kms which constitutes about 4% of the total Country's area, despite this the State is endowed with species richness in terrestrial and coastal ecosystems. Out of 17,672 angiosperm diversity in the Country, the State of Tamil Nadu ranks first in the angiosperm diversity with about 5640 species i.e. nearly one third of the total flora of India. The State has a legacy of having about 533 endemic species, 230 red listed species, 1559 medicinal plants and the 260 species of wild relatives of cultivated plants. The Tamil Nadu also shares the Western Ghats (one of the 25 biodiversity hotspots) with the States of Kerala, Karnataka, Goa, Maharashtra and Gujarat.

Geographical Area	130060 sq.km
Geographical coordinates	Latitude 8°05' to N 13° 35'N Longitude 76° 15' to E 80° 20'E
Population (as per census 2011)	72.15 million urban - 34.92 million (48.40 %) Rural 37.23 million (51.06%) Tribal 0.79 million (1.10%)
Average population density	555 per sq.km
Livestock population (as per 19th livestock census)	22.72 million
No. of districts	38

(iii). The State of Tamil Nadu in the past have taken efforts in increasing the forest density in the recorded forest area as well as the tree cover outside the recorded forest areas, which has resulted in the present forest cover of 26,419 sq.kms and 4424 sq.kms of tree cover. Due to the efforts taken in the past on forest and tree conservation, the State of Tamil Nadu could bring 23.70% of its geographical area under forest and tree cover. Further the forest cover of the State as per the ISFR 2021 has sequestered 214.6 million tonnes of carbon which is 2.98% of the total carbon stock of 7203 million tones stored in India forest cover.

(iv). It is well established that local and global issues linked with food and livelihoods, climate, good quality water and air are intensified by the loss and degradation of the world's forests. Degraded landscapes are more susceptible to calamities and harsh weather, such as landslides, floods, and heavy rain. By upgrading landscapes in ways that provide long-term benefits on a sustainable basis, forest land restoration has the ability to effectively address these problems. These benefits include better local climate

regulations, improved flood and erosion control, species richness and economic opportunities for local people. Moreover, the restoration process results in higher living standards and greater resilience in those who depend on forests. Thus, forest land restoration improves the protection of forests, soils, water sources, air quality, regional climate, and biodiversity.

(v). The decade of 2020-2030 has been designated by the United Nations as the decade of Ecosystem Restoration. Many people and experts term this decade in the light of climate change as the ‘make or break’ decade for the long-term survival of life on earth. Fittingly the theme for the World Environment Day (5 June 2021) of the first year of this decade was set as “Reimagine, Recreate, Restore”.

(vi). Sustainability in forestry has been talked about at length at several National & Global forums. It is high time that under the Green Tamil Nadu Mission, the concept of economic, social, and ecological aspects of development are practiced in principle for augmenting the socio-economic & ecological benefits within and outside the forest landscape. It has been recognized that ecologically sustainable forestry addresses environmental issues brought on by deforestation. In particular, environmentally sustainable forest management enhances air quality by producing oxygen and trapping air pollutants with the help of trees; reduces biodiversity loss by sustaining a variety of flora and fauna; mitigates climate change caused by the accumulation of carbon in forest soil and trees (about 50% of tree biomass is carbon); and prevents soil erosion by stabilising the soil with a forest floor and strong tree root systems, which slow down water flow thereby reducing flooding.

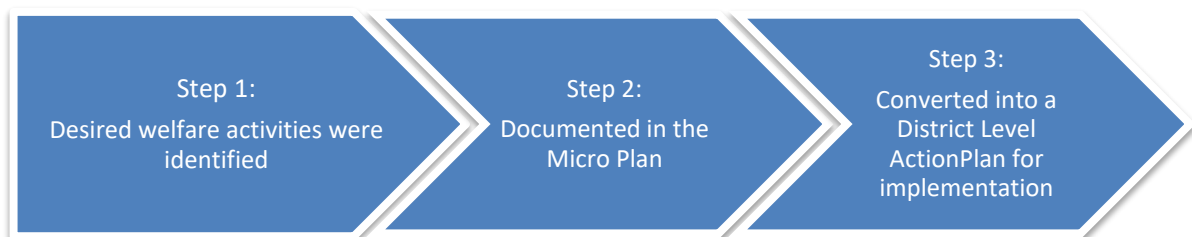
(vii). As the Forest Land Restoration based on the principle of

sustainability provides opportunities to enhance or develop new institutional frameworks for stakeholder participation, the Green Tamil Nadu Mission shall aim to boost stakeholder consultations, participation and ownership and ensuring greater transparency and accountability to decision making processes on contentious issues such as degraded landscape restoration, effective land-use management for reduction in carbon emissions and improving livelihoods. Forest land restoration by disadvantaged groups, whose voices and opinions are often ignored, i.e. poor and landless people, women, youth, and indigenous communities shall be a priority area for intervention under the Mission. Due to participatory processes, capacity building, and enhanced economic and social returns from sustainable land management methods both inside and outside of forest areas, these groups shall be empowered and given more recognition.

(viii). The State of Tamil Nadu implemented the JICA funded Tamil Nadu Afforestation Project (TAP) on participatory mode Joint Forest Management (JFM) from 1997-98 to 2012-13 under two phases of the Project over degraded forests over an area of 6.6 lakhs hectares and ecological restoration was undertaken with the participation of about 2317 Village Forest Councils. More than 1,75,000 forest dependents and poorer sections were benefited by alternate employment generation. About 3900 Self Help Groups were formed in all programme villages. The project has also provided micro-finance of about Rs.53.00 crore to help the forest dependents and the poorer sections. Further the community assets like overhead tanks, bore wells and hand pumps, community halls, threshing floors, ration shops, libraries, anganwadis, etc. were constructed to improve the quality of life in all programme villages for invoking the public participation in the ecological restoration programme on a

massive scale.

(ix). The water harvesting structures constructed under TAP phase I to Phase II had a storage capacity of 1823.43 million cubic feet. These measures vastly contributed to the recharge of natural springs and aquifers and have also resulted in significant increase in water table level and helped to improve agricultural productivity. One of the major tangible and immediate benefits was employment generation in JFM villages. The Project activities provided vast scope for generating rural employment. JICA funded TAP was first to introduce SHG concept in Afforestation programme. This helped the poor women in the programme villages to become self-reliant and empowered. The services of NGOs/ Voluntary organizations were utilized in mobilizaion, awareness creation and institutional building. The project pioneered the concept of convergence to dovetail development works of line Departments in the programme villages by



Therefore, the State of Tamil Nadu gained varied experience in degraded forest restoration under the TAP wherein the ecological restoration was undertaken by carrying out mostly the artificial regeneration inside the degraded forest landscape by involving the local communities.

(x). Tamil Nadu Forest Department has also wide and rich

experience in the implementation of people-oriented scheme “Tree Cultivation in Private Lands (TCPL)” under the Tamil Nadu Biodiversity Conservation and Greening Project since 2012-13. This programme focused on fallow lands and marginal farmers. Under the said component, planting of about 8.2 crore trees of economic value covering a notional area of 1,51,600 hectares in 7,315 villages was undertaken. Farmers welcomed the programme as it provided remunerative land use for their fallow lands. The services of more than 100 non-governmental organizations (NGOs) were utilized in the implementation of the programme. Various economically important trees like *Melia dubia* (Malai Vembu), *Ailanthus excelsa* (Peenari), *Tectona grandis* (Teak), *Gmelina arborea* (Kumil) amongst others were planted on the farm lands of about 91,000 farmers. The farmers were encouraged to plant trees on their lands and they were rewarded by way of distribution of incentives by the department in the beginning of 3rd year of planting. An amount of about Rs.13.44 crore was distributed to the farmers as an incentive after evaluating the survival of the seedlings in the 3rd year of planting. The farmers were also provided technical know-how by way of giving them onsite training. The tree-based assets created under TCPL were expected to improve the income of farmers considerably, besides improving the carbon sink as a climate mitigation strategy in the State.

(xi). The rich experience gained in implementation of Tree Cultivation on Private Lands under the JICA funded Tamil Nadu Biodiversity Greening Programme shall be replicated in a more organized way and growing trees outside Forests (ToF) shall be an integral and vital component of the Green Tamil Nadu Mission as trees have proved to play an important role in climate change adaptation through diversified land-use practices

improving the sources of income and for providing the buffering against weather related production losses, resilience building against climate impacts in farming systems etc.

(xii). Due to enhanced focus on the biodiversity conservation and management outside the forest area, the Agro-Forestry is expected to play a significant role under the Mission in order to meet out the pulp wood, plywood, matchwood, dendro-biomass, requirements for the rural & urban population, reducing the anthropogenic pressure on the natural forests leading to reversal of deforestation and forest land degradation. The farmlands and fallow lands shall be brought under the tree cover for not only achieving the 33% target but also for augmenting the farmer's income (agri-silviculture) by promoting economically viable trees on farmlands. In addition, the trees outside forest shall create additional carbon in its tree cover and augment the ever-increasing demand of the wood in the State.

OBJECTIVES

(i). The objective of paramount importance of the Mission shall be to plant native and climate resilient high-quality seedlings specific to the agro- climatic zones for ensuring maximum survival. The planting of State Tree i.e. *Borassus flabellifer* (Palmyra tree) shall be given the push under the Green Tamil Nadu Mission to restore and increase its number keeping in view of its ecological, cultural and economic significance. Recently, the Hon'ble Chief Minister of Tamil Nadu launched a "Palmyra Development Mission". Therefore, the Green Tamil Nadu Mission shall take up planting of *Borassus flabellifer* (Palmyra tree) in substantially large number on the river banks and the coastal areas including the rural areas for increasing the number of Palmyra trees for enhancement of rural economy. The list of the native, heritage and endemic tree species of the State is given below:

Native Trees of Tamil Nadu

<i>Abutilon indicum</i>	<i>Cleome gynandra</i>	<i>Hardwickia binata</i>	<i>Phoenix sylvestris</i>
<i>Acalypha indica</i>	<i>Clerodendrum infortunatum</i>	<i>Holoptelea integrifolia</i>	<i>Phyllanthus maderaspatensis</i>
<i>Acanthus iliciifolius</i>	<i>Coccinia grandis</i>	<i>Hopea parviflora</i>	<i>Pogostemon travancoricus</i>
<i>Adina cordifolia</i>	<i>Cordia dentata</i>	<i>Hydreocarpus macrocarpus</i>	<i>Pongamia pinnata</i>
<i>Aegle marmelos</i>	<i>Cordia sinensis</i>	<i>Hygrophila auriculata</i>	<i>Psidium guajava</i>
<i>Agasthiyamalai pauciflora</i>	<i>Dalbergia sissooides</i>	<i>Impatiens acaulis</i>	<i>Pterocarpus marsupium</i>
<i>Albizia amara</i>	<i>Delonix regia</i>	<i>Impatiens auriculata</i>	<i>Pterocarpus santalinus</i>
<i>Albizia lebbek</i>	<i>Derris trifoliata</i>	<i>Impatiens grandis</i>	<i>Rauvolfia serpentina</i>
<i>Albizia odoratissima</i>	<i>Dillenia indica</i>	<i>Impatiens tamilnadense</i>	<i>Rauvolfia tetraphylla</i>
<i>Alstonia scholaris</i>	<i>Diospyros montana</i>	<i>Indigofera tinctoria</i>	<i>Rubia cordifolia</i>
<i>Amaranthus spinosus</i>	<i>Diospyros neilgerrensis</i>	<i>Ixora nigricans</i>	<i>Santalum album</i>
<i>Amorphphallus paeoniifolius</i>	<i>Diospyros nilagirica</i>	<i>Jatropha curcas</i>	<i>Sapindus emerginatus</i>
<i>Anacardium occidentale</i>	<i>Diospyros paniculata</i>	<i>Jatropha glandulifera</i>	<i>Senna occidentalis</i>
<i>Andrographis paniculata</i>	<i>Elaeocarpus munroii</i>	<i>Justicia adhatoda</i>	<i>Sesbenia grandiflora</i>
<i>Annona squamosa</i>	<i>Elettaria cardamomum</i>	<i>Justicia santanapau</i>	<i>Spathodea campanulata</i>
<i>Aristolochia indica</i>	<i>Erythrina stricta</i>	<i>Lagerstroemia indica</i>	<i>Spondias pinnata</i>
<i>Artocarpus heterophyllus</i>	<i>Erythroxyllum monogynum</i>	<i>Lagerstroemia parviflora</i>	<i>Sterculia foetida</i>
<i>Asparagus gonocladus</i>	<i>Eugenia calcadensis</i>	<i>Lapidagathis barberi</i>	<i>Sterculia urens</i>
<i>Awietenia mahagoni</i>	<i>Eugenia roxburghii</i>	<i>Lawsonia inermis</i>	<i>Strobilanthes cordifolia</i>
<i>Azadirachta indica</i>	<i>Euphorbia indica</i>	<i>Madhuca longifolia</i>	<i>Strobilanthes kunthianus</i>
<i>Bacopa monnieri</i>	<i>Fartocarpus hirsutus</i>	<i>Magnolia champaca</i>	<i>Strychnos nus-vomica</i>
<i>Barringtonia acutangula</i>	<i>Fartocarpus hirsutus</i>	<i>Magnolia nilagirica</i>	<i>Syzygium cumini</i>
<i>Barringtonia racemosa</i>	<i>Ficus benghalensis</i>	<i>Mallotus philippensis</i>	<i>Tamarindus indica</i>
<i>Bereberis tinctoria</i>	<i>Ficus benghalensis</i>	<i>Mangifera indica</i>	<i>Tectona grandis</i>
<i>Bixa orellana</i>	<i>Ficus dalhousiae</i>	<i>Melastoma malabathricum</i>	<i>Terminalia anogeissiana</i>
<i>Borassus flabellifer</i>	<i>Ficus microcarpa</i>	<i>Melia azedarach</i>	<i>Terminalia arjuna</i>
<i>Buchanania cochinchinensis</i>	<i>Ficus nervosa</i>	<i>Mesua ferrea</i>	<i>Terminalia bellirica</i>
<i>Butea monosperma</i>	<i>Ficus racemosa</i>	<i>Mimusops elengi</i>	<i>Terminalia catappa</i>
<i>Calophyllum inophyllum</i>	<i>Ficus religiosa</i>	<i>Mitragyna parvifolia</i>	<i>Terminalia chebula</i>
<i>Calotropis gigantea</i>	<i>Fimbristylis falcata</i>	<i>Moringa oleifera</i>	<i>Terminalia paniculata</i>
<i>Capparis grandis</i>	<i>Garcinia gummi-gutta</i>	<i>Moringa concanesis</i>	<i>Thespesia populnea</i>
<i>Cassia fistula</i>	<i>Gloriosa superba</i>	<i>Neolamarckia cadamba</i>	<i>Thunbergia alata</i>
<i>Ceiba pentandra</i>	<i>Gmelina arborea</i>	<i>Nothopegia beddomei</i>	<i>Tinospora cordifolia</i>
<i>Chloroxylon swietenia</i>	<i>Gomphrena globosa</i>	<i>Opuntia rufida</i>	<i>Veteria indica</i>
<i>Cinnamomum agasthiyamalayanum</i>	<i>Gomphrena serrata</i>	<i>Peltophorum pterocarpum</i>	<i>Wrightia tinctoria</i>

Endemic Trees of Tamil Nadu

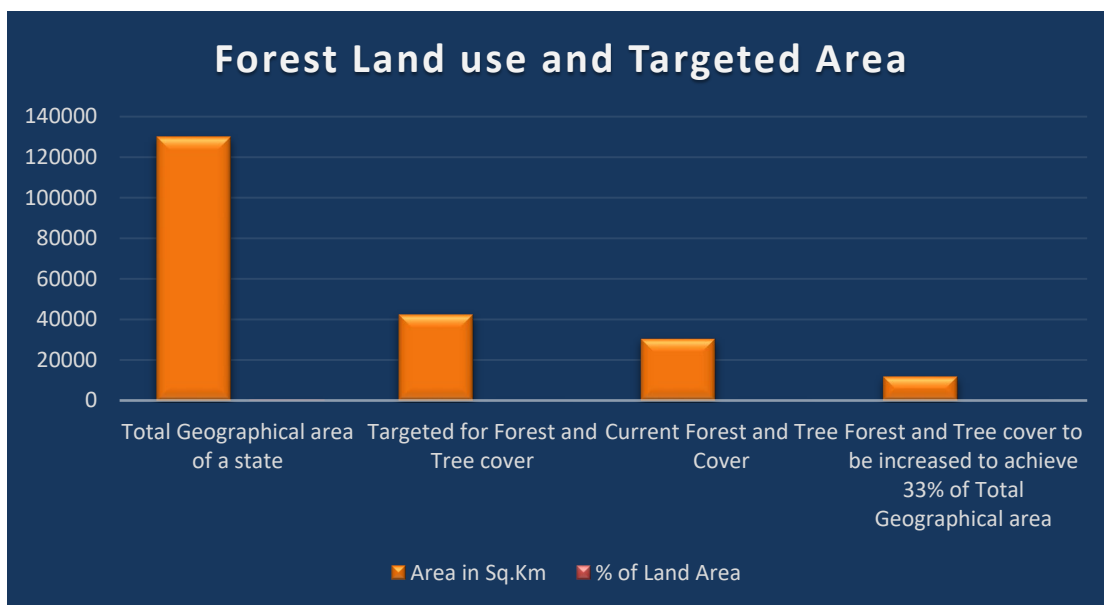
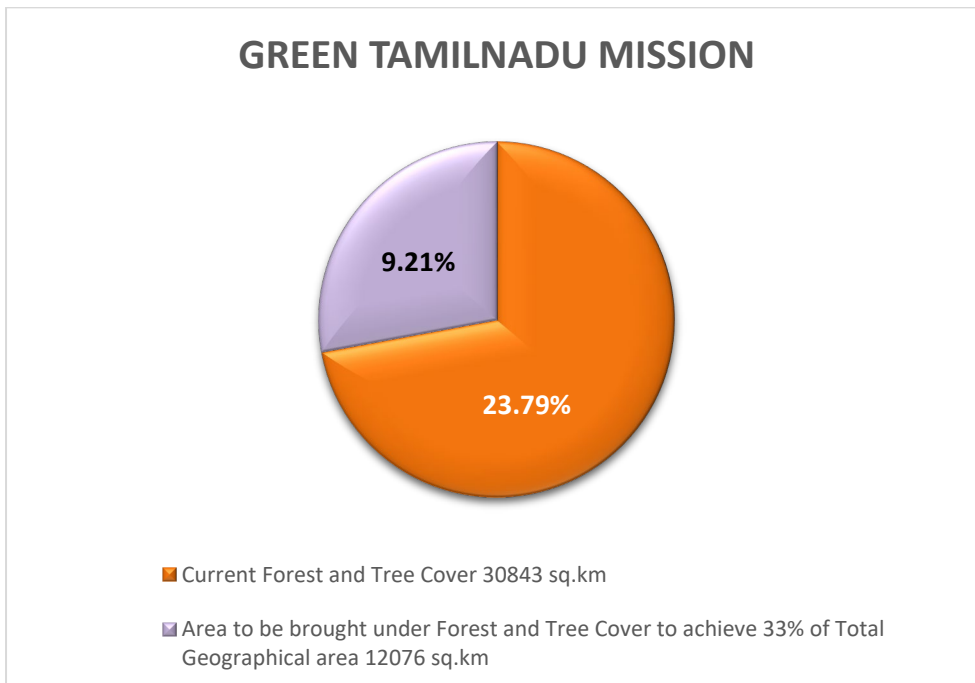
<i>Adansonia digitata</i> (Anai Puliymaram)	<i>Mangolia champaku</i> (Shenbagam)
<i>Ailanthus excels</i> (Pi-nari maram)	<i>Manikara hexandru</i> (Ulakkai Palai)
<i>Albizia soman</i> (Thoongu Vagai)	<i>Mimusop elengi</i> (Makizham)
<i>Artocarpus hirsutus</i> (Ainipila)	<i>Modhuva longifolia</i> (Iluppai)
<i>Artocarpus lacucha</i> (Kuranku Pala)	<i>Pancha vriksham</i> (Aintu maram)
<i>Artocarpus hetrophyllus</i> (Pala)	<i>Premna serratifolia</i> (Pasumunnai)
<i>Azadirachta indica</i> (Vembu)	<i>Prosopis cineraria</i> (Vannimaram)
<i>Bombox ceiba</i> (Mull Ilavu)	<i>Pterocarpus marsuplum</i> (Vengai)
<i>Cassine glauca</i> (Kanniramaram)	<i>Pterocarpus santalinus</i> (Sivappu Sandanam)
<i>Conorium strictum</i> (Karun Kungiliya)	<i>Saalvodoru persica</i> (Ugamaram)
<i>Couropita gulanensis</i> (Nagalingam)	<i>Santalum album</i> (santhanam)
<i>Dalbergia lotifolia</i> (Eeti)	<i>Sterrculia foetida</i> (Kuthirai kolambu)
<i>Ficus benghalensis</i> (Ala maram)	<i>Stychnos nux vomica</i> (Etti)
<i>Ficus lacor</i> (Malai ichi)	<i>Swietenia macrophylla</i> (Mahogany)
<i>Ficus racemosa</i> (Aathi)	<i>Swietenia mahogany</i> (Asal Mahogany)
<i>Ficus religiosa</i> (Arasa maram)	<i>Syzygeium cumenii</i> (Navel)
<i>Ficus retusa</i> (Ichichi)	<i>Syzygeium densiflorum</i> (Malai Naval)
<i>Gmelina arborea</i> (Perum kumil)	<i>Tamarindus indica</i> (Pulimaram)
<i>Great bunyan tree</i> Adyar (Maha Ala maram)	<i>Tectona grandis</i> (Thekku)
<i>Haldina cordifolia</i> (Manja kadampa)	<i>Terminalia arjuna</i> (Marutha maram)
<i>Hidegardio populifolie</i>	<i>Terminalia bellarica</i> (Thandri)
<i>Holopteho integrifolia</i> (Aaya)	<i>Terminalia chebula</i> (Kaduka)
<i>Hopea parviflora</i> (Vellai Kongu)	<i>Tetrameles</i> (Chenni maram)
<i>Mangifera indica</i> (Maa maram)	<i>Toona ciliata</i> (Sandana vembu)

Heritage Trees of Tamil Nadu

<i>Actinodaphne campanulata</i> var. <i>campanulata</i>	<i>Grewia pandaica</i>
<i>Cinnamomum walaivarense</i>	<i>Homalium jainii</i>
<i>Diospyros barberi</i>	<i>Hopea utilis</i>
<i>Elaeocarpus blascoi</i>	<i>Ixora saulierei</i>
<i>Elaeocarpus venustus</i>	<i>Memecylon molestum</i>
<i>Eugenia calcadensis</i>	<i>Pittosporum viridulum</i>
<i>Eugenia discifera</i>	<i>Poeciloneuron pauciflorum</i>
<i>Eugenia floccosa</i>	<i>Robiquetia josephiana</i>
<i>Eugenia rottleriana</i>	<i>Schoenorchis jerdoniana</i>
<i>Eugenia singampattiana</i>	<i>Sirhookera latifolia</i>
<i>Euphorbia santapau</i>	<i>Symplocos macrocarpa</i>
<i>Ficus angladei</i>	<i>Symplocos macrocarpa</i>

(ii). As per the India State of Forest Report of the Forest Survey of India, Dehradun, the forest and tree cover in the State of Tamil Nadu is 26,419 sq kms and 4424 sq kms respectively which is 23.6% of its Geographical area of 1,30,060 sq.kms. Under the “Green Tamil Nadu Mission”, the Government of Tamil Nadu proposes to increase the forest and tree cover in the State from present 23.6% to 33% by the year 2030-2031 as per the National Forest Policy 1988 and vision of the Government of Tamil Nadu.

(iii). Recognising the fact that the Tree outside Forests (ToF) in general and agri silviculture in particular would help the State to achieve the target of bringing 33% of its geographical area under Forest and the Tree cover as per the National Forest Policy 1988. Increasing the tree cover on the farmlands, fallow lands, educational Institutions, temple lands, sacred groves, urban and peri urban areas, tank foreshore, water bodies, river flood plains, padugai areas and areas under the control of Defence and Police establishments (8000-9000 sq.kms) along with the afforestation and restoration activities on the degraded forest landscape about (4.500 sq.kms) shall be the way forward under the Mission.



(iv). The Agro forestry has been a formidable component of the Green India Mission and accordingly the Sub-Mission on Agro Forestry (SMAF) under the National Mission for Sustainable Agriculture (NMSA) launched in the financial year 2016-17 by the Government of India clearly spelt out the operational guidelines to increase the tree cover on farms alongside agricultural crops

using multi-pronged strategies. As the tree growing on the farmlands offers a tremendous opportunity for the farmers to supplement their income in addition to the agricultural crops, it is high time that the consistent efforts are taken to increase the tree cover on the farm lands and built up the robust data base on the farmers and the growing stock in their land. This will help in developing a strong institutional marketing linkage in the future for the benefit of the tree growing farmers for enhancing their livelihood opportunities, which was lacking in the past leading to several farmers backing out from practicing the agro-forestry

(v). Improving the growing stock and the biodiversity in view of decreasing growing stock in the forest cover of the State from 144.404 million cubic meter in the year 2011 to 92.27 million cubic meters in the year 2021 (-52.13 m.cu.m) mandatorily requires strategic interventions adopting Community Public Private Participation (CPPP model) for the restoration of degraded forest landscape. The natural forests are undoubtedly sustainable carbon store house for mitigating the adverse impacts of climate change besides creating umpteen number of livelihood opportunities for the forest dependent communities in terms of harvesting and marketing of Non-Timber Forest Produce and for the non-marketed ecosystem services the natural forests provide. Therefore, one of the prime objectives of Green Tamil Nadu Mission shall be to put the natural forests at the center of the sustainability and the way it changes over time for measuring progress towards the SDG no 15. It is again a widely known fact that the forests feature in the SDGs because of their significant contributions to food security and livelihoods and for the several products and ecosystem services it provides for fulfilling the commitments as envisaged under SDG 15 (“life on land”) and SDG no. 1 (no poverty), SDG no. 2 (zero hunger), SDG no. 3 (good health & well-being), SDG no. 11

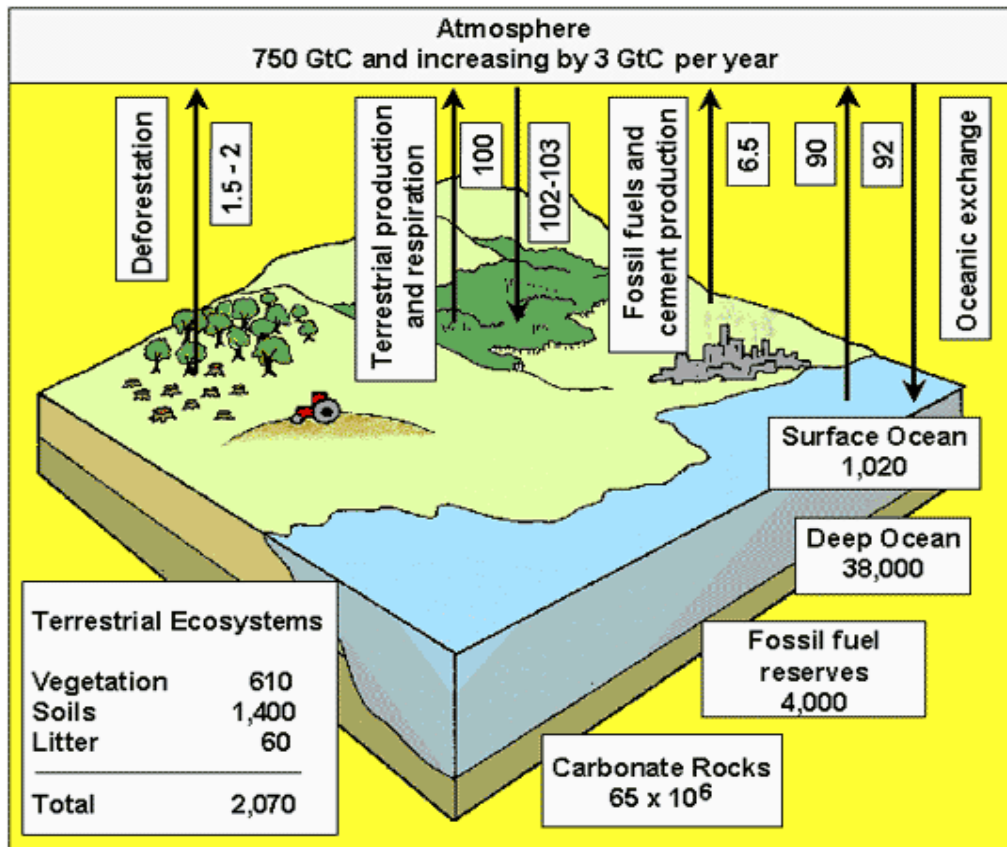
(sustainable cities and communities), SDG no. 12 (Responsible Consumption and Production), SDG no. 13 (Climate action), SDG no. 14 (live below water). In view of these climate and non-climate centric advantages “protection, restoration and promotion of terrestrial ecosystems in combating desertification, and reversing the land degradation shall be adopted under the Green Tamil Nadu Mission.

(vi). Under the Bonn challenge 2011, to which the India is signatory has pledged for restoration of 26 m ha of degraded forest land by the year 2030. Therefore, the restoration of degraded Forest Landscape in the State to an extent of 4500 sq km shall be under taken for improving the growing stock and carbon sequestration potential in the natural forests besides improving the forest productivity and well-being of the forest dependent communities in the State. Here it is pertinent to make a mention that ecological restoration of minimum 4500 sq km out of there 11,725 sq km of open degraded forests and Scrubs forests of 715 sq km shall be instrumental in enhancing the ecological security of the State in terms of sound mitigation and adaptation measures for meeting the growing challenges of the Climate Change.

(vii). Threats to biodiversity have several root causes, including poverty, lack of viable alternative livelihoods, financial and social incentives for resource-dependent communities and integration of biodiversity and livelihood consideration in development planning around biodiversity-rich areas, have been identified as some of the root causes of threats to biodiversity. Therefore, restoration of biodiversity and arresting the erosion of biodiversity shall be another indomitable objective under the Mission.

(viii). Reducing emissions from deforestation and degradation in the forest areas shall be another challenge in combating the adverse impacts of climate change on the Biodiversity Conservation and Protection. Due to anthropogenic factors, the natural forests which have been potential carbon sink should not turn out to be a source of the carbon emissions posing various climate challenges. Therefore, the implementation of REDD+ strategy in letter and spirit shall be another prime objective under the Mission. A mechanism that is inclusive enough to prevent leakage (at project and state levels) along with a monitoring and reporting framework that allows for detecting leakage. Leakage (displacement of emission) in REDD+ is normally caused by the displacement of land use pressure to other forests and ecosystems, e.g., the pressure to convert natural ecosystem to agricultural land. It has been a widely accepted fact that the success of REDD+ is closely linked to not only an increase in agricultural productivity and the restoration of degraded lands, but also to the sufficient supply of timber from production forestry or agri-silvicultural practices that are not necessarily included in REDD+ efforts, including plantations. Therefore, for the first time, the REDD+ strategy shall be adopted in the State of Tamil Nadu under Green Tamil Nadu Mission and shall be an integral and inseparable part of the Mission.

A simplified diagram indicating carbon pools and CO₂ fluxes between the earth and the atmosphere for implementing the REDD+



Source: Edinburgh Centre for Carbon Management (<http://www.eccm.uk.com/climate.htm>)

Carbon pool: A reservoir of carbon. A system which has the capacity to accumulate or release carbon.

Carbon stock: The absolute quantity of carbon held within a pool at a specified time. The units of measurement are mass.

Carbon flux: Transfer of carbon from one carbon pool to another in units of measurement of mass per unit area and time (e.g., GtC/yr)

Carbon sink: Any process or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. A given pool (reservoir) can be a sink for atmospheric carbon if, during a given time interval, more carbon is flowing into it than is flowing out.

Sequestration (uptake): The process of increasing the carbon content of a carbon pool other than the atmosphere. (IPCC, 2000).

(ix). 81% of the carbon in the soil and 19% of the carbon in plants are stored in the earth's biosphere on a global scale. Approximately 31% of the carbon in all forests, tropical, temperate, and boreal

combined, is stored in the biomass, while 69% is stored in the soil. About half of the carbon in tropical forests is stored in biomass, and the other half is in the soil (IPCC, 2000). Significant carbon pools also exist in the form of wood products made from harvested timber. Depending on how they are used, their lifespans might range from a few decades or even centuries for lumber to less than a year for fuel wood. The following processes lead to the oxidation of carbon contained in organic matter and the resultant releases of CO₂:

- a. Respiration of living biomass;
- b. Decomposition of organic matter by other living organisms (also called heterotrophic respiration);
- c. Combustion (fires).

(x). Forests act as CO₂ sinks by absorbing CO₂ from the atmosphere, which is a function of photosynthesis. Atmospheric CO₂ is incorporated into complex organic compounds that are used by the entire plant after being fixed in the chlorophyll of the plant.

The carbon cycle in the forest

The participation of forests in climate change is thus three-fold, they are:

- a. As Carbon pools
- b. As sources of CO₂ when they burn, or, in general, when they are disturbed by natural or human action
- c. As CO₂ sinks when they grow biomass or extend their area.

The earth's biosphere constitutes a carbon sink that absorbs approximately 2.3 GtC annually. This represents nearly 30% of all fossil fuel emissions (totaling from 6.3 to 6.5 GtC/year) and is

comparable to the CO₂ emissions resulting from deforestation (1.6 and 2 GtC/year).

Current scientific evidence suggests that well managed and old grown forests sequester carbon at rates of up to 6 ton / ha. These results question the paradigm that old grown forests are in equilibrium with a net carbon balance. On the other hand infrequent disturbances (fires, pest outbreaks, storms) triggers a sporadic, but massive return of carbon to the atmosphere"(Valentini et al., 2000). The soil specialists have emphasized that "there is a potential for reversing some of these processes and sequestering carbon in soils in terrestrial ecosystems, particularly grassland which are often being ignored under ecological restoration programmes.

(xi). Climate and CO₂ levels in the atmosphere have an impact on the carbon cycle, which includes photosynthesis, plant respiration, and the breakdown of organic matter, in a particular forest. Therefore, it is difficult to distinguish between natural and anthropogenic factors that affect plant growth. Thus the rise in atmospheric CO₂ has a "fertilising effect" on photosynthesis and, consequently, on the development of plants. There are still questions regarding the long-term future of the biospheric carbon pool. Several bio-climatic models indicate that the ecosystems' absorption capacity is approaching its upper limit and should diminish in the future, possibly even reversing direction within 50 to 150 years, with forests becoming a net source of CO₂. Indeed, global warming could cause an increase in heterotrophic respiration and the decomposition of organic matter, and a simultaneous decrease of the sink effectiveness, thereby transforming the forestry ecosystems into a net source of CO₂ (Scholes, 1999).

Creation and management of carbon sinks and pools	Reduction of greenhouse gas emissions by sources	Biomass and soil organic matter in forests	Emissions resulting from forestry activities or products
Introduction of trees on non-forest or degraded forest lands: <i>industrial plantations, village plantations, restoration of natural forest, watershed protection, orchard and perennial cultures, agro-forestry urban & peri-urban areas</i>	Improving the management of natural forests: Forest enrichment, improved forestry techniques, (i.e sustainable forest management) rotations and felling cycles under the agro-forestry	Conservation of forests and entrancement of carbon sink. Combatting forest fires	Improving the growing stock and substitution of cement or steel with wood products, preventing forest fires.

Wood products	Substitution: avoided emissions
Products with long lifetimes Increasing product lifetime by recycling or maintenance	Fossil-fuel substitution by biomass Substitution of energy-intensive materials (cement, steel) by lumber

Table: Forestry activities that mitigate the greenhouse effect

(xiii). In addition to protecting the environment, forestry activities that mitigate climate change provide national, regional and local benefits, as long as they are adapted to the local context. Forest offers potential income to rural populations in forest areas. Industrial plantations apart from ameliorating the environ-green, local conditions generate employment in seed collection, NTFP, nursery operations, harvesting and tending operations. Community plantation and restoration projects involves direct payments to villagers for payment of ecosystem services. Timber and other

plantation projects, increases forest industry efficiency, raise competitiveness by adding value to production and processing. Conserving forests is a means of adapting to climate change. It helps provide protection against surface erosion regulates water flows and limits landslides and rock falls. Forests at the coastline provide protection against wind and water erosion as well as water and sand intrusion besides proving saviours to the coastal communities. Therefore, under the Green Tamil Nadu Mission, the priority shall be accorded to the planting of heritage, endemic and economically valuable native tree species which has been duly mentioned in the Mission document.

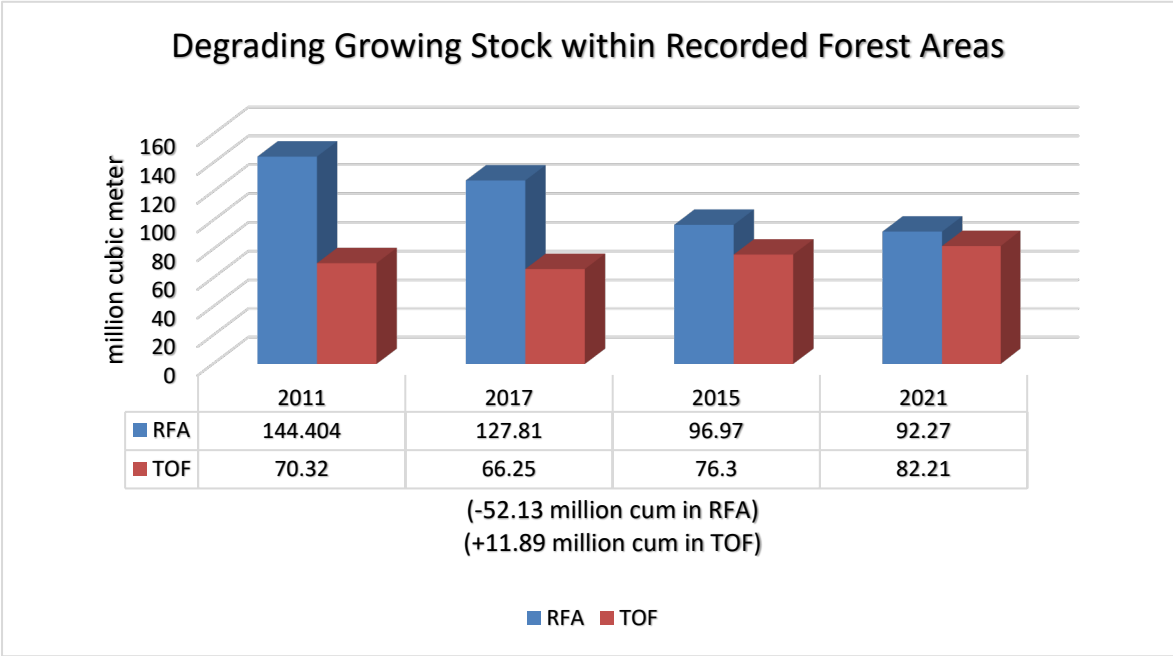
ISSUES / PROBLEMS TO BE ADDRESSED

(i). Forest land restoration (FLR) with the participation of the indigenous and local communities have been widely talked about but very little has been done in this regard to increase the forest cover by involving the tribal and local communities. It has been duly recognized nationally and globally that the Forest Land Restoration is a vital tool in the hands of the Government to achieve the Land Degradation Neutrality (LDN) within the forest areas. FLR has gained greater significance in the recent past since it facilitates climate change mitigation and adaptation. The restorative practices have proved to enhance the quality of life of local communities particularly the indigenous communities by the way increased biodiversity and non-timber forest produces. The FLR has proven its worth for better resilience of people dependent on forests also for the people residing away from the forests.

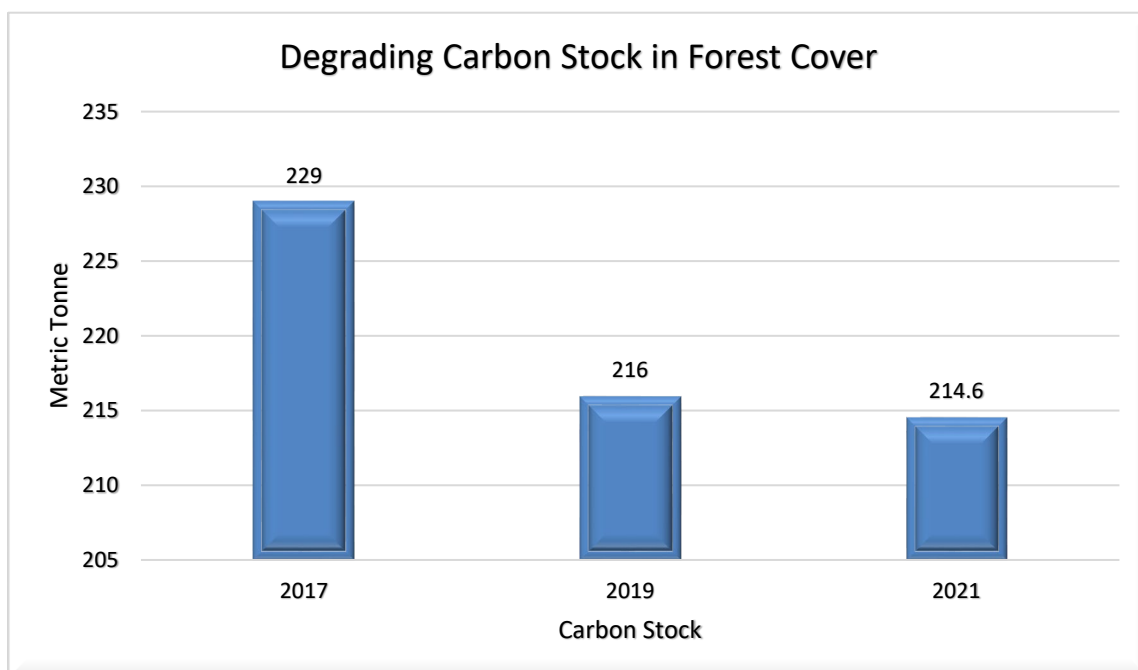
(ii). The intensive afforestation and restoration activities on various landscapes shall be required in order to increase the forest and tree cover to 33% of the geographical area by invoking people's and Institutional participation in a big way. The village forest committees as well as the Self-Help Women Groups which have been created under the JICA funded Tamil Nadu Afforestation Project Phase I and Phase II shall be revitalized for ensuring the forest protection and conservation so as to reduce the land degradation and associated carbon emissions from the deforestation and land degradation.

(iii). The State of Tamil Nadu has 22.43% of Southern Dry Mixed Deciduous forests, 9.90% Secondary dry deciduous Forests, 6.73% Southern Thorn forests, 5.32% Carnatic Umbrella Thorn forests and 4.53% Southern Moist Mixed Deciduous forests (ISFR 2021). Few research studies have strongly indicated that biodiversity and climate change are intricately linked and is known to enhance biomass and carbon stocks of forests (*S. Kothandaraman, Javed*

Ahmad Dar, Mohammed Latif Khan, article published in nature.com in August 2020). Therefore, the State being endowed with great species richness in its forest cover shall undertake protection and restoration of biodiversity in the recorded forest areas under the Green Tamil Nadu Mission in order to contribute to greenhouse gas mitigation actions by reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks in order to offset the future carbon emissions from the industrial and transport sectors (REDD+). The State of Tamil Nadu has suffered severe degradation in its growing stock between the years 2011 and 2021 (India State of Forest Report) with a loss of growing stock of 52.134 m.cu.m in the Recorded Forest Areas which is a cause of great concern and shall be scientifically and practically addressed under the Green Tamil Nadu Mission.



*Source: Indian State of Forest Report



**Source: Indian State of Forest Report*

(iv). Creation of additional carbon sink in forest and tree cover is considered important in the fight against impending climate crisis. since the recent researches have indicated that forests and trees help to sequester twice as much as CO₂ as they emit. Therefore, even if the updated commitments of the Nationally Determined Contribution given by the Union of India before the UNFCCC during the year 2022 does not mention about the creation of additional carbon sink in the forest and tree cover, these nature-based solutions cannot be ignored as a carbon offsetting mechanism. The 50% electricity which is still going to be generated from the fossil fuels by the year 2030 desperately requires the offsetting of carbon emissions either by way Direct Air Capture (DAC) or through forest land restoration and growing of more trees outside the forests as well as in the aquatic ecosystems (wetlands and water bodies). Thus, strategic interventions under the Mission would be required for primarily maintaining and restoring the rich biodiversity for improving the forest productivity which has been a cause of concern at present due to the dwindling growing stock inside the recorded forests of the State. Similarly, the trees outside forests are also

required to be enhanced on a massive scale for greenhouse gas mitigation, air quality improvement, reducing the urban heat island effects, livelihood improvement, biodiversity and allied nature restoration.

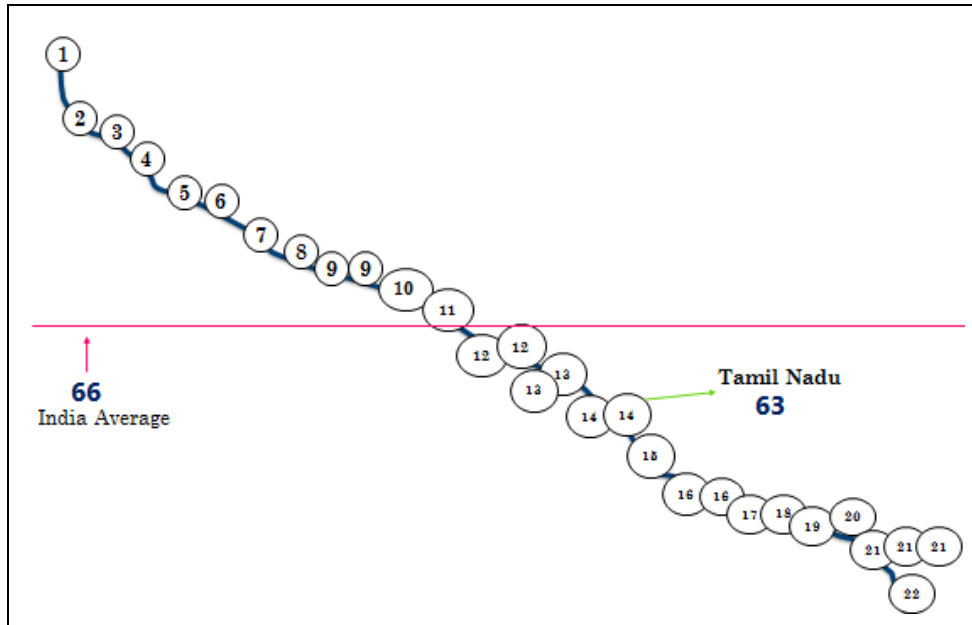
Name of the State	Total Geographical Area	Forest Cover	Very Dense Forest	Moderately Dense Forest	Open Forest	Total Change
Andhra Pradesh	1,62,968	29,784	0	-9	656	(+) 647
Odisha	1,55,770	52,156	243	-557	851	(+) 587
Karnataka	1,91,707	38,730	32	-63	186	(+) 155
Jharkhand	79,716	23,721	-2	2	110	(+) 110
Telangana	1,12,077	21,214	16	332	284	(+) 632
Tamil Nadu	1,20,060	26,419	-12	4	63	(+) 55

**Source: India State of Forest Report*

(v). The above tabulated statement indicates that the State of Telangana have increased the forest cover in all the density classes probably because of Haritha Haram scheme of the Government of Telangana. 230 crores of seedlings were planted under the above greening scheme wherein 100 crores of in-situ (root stock) were raised through assisted natural regeneration within the recorded forest areas of Telangana State. Therefore, the State of Tamil Nadu shall replicate the best practices of raising 100 crores of seedlings by way of in situ assisted natural regeneration works inside the recorded forest area with the involvement of local and indigenous communities.

(vi). In so far as the SDG 15 i.e., life on land is concerned as per the SDG India index 2020-21, NITI AAYOG, the State of Tamil Nadu has not been progressing as in case of other SDGs like SDG no 1,2,3,5,7,9. Despite several afforestation and biodiversity conservation being implemented in the State in the past decade, the

State stands at no 14 out of 22.



*Source: Niti Aayog SDG India Index 2020-2021

(vii). The Green Tamil Nadu Mission shall play a pivotal role in arresting the forest degradation since in the last decade 1373 sq km of area has increased under the category of the open forests in the State as per the Indian State of Forests Reports 2011 & 2021. The good thing which has happened as a decadal change in the forest cover is the increase of 712 sq km of moderately dense forests and 545 sq km of very dense forests. Therefore, the reason which has pulled down the performance of the State in the SDG no 15 (Life on land) is the degradation in the very dense forests and increase in the open forests leading to increased human-wildlife conflict, reduction in the flow of ecosystem goods and services to the local communities and communities living away from the forests. The plausible causes of forest degradation are urgently required to be addressed under the Green Tamil Nadu Mission for biodiversity conservation by involving the local communities and the indigenous people in restoration of degraded forest landscape.

(viii). The ecological restoration of the Western Ghats and the Eastern Ghats in particular shall be given impetus under the Green Tamil Nadu Mission to preserve and manage its rich bio-diversity. The series of broken hills in Peninsular India, which have an average elevation of 1,000 metres, stretch from the Mahanadi in Odisha to the Vaigai in Tamil Nadu. The sandal-rich Javadhi Hills, Yelagiri, Balamalai, Bargur, Servarayan, Bodhamalai, Chitheri, Kalrayans, Kolli Hills, Pachamalai, Piranmalai, Semmalai, Sirumalai, Karanthamalai, Azhagar Malai, etc. comprise the Ghats in Tamil Nadu. Near Doddabetta in the Nilgiris, the hills extend west and south-western before merging with the Western Ghats. The Eastern Ghats are enriched with biodiversity but these fragile ecosystems are degraded by illegal logging and exploitation of forest wealth. Moreover, tribal population inhabiting these hills for ages have been exploited by affluent people and timber mafias, which facilitated the large-scale smuggling of sandal wood and Red sanders. Therefore, an urgent need has been felt to restore the native flora & fauna of the Eastern Ghats under the Green Tamil Nadu Mission. The Eastern Ghats receive an average rainfall of 1000 millimeters, mostly from the north-east monsoon and rivers like Naga Nathi, Cheiyaru, Amirthiyaru, Kovilmalaiyaru, Idiyaru, Mriganda, Pennaiyaaru, Puliyancholaiyaaru, Aiyaaru, Swetha nadhi, Cauvery, Sarabanga nadhi and Thirumanimuthaaru. As they originate from the hills of the Eastern Ghats, they irrigate lakhs of hectares of land at the foothills and nearby plains. The catchment area treatment plan shall have to be prepared using the GIS mapping in order to control the runoff through vegetative measures from these rivers to protect the siltation of the waterbodies down streams. The Eastern Ghats biospheres are also rich in forests, perennial and semi-perennial streams, and other natural resources even though it's not as well known as the Western Ghats.

(ix). The aromatic and priceless sandal trees, which were once widely distributed in Chitheri, Javadhis, Yercaud, Kolli Hills, Pacha Malai, and Bodhamalai, among other places, have been indiscriminately cut down and illegally removed. The

precious species is on the verge of extinction. In a few isolated places in some hill ranges, only younger regeneration is apparent. which shall to be restored involving the local tribal communities through low cost assisted natural regeneration methodology. Non-native species such as poochedi (*Lantana camara*), vengaya thamarai (*Icornia crassipes*) and veli karuvai (*Prosopis juliflora*) have become predominant destroying native species and leading to ecological imbalance. The restorative measures shall be due importance in order to restore the ecology of the Eastern ghats under the Green Tamil Nadu Mission.

(xi) The pristine environment of Yercaud, Yelagiri, Javadi, Kolli Hills, Kalrayans, Sirumalai, Thiruvannamalai, Hogenakkal, Azhagarmalai, etc, have been getting adversely impacted due to increased anthropogenic factors. The local people shall be sensitized by way of awareness generation on the importance of a clean environment for the natural resources protection. Under the Green Tamil Nadu Mission an effective strategy for the ecological restoration of sandal bearing areas of Eastern Ghats shall be implemented through low cost ANR methodology involving the local people for the protection and conservation of precious diverse flora particularly the young recruits of the sandalwood otherwise the future of the Eastern Ghats and its precious biodiversity may become an illusion.

(x). The significant changes that have been identified to be addressed under the Green Tamil Nadu Mission through the Forest land restoration and the agri-silviculture system are as follows:

a) Heat and Temperature Stress

The increasing temperature has been the biggest threat faced by the human kind. The earth's average temperature rose about 0.7°C in the 20th Century which causes global warming and the associated economic and environmental effects.

b) Land Degradation through soil erosion and loss of organic

matter

The climate change causes increased land degradation due to high temperature, wind and uncertain rainfall resulting in extreme soil and water erosion. The surface soil erosion leads to low organic status to the soil. These activities convert the productive land into degraded lands unsuitable for commercial agriculture and allied activities.

c) Limited Food Supply

The climate change alters the schedule and the duration of cropping seasons resulting in poor productivity and food supply. Water shortage during dry months also affects forest and the crop growth and overall food production.

d) Occurrence of Pest and Diseases

Climate change can vary the life cycle of pests by increasing their population at a different time. Farmers may be unaware of these changes and experience huge crop loss. Similarly diseases may also become epidemic due to changes in climate and may cause crop failure. Occurrences of pest and diseases and their remedial measures have so far been not given the due priority in dealing with the forest landscape which gets adversely affected by pests and diseases and becomes a source of carbon emissions after its death and decay.

e) Threat to Bio-diversity

The increasing concerns on global climate change particularly global warming and acid rain have become a threat to biodiversity due to sudden changes in local habitat. This results in migration and erosion of rare, endangered and endemic species causing serious threat to the biodiversity.

f) Ecological Imbalance

Climate change can vary the life cycle of pests by increasing their Climate change which can cause summer months warmer and winter months cooler. These changes attribute to the ecological imbalances and will be threat to both biotic and abiotic components.

g) Threat to Food and Nutritional Security

All the above indicated constraints and threats are a very serious concern for forestry, agri-silviculture and allied activities which gets adversely affected directly and shall be a blow to the food and nutritional security, in the coming years.

(xii) The limitation factor in so far with the growing of trees on the farmlands have been a long rotation period of the economically viable trees which discourages the farmers to take up the planting of trees on their farmland. To circumvent the problem of long rotation period of economically important trees like *Melia dubia*, *Neolamarckia cadamba*, *Alianthus excelsa*, *Gmelina arborea*, *Swetenia mahogany*, *Casuarina spp*, the Forest College & Research Institute, Mettupalayam(a constituent College of the Tamil Nadu Agriculture University Coimbatore) has experimented the Precision Silviculture farming with the help of calibrated water and fertigation regime coupled with appropriate spacing between the trees, reduction in the rotation period of the above trees from 8-12 years to 3-6 years for making it economically viable options for farmland planting. Further, the clonal technology has also been successfully experimented through field trials and has been playing a major role in reducing the maturity age of the economically viable trees for the benefit of the farming communities. Under the Green Tamil Nadu Mission, it is proposed to sign a MoU with the Tamil Nadu Agriculture University, Coimbatore and its constituent college namely the Forest College and Research Institute, Mettupalayam,

Coimbatore, for the necessary technical support and inputs on the precision silviculture and on the advanced clonal technology method for shortening the rotation of the economically valuable trees on farmlands for making the tree growing on the farmlands popular and attractive amongst the farming communities.

PROCESS TO ADDRESS THE PROBLEMS

(i). Recognizing the fact that the State has 11,729 sq km of open forests, the restoration of degraded forest land i.e., between 10-40% Crown density shall be a priority area to be undertaken under the Green Tamil Nadu Mission. Allowing degraded natural forests to re-grow is a more effective, immediate and low-cost method for removing and storing atmospheric carbon than planting new trees, as has been mentioned by (*Dr Kate Dooley, University of Melbourne and Professor Brendan Mackey, Griffith University*). Two years ago, a study reported that these natural climate solutions (<https://www.pnas.org/content/114/44/11645>) provides approximately 37 per cent of the carbon dioxide reduction needed to keep the rise in global temperature below 2°C degrees – as outlined in the Paris Agreement.

(ii). Nature-based solutions are usually misinterpreted to imply that the priority is to carry out massive tree planting instead, the major climate solution from the land is, the protection and recovery of carbon-rich primary ecosystems, especially natural forests.

(iii). The latest IPCC report, also mentioned that it is better to prioritize the protection, recovery and buffering of primary ecosystems beside planting of trees because the Forest ecosystems (including soil) store more carbon than is found in the atmosphere. The loss and degradation of the natural forests triggers emissions that would cause global warming to exceed the 2°C let alone the 1.5°C degree threshold. Therefore avoiding further loss and degradation of forest biodiversity and carbon stock would be an essential and complementary mitigation action

<https://rss.onlinelibrary.wiley.com/doi/10.1111/j.17409713.2014.00720.x>) that goes hand in hand with the rapid transition from using fossil fuel to clean energy. These forest ecosystems as a result of ecological and evolutionary processes – and their natural patterns of distribution and abundance of plants and wildlife have greater resilience to external shocks. <https://www.pnas.org/content/115/20/5181>

(iv). The natural forests recovery adapts to changing conditions and store more stable natural carbon stocks <http://www.pnas.org/content/106/28/11635>) than young, degraded or plantation forests. New research studies have also demonstrated the globally significant potential of allowing degraded natural forests to continue re-growing in order to reach their ecological potential. This approach has been proved to be more effective, immediate and low-cost method for removing and storing atmospheric carbon in the long-term than tree planting.

(v). Growing existing natural forests to maturity, optimises their biological sequestration potential to remove carbon dioxide from the atmosphere by plants and stored in vegetation and soils. Therefore avoiding further loss and degradation of primary forests and intact forest landscapes, and allowing degraded forests to naturally regrow, would reduce global carbon emissions annually <https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.13876>) by about one giga tonne or 1 Gt, and reduce another two to four Gt of carbon emissions through just allowing natural regrowth.

In the COP26 at Glasgow (2021), India is certified to reduce carbon emission by 1 billion tonnes by the year 2030

FSI + Birla Institute of Technology Science , Pilani (BITS - Goa campus) has mapped Climate hot spots in the forest area of the country

Climate hotspots area which are likely to face severe impact of climate change

Climate projection based upon the RCP scenarios

(vi). Tree planting (afforestation or reforestation) carries limited climate benefits. On the other hand, increasing canopy cover through natural regeneration of degraded forests has superior climate benefits by sequestering 40 times more carbon.

(<https://nature.com/articles/d41586-019-01026-8>).

Any expansion of natural forest area is best achieved through allowing degraded forests to naturally recover. Allowing trees to regenerate naturally, using nearby remnants of primary forests and seed banks in the soil of recently cleared forests, is more likely to result in a resilient and diverse forest *(<https://advances science mag.org /content/3/11/e1701345>)* than planting massive numbers of seedlings. The resilience and longevity of primary forests' carbon stores will be enhanced if restoration prioritises buffering and reconnecting forested areas. This will result in larger and more stable and longer lasting carbon stores. This scale of sequestration is comparable to what ecologist Jean-François Bastin and his colleagues forecast with 900 million hectares of new canopy cover. Therefore under the Mission the restoration of degraded forest landscape by way of

assisted natural regeneration and gap planting on a smaller scale with the native and climate resilient species shall be given priority for biodiversity enrichment with the active involvement of the tribal communities, other forest dwellers, local communities (JFMC's, VFC's , SHG's etc.) for the climate change mitigation and adaptation, increase in water provisioning, sediment retention for sustenance of livelihood of the people.

(vii). The forest and tree cover in the state of Tamil Nadu is 23.6% of the total geographical area of the state. Preserving and improving the health of the existing forest is of prime importance in achieving the goal of Green Tamil Nadu mission. A healthy forest contributes for enhanced ecosystem services in comparison with a degraded forest and therefore increasing tree cover and forest density by way of afforestation and the restoration shall be the two pronged strategy under the Mission for improving the carbon sequestration capacity of the existing forests and also provide for numerous indirect services like decreased soil erosion, increased water percolation, local climate regulations, improved flood and erosion control etc., For this purpose , activities like afforestation with native & climate resilient species specific to particular agro-climatic fauna shall be accorded priority along with soil and moisture conservation works, forest fire prevention, capacity building of the forest staff etc. with a financial outlay of Rs.1959 Crore under the NABARD project. The indigenous species which are proposed for forest land restoration and for institutional planting for creation of an additional carbon sink in the natural forests / tree outside forests as already been mentioned in the Mission document.

(viii) As per the ISFR 2021 there is 715 sq km of scrub forests (crown

density < 10%) including the grass lands. Due to their ability to fix atmospheric carbon into organic matter or biomass, grassland systems, like forests, play a crucial role in the carbon cycle. It stores the carbon in the world's largest terrestrial carbon reservoir (SOC), i.e. the thick underground network of roots, as well as other organic soil matter (5000 MT loss in India annually and 1600 MT flows into the sea). India has reportedly lost 31% or 5.65 million hectares of grass lands between 2005-2015 as per the data presented by the Union Government to the UN Convention on Combating Degradation and Desertification (UNCCD). The loss of grasslands along with the deforestation have probably been one of the main reasons behind the annual loss of 5000 million tonnes of productive soil which has been a leading cause of heavy sedimentation of dams, water bodies and wetlands putting severe strain on the Government exchequer for the dredging process. In spite of this, restoring grasslands is not as common as planting trees or growing forests to prevent soil loss and to mitigate the adverse effects of the climate change in any of the Indian States. It is again pertinent to make a mention here that using restoration of natural forests and grasslands to tackle degradation and deforestation is one of the main objectives of Bonn challenges where the India is a signatory. In the face of upcoming climate change impacts like drought, declining forest cover, altered hydrological cycles (reduced stream flow), decreased albedo (a measure of solar radiation reflected from the earth's surface) which contributes to global warming, and loss of the unique biodiversity, grasslands are likely to be more reliable carbon sinks. The State of Tamil Nadu therefore proposes to include the grassland restoration under the Green Tamil Nadu Mission due to its wide ranging ecological and aesthetic benefits including creation of additional carbon sink in its roots and soils, besides improving the fodder base for the healthy predator prey ecosystems. Grasslands store the most

plant biomass below the ground (67%) compared to forests and shrub land (22% and 43%), according to a recent study that analysed above- and below-ground biomass across various vegetation types around the world, including India. The estimated carbon sequestration potential of world soils lies between 0.4 to 1.2 Gt per year which includes 0.01 - 0.30 Gt per year from grassland.

(ix). India adopted Aichi Target 9 as its National Biodiversity Target 4 to identify invasive alien species and their pathway of introduction for developing the strategic interventions to manage prioritized invasive species by the year 2020. Despite all the past interventions to eradicate the invasive species from the forest areas of Tamil Nadu, the efforts have not yielded any positive outcomes probably because of lack of scientific knowledge on the eradication of invasive species. As per the ISFR 2021, about 1515 sq kms are under the invasion by various invasive alien species out of which the *lantana camara* invasion into the forest landscape is up to 1154 sq kms. The invasive species are proving to be a great threat to the forest biodiversity in the State which requires an immediate scientific intervention with realistic documentation on the success or failure of past invasive species eradication programme under various forestry schemes. In the year 2001 itself, the forest economists pegged the cost of damages caused by the invasive species to the Agricultural and Forestry sector at about \$91 billion a year in India alone. In view of this fact, the restoration of biodiversity by successful eradication has been achieved in Kodaikanal shola gran land. This shall be one of the top priorities of the Green Tamil Nadu Mission for cumulating the adverse impacts on local livelihood, hydrology, soil stability and overall ecological balance of the Hill ecosystems.

(x). To achieve the target of achieving 33% forest and tree cover in the state of Tamil Nadu, it is proposed to plant a total of about 130-140 crore seedlings over 7-8 lakh hectares over a period of 10 years through growing more trees outside the forests. In the first two years of the Mission period, 5000 hectares each year will be planted with approximately 2.5 crore seedlings. In view of the huge funding required for the successful implementation of the Green Tamil Nadu Mission and since the Green Tamil Nadu Mission has to be a people's movement, the major funding for the implementation of Green Tamil Nadu Mission would to be met from Corporate Sustainability Responsibility (CSR) funding from Public & Private sectors, Corporate Environment Responsibility (CER) fund, donations, voluntary participation besides the Government funding. Green Tamil Nadu Mission with the support of voluntary donations from citizens for the purpose of greening and restoring degraded landscapes, habitat restoration for wildlife protection, restoring Mangroves, empowering rural livelihood, perpetual protection monitoring of plantation raised from donation, administrative expenses, research and training. A dedicated payment gateway for receiving the donation is established for the Mission. The raised donations are accountable under Tamil Nadu Government Mission. All the donations and expenditures are 100% monitored by 3rd party monitoring. Public dash board will showcase the progress and real time images of the planted landscapes available in the web portal (www.greentnmission.com). The web based data collection and further dissemination to the public, ensures there is complete transparency of the funds utilized.

(xi). The seedlings and the species proposed under Green Tamil Nadu Mission have been finalized after taking into consideration

several aspects like native species, high economic value species, fast growing species, environmentally friendly species etc, (species having high carbon sequestration potential, temperature regulation and Air pollution tolerance capacity) with an aim to achieve highest level of carbon sequestration and improved air quality. The farmland plantations (Agro forestry) have been given the highest priority considering its various benefits like economically valuable to the farmers, augmenting the increased demand of the wood and in achieving the goal of carbon sequestration in stipulated time. Nearly 5 Lakh hectares over a period of 10 years is planned to be planted under Agroforestry with an estimated cost of Rs.7875 Crores in order to meet the increased demand of pulpwood, plywood, matchwood, timber in the State. Similarly, species like Melia dubia, Anthocephalus Cadamba, Swetenia Mahogany, Dalbergia Sissoo, Red Sanders, Sandal wood etc, shall be given due importance because of its economic and ecological benefits and the said plantations shall be encouraged considering site specific and agro-climatic needs of the farm/ fallow lands

(xii). Plantation on panchayat tanks, water bodies, coastal beets (mangrove), wetlands etc shall be taken up on large scale to on extent of minimum 2,00,000 hectares with suitable riparian species. Major thrust shall be given upon tank foreshore plantations, by planting Acacia nilotica as it not only helps in ensuring successful growth of plants but also provide numerous direct benefits like availability of fuel wood etc., and indirect benefits like controlling soil erosion, increasing water percolation, carbon sequestration etc, augmenting the ground water table of the nearby areas for irrigation purposes ensuring the increased productivity of the farm lands.

(xiii). As of now Tamil Nadu has a total of 32 Forest extension centers, out of which 16 Extension Centers were modernized at the rate of Rs.30lakhs per center during the years 2018-2020. In order to enhance the capacity of nursery raising in each district, another 16 Forest Extension centers need similar modernization for which Rs. 40 Lakhs would be required. Similarly, creation of 10 regional nurseries at the cost of Rs.30 lakh per nursery is proposed to be created for enhancing the capacity of the nursery raising. Present nurseries created under various schemes needs immediate maintenance capacity enhancement to make them self reliant in production of quality planting materials. Therefore, Rs.15 lakhs per nursery is proposed as maintenance cost for the existing 250 nurseries of the forest department in the State. The works related to modernization of Forest extension centers, creation of regional nurseries and maintenance of existing central nurseries in each district and other nurseries shall be of paramount importance in successful implementation of Green Tamil Nadu mission.

(xiv). Agri-silviculture is one of the most conspicuous land use systems which has excellent potential for climate change mitigation and adaptation besides augmenting the income of the farming communities. Agri-silviculture in general and trees in particular act as carbon stocks by sequestering carbon in the atmosphere. The trees exhibit wide range of mechanisms to adapt to climate change such as improved micro climate, reduced temperature, reduction in evaporation and transpiration, improving the soil quality and acting as a sink for carbon. For these reasons, the Forest College and Research Institute during the last four decades has established wide range of Agri-silviculture models

like multi-functional agri-silviculture, silvi pasture, wind breaks and shelter belts systems and dendro biomass/energy based Agri-silviculture models. These models though have been primarily aimed for ensuring effective land use and for creating livelihood opportunities for the tree growing farmers but these models have also significantly contributed towards climate change mitigation measures which have so far not been accounted for in the carbon stock of the State. It has been assessed and estimated that these models have already sequestered over 3.7 million tons of carbon and proved as a potential land use system for climate change mitigation and adaptation. These models are scientifically proven models and shall be replicated under Green Tamil Nadu Mission to mitigate the climate change associated risk besides enhancing the productivity of the land and profitability of the practicing agri- silviculturists.

(xv). A Consortium of Farmers, Industries (Wood based), Scientific Institutions and the Forest Department would be a viable business solution for providing support to the farming communities right from availability of the quality planting stock, technical advice on site-specific agri-silviculture model, estimation of growing stock, linkage to the Industries and getting best price for their product, as the recent survey undertaken by the Social Forestry and Extension wing of the Tamil Nadu Forest Department indicated that the small and marginal farmers are being exploited by the middleman and are getting on an average 40% of the actual revenue out of their tree products. The proposed Consortium comprising of the Forest Extension Officers (Tamil Nadu Forest Department) Krishi Vigyan Kendras (KVKs) (Tamil Nadu Agricultural University), Research Centers (Tamil Nadu Forest Department) , Tree growing farmers and the Wood based Industries shall be

instrumental in taking the site specific technical decisions right from the raising of quality planting stock, planting operations, harvesting of the tree produce and the value added products till the realization of the actual market price of the tree based commodities by the farmers for successful participatory greening of the farmland/fallow lands.

(xvi). The District level Consortium under the District Green Committees shall be a way forward wherein the rates of the pulpwood, plywood, matchwood and other value added products shall be approved as the existing market rate at the time of selling of the products so that the tree growing farmers shall get the actual revenue benefits for their tree based commodities without the involvement of the middlemen. In order to ensure that the rates given by the Wood based Industries are in consonance with the rates of the wood based produce approved by the DGC, it is proposed to introduce a transport system on the Green Tamil Nadu web portal (**www.greentnmission.com**) that the wood based industries upload the list of tree based commodities obtained from the along with the payments made to the farmers to maintain fairness and transparency in the business operations. This transparent procedure of marketing linkage and receipt of benefits shall encourage the tree growing farmers to take up the cultivation on the farm land like never before due to lease of data base on tree growing farmers, growing stock and revenue recopy etc.

(xvii). In order to monitor and supervise the agroforestry component under the Green Tamil Nadu Mission it is proposed to constitute a “Project Technical Team” under the Chairpersonship

of Additional Principal Chief Conservator of Forests and Mission Director with following officials/experts:

- (a)** Dean, Forest College and Research Institute, Mettupalayam
- (b)** Dean, Agriculture Extension Centre, Tamil Nadu Agriculture University, Coimbatore
- (c)** Representative from Institute of Remote Sensing, Anna University, Chennai.
- (d)** Representative of Madras School of Economics
- (e)** Ten Representatives from Non-governmental Organizations

The Agri-silviculture can provide better livelihood to the farming communities of the State, by mainstreaming the tree farming into the agriculture farming bringing more prosperity to the Indian farmers. Therefore, the Green Tamil Nadu Mission shall bring the Forest Department closer to the people and pave the way for conserving and protecting the natural biodiversity within the forest areas by minimizing the anthropogenic pressure on the natural forests, thereby controlling GHG emissions and enhanced carbon sequestration in the natural forests as well as in the Trees Outside Forests. Agri-silviculture shall also be instrumental in augmenting the farmer's income through sale of their tree produce to the Wood based Industries, through the Consortium comprising of Forest Extension Officers, Wood based Industries and the Tree growing farmers which shall be first institutionalized at the Regional level and later at the District level for the convenience of the tree growing farmers.

(xviii). Tamil Nadu Forest department shall be nodal agency for the Green Tamil Nadu Mission and the Forest Department shall be a major stakeholder in nursery raising and plantation works on farm/fallow lands. Other line departments viz RD&PR / Agriculture Departments shall also undertake nursery raising and plantation

works on farm lands. Nursery raising, plantation and distribution of taller seedlings of mixed species in Temple lands, Industrial Units, Homesteads, Roadside, Schools, Institutions, Railway lines, Tank foreshore (Panchayat) and Other common lands shall be undertaken by the Forest Department, with funding or Afforestation/Re-Afforestation drive from the following sources:-

- (a) NABARD
- (b) CAMPA
- (c) Tamil Nadu Forest Plantation Corporation Limited, Trichy
- (d) Tamil Nadu Bio-Diversity Conservation and Greening Project Phase II
- (e) Sub-Mission on Agro Forestry
- (f) Tamil Nadu Pollution Control Board
- (g) Department of Environment, Government of Tamil Nadu
- (h) Corporate Social Responsibility Funds
- (i) Private sector funding or resource mobilization.

In addition to above, the investment opportunities for the Green Tamil Nadu Mission shall be explored through earmarking of 1% of funds from all the infrastructure development projects implemented in the State of Tamil Nadu as a Green Fund. The necessary funds towards the raising and planting shall be transferred to the Tamil Nadu Green Climate Company for funding the Green Tamil Nadu Mission for the raising and planting activities.

(xix). Awareness generation on the ecological, economic and health benefits of the tree plantation inside and outside the forests should become a consistent process by way of widespread dissemination of information through electronic and print media in Tamil as well as in

English up to the Panchayat and Village level. The impetus of the widespread awareness shall be on importance of tree plantation in decreasing global warming, pollution reduction, reduction in lung diseases, prevention of soil erosion, damages to the reservoirs and water bodies and stability in precipitation. Tree plantation shall become a community driven exercise with a target of planting a minimum of 5 seedlings per every household in future the places identified by the Government and Private establishments in order to have an ownership feeling of the communities with the planted trees.

SOLUTIONS IDENTIFIED

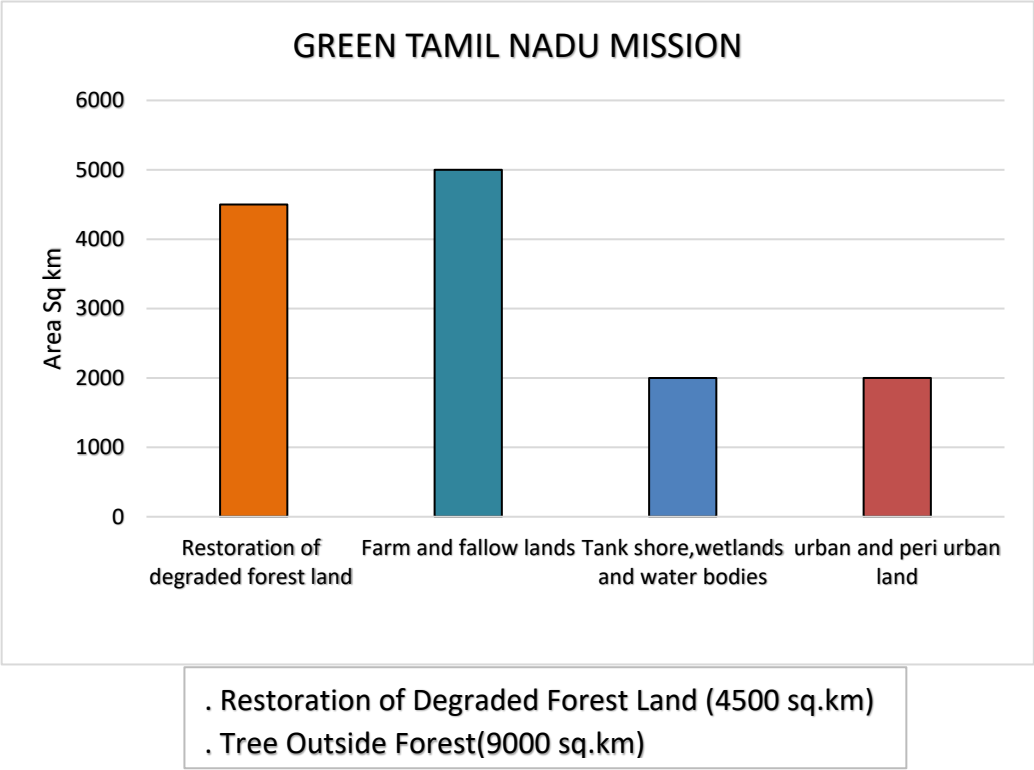
1. The intriguing of scenario of major forest and tree cover loss being predicted to occur in three major forest types i.e. Tropical Dry Deciduous Forests, Tropical Moist Deciduous Forests and Tropical Semi-Evergreen Dry Forests from the year 2050 onwards due to climate crisis (ISFR 2021) has been taken into consideration while proposing a road map in rolling out of the Mission. Similar to other massive afforestation, re-afforestation and restoration activities taken in the past, the Mission shall focus on the production and planting of quality planting material as per the site conditions. However, major emphasis laid on native tree species of the particular agro-ecological zones (except choice of farmers in agro forestry component) in order to ensure 99% survival in harsh climatic conditions in spite of it being a humungous challenging task. The emphasis of the Mission in the initial years of its launch i.e. from 2021-22 to 2024-25 shall be more on consolidating the multi-sectoral efforts at the District level and therefore the number of seedlings to be planted outside the recorded forest areas shall be kept minimum i.e. ranging from 2.5 crore in 2021-22 & 2022-23 to about 10 crore in the year 2024-25. Thereafter the number of seedlings to be planted outside the forest areas shall be increased from 2025-26 till 2030-31 @ 25 crore seedlings every year so as to achieve the 33% of forest & tree cover under the Green Tamil Nadu Mission. The restoration of degraded forest areas through assisted natural regeneration shall be in addition to this afforestation / reafforestation activities. The Mission shall replicate the best practices of restoration of degraded forest landscape of Haritha Haram of Telangana State where under the massive greening programme, in-situ regeneration of 100 crore seedlings were taken up successfully by the Forest Department with the help of local communities.

2. The district wise patches shall be communicated to the Circle Officials/ District Forest Officers for undertaking the peripheral plantations either by raising or through assisted natural regeneration in order to increase the forest cover in the State. The District Forest Officer's shall be specifically instructed to take up the artificial or assisted natural generation works on the peripheries to increase the forest cover since the artificial regeneration/assisted natural regeneration inside the 42,372 patches across the State shall not lead to increase in the forest cover. The extent of increase in the forest cover shall be calculated by deriving the perimeter of the patches through the use of ArcGIS and the buffer area shall be kept all along the perimeter for clarity in the projected increase in the forest cover.

Forest Cover in different Patch Size Classes				
Sl. No	Patch Size Range in sq. km	No. of Patches	Area (sq. km)	% age
1	$\geq 0.01 \leq 1.0$	41,335	3,288	12.51
2	$> 1.0 \leq 10$	907	2,461	9.36
3	$> 10 \leq 100$	112	2,871	10.92
4	$> 100 \leq 500$	12	3,019	11.49
5	$> 500 \leq 1000$	0	0	0.00
6	$> 1000 \leq 5000$	6	14,642	55.72
	Total	42,372	26,281	100.00

3. The State has increased its forest cover by 2.5% in a period of 10 years as per the ISFR Reports of 2011 and 2021. The Mission shall focus intensively on increasing the forest cover to another minimum 4-5 % through combined and concerted efforts of all the Stakeholders largely through restoration activities by the local and

indigenous communities supported by CSR /CER, Corporate and Government funding. Another strategy which would be a major component of the Mission Action Plan shall be to improve the tree cover outside the forest areas by about 7-8 % from the level of the year 2021 ISFR Report. The ToF shall be expanded largely on farmlands (4000-5000 sq kms), Urban & Peri urban areas (1500-2000 sq kms) and Tank beds, Water bodies, Catchment and Watershed areas, Riverine areas , Wetlands and Coastal areas (2500-3000 sq kms). The land parcels for the planting sites shall be identified by the District Green Committees along with the number of seedlings to be planted District wise so that a bottom up approach is scrupulously followed for the impactful and successful implementation of the Green Tamil Nadu Mission adopting multi-sectoral approach including the household participation in the Mission



4. The agroforestry is going to play a pivotal role in increasing the tree cover provided that the farmers are given access to the quality planting material of economical viable species with short rotation

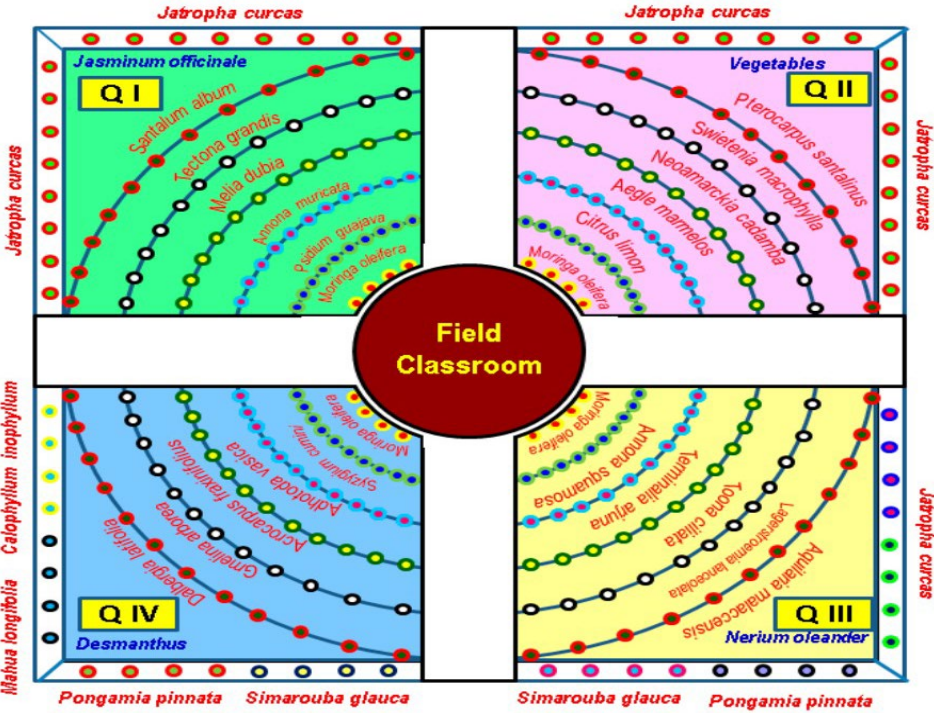
duration and the marketing linkages to the wood based industries. The sample survey conducted during May-June 2021 with 822 tree growing farmers indicated that about 35% of farmers have resorted to desperate sale to the middle man/ merchant and got 40-50% lesser revenue than the market price. As the import bills of timber in the Country has been steadily increasing@ 0.9 million cum per annum as per the report of Centre for Science and Environment, New Delhi and if this trend continues in the next ten years i.e., till the year 2030, the Country's import is projected to be 31.5 million cu.m.

5. In the State of Tamil Nadu there is almost 100% import of phased veneer. In view of these circumstances the tree growing farmers shall be encouraged to take up the Multi-Functional agroforestry system wherein food and wood production shall be balanced in such a way that there is no shortfall in food production. In order to circumvent the involvement of middle men / merchants in the sale of harvested wood products to the wood based industries, a Consortium of farmers and Industries under the aegis of the District Green Committees shall be formed and the sale of harvested wood shall be ensured at the market price through establishing direct linkages with the Industries. Further the felling restrictions on the valuable timbers that are grown on the farmlands shall be eased out to encourage the tree growing farmers to take up the agro forestry (Agri-Silviculture, Agri-Horticulture and Agri-Pastoral models) based upon the agro-climatic zones.

6. The Consortium model proposed in the preceding paras needs to be made an independent and sustainable body in long run so as to ensure that the tree growing farmers, being the major stakeholders get the maximum benefit in terms of choice of species, technical inputs, fertigation and irrigation facilities and desired revenue benefits for their tree-based commodities. In order to ensure the sustainability of the Green Tamil Nadu mission it shall be appropriate to get the Consortium (the district level) under the Tamil Nadu Societies Registration Act, 1975 and the said Consortium

shall enter into Memorandum of Understanding (MoU) between the tree-growing farmers and the wood-based industries and biomass industries in contributing one-time membership fee into the Consortium account @ Rs - 5000 per farmer and @Rs. 25,000 per industry. The said MoU should also include for contribution of 5-10% of the total revenue earned by the tree - growing farmers by way of selling their produce into the Consortium fund for future nursery and plantation activities. It is proposed to disseminate the multi - functional agro forestry system among the farmers to upscale the agro forestry practices under the Green Tamil Nadu Mission and the farmers would be made aware about the immense benefits of the MAF system. The MAF system proposed under the Mission is as follows:

MULTIFUNCTIONAL AGRO FORESTRY



MULTIFUNCTIONAL AGRO FORESTRY

Tree Species	Number of Trees
Quadrant I	
<i>Moringa oleifera</i>	4
<i>Psidium guajava</i>	10
<i>Annona mucronata</i>	11
<i>Melia dubia</i>	11
<i>Tectona grandis</i>	12
<i>Santalum album</i>	12
Intercrops (Flowers)	
<i>Jasminum officinale</i>	72
<i>Jasminum grandiflorum</i>	104

MULTIFUNCTIONAL AGRO FORESTRY

Tree Species	Number of Trees
Quadrant II	
<i>Moringa oleifera</i>	4
<i>Citrus limon</i>	10
<i>Aegle marmelos</i>	11
<i>Neolamarckia cadamba</i>	11
<i>Swietenia macrophylla</i>	11
<i>Pterocarpus Santalinus</i>	12

MULTIFUNCTIONAL AGRO FORESTRY

Tree Species	Number of Trees
Quadrant III	
<i>Moringa oleifera</i>	4
<i>Annona Squamosa</i>	10
<i>Terminalia arjuna</i>	10
<i>Toona ciliata</i>	11
<i>Lagerstroemia lanceolata</i>	12
<i>Aquilaria malaccensis</i>	12
Intercrops	
<i>Nerium oleander</i>	28
<i>Murraya Koenigii</i>	350

MULTIFUNCTIONAL AGRO FORESTRY

Tree Species	Number of Trees
Quadrat IV	
<i>Moringa oleifera</i>	4
<i>Syzygium cumini</i>	11
<i>Adhatoda vasica</i>	12
<i>Acrocarpus fraxinifolius</i>	12
<i>Gmelina arborea</i>	12
<i>Dalbergia latifolia</i>	12
Peripheral Planting	
<i>Jatropha curcas</i>	50
<i>Calophyllum inophyllum</i>	5
<i>Simarouba glauca</i>	10
<i>Pongamia pinnata</i>	10
<i>Madhuca longifolia</i>	5

7. Co-generation of wood and food on the farmlands would be an ideal way in meeting the target of achieving 33% of the Geographical Area of the forest and tree as well as in growing demand of wood, improving the nutrient cycling and ameliorating the microclimate for increasing the agriculture productivity. Under such circumstances, dendro-biomass production through agro forestry is bound to gain global attention as an alternate land use practice. That is resource efficient and environment friendly. It would provide greater opportunity to enhance the land productivity, farmer's income and sustainable livelihood option than ocean and other terrestrial ecosystem. Because of its potential capacity of land use management and socio-economic and environmental benefits such as food security and secured land tenure, increased farm income, restoring and improving the above and below ground biodiversity, maintaining watershed hydrology and soil conservation.

8. The potential capacity of agro-silviculture to adapt to extreme climate change is greater than the agriculture because it plays a

critical role in ecosystem services and prevents land degradation which makes them to adapt to vagaries of climate change. Against this backdrop, the Forest College and Research Institute has established various agro forestry models, though they are not primarily designed for carbon sequestration, but at present provides a greater opportunity for immensely improving the technology dissemination of short rotation tree crops leading to enhanced carbon sequestration through the biomass grown.

9. The small holder farmers are more susceptible to the effects of the climate change, therefore both stability of the production systems and the livelihood of the rural people that are increasingly at risk need to be addressed through robust land use pattern.

In this regard much has been talked and discussed about the climate smart agriculture, similar approach is required to be adopted for the forestry sector through developing appropriate “agro-silvi pastoral models” in the seven different ecological zones of Tamil Nadu (*Melia dubia* + Groundnut + Chilli + Turmeric; *Gmelina arborea*+pulses + Ground nut + Banana; *Casuarina*+ Watermelon + Gingelly).

10. There is a strong need for the agriculture sector to hold hand of the forestry sector, so that with the help of technological information on tree-based biomass, available with the Forest Department are grown on the farmland and there exists co-generation of wood and food in the farm lands for the food and income security of the farmers. Small / marginal farmers are particularly found at high-risk end due to drought, eroding their capacity to take risks and restricting their investments in tree and agriculture crop farming. Any project which does not give subsidy for the drip irrigation assistance is bound to perform poorly on account of tree crop failure particularly when the rain water is unavailable. To bring back “Greening with sustainability” drip irrigation with appropriate fertigation schedule in the form of vermicompost, cow dung and essential nutrients (NPK) etc., is the

immediate need of an hour, for successful Agri-silviculture practices and in the greening of the farm land.

11. The trees in general and Agri-silviculture in particular have great potential to adapt and mitigate climate change through their multifarious ameliorative role. Agri-silviculture is ecologically dynamic, complex and sustainable system which provides opportunity in farm lands through complementary economic and environmental benefits.

a. Adaptation Measures

The Multifunctional Agri-silviculture system give small holder farming systems opportunities to diversify production systems and improve their sustainability. From the perspective of small-scale farmers, the most difficult aspect of climate change is the rise in temperature and rainfall fluctuation between years. There are several clear benefits to tree-based systems for sustaining production during wetter and drier years. First, during droughts, their deep root systems will be able to search a broader area of soil for water and nutrients. Second, greater soil porosity, decreased runoff, and greater soil cover result in greater water uptake and retention in the soil profile, which can lessen moisture stress during years with low precipitation. Third, compared to pastures or row crops, tree-based systems have higher evapo-transpiration rates and can thus maintain aerated soil conditions by pumping excess water out of the soil profile more rapidly than other production systems. Finally, tree-based production systems often produce crops of higher value than row crops. In order to mitigate the revenue risks brought on by climatic fluctuation, the production system could be diversified to incorporate a significant tree component.

b. Mitigation Measures

The greatest role of agri-silvicultural models towards climate mitigation is the reduction of CO₂ in the atmosphere through carbon sequestration in short rotation of 3-5 years. The tree component of the agro forestry system can significantly be a sink for carbon in the land use practiced with agri-silviculture. The three major path through which trees can help to reduce atmospheric carbon are:

- conservation of current carbon reservoirs through actions like avoiding deforestation and finding alternatives to slash and burn.
- Sequestration through improved fallows and integration with trees
- Substitution through bio-fuel and bio-energy plantations to replace fossil fuel use.

12. With an aim to supplement income of farmers who are into agro forestry/agri-silviculture, a pilot project on the lines of the Gujarat Forest Department to assess the amount of carbon dioxide (CO₂) sequestered in around trees proposed to be grown on the farmlands (agro-silviculture) and other Institutional lands in all the Districts is need to be undertaken and for monetization of the carbon by selling it to the industries in form of carbon credits and help the latter offset their greenhouse gas (GHG) emissions. The entire farmland plantation of about 5 lakh hectares may be covered in a period of 10 years for earning carbon credits to the farming Committees (Tree growing farmers), through voluntary carbon market. Under Green Tamil Nadu Mission the carbon credit project shall be implemented in collaboration with the Farmers, directly by the project developer on the farmlands for the trees raised under the Green Tamil Nadu Mission after obtaining the consent of the farmers. The Carbon credits earned by the farmers shall be uploaded on the web portal of the Green Tamil Nadu Mission for record

purpose.

13. The climate resilient trees and their associated agri-silvicultural models can act as effective adaptation strategies both for climate change mitigation and adaptation. The climate vulnerable land use system mapping shall be undertaken for establishing site specific agri-silviculture models to address the issues of climate change mitigation and adaptation. The gap bridging of the requirement of wood for small timber pulpwood, plywood, matchwood, dendro-biomass etc. is required to be done through growing of wood based biomass outside the conventional forest area not only to reduce the pressure on the Government exchequer by way of importing wood but also to ensure that the fast growing tree based biomass increase the trees outside the forest area (TOF) for fulfilling the societal/industrial demand of the wood leading to reduced or nil biotic pressure on the protected areas where the biodiversity conservation has to be accorded priority. By this way our country would be able to keep its conventional forest area intact (Reserve Forests, protected forests, wildlife sanctuaries and National parks). Meeting the growing wood / biomass requirement from the farm lands would be a triple edged weapon in terms of improving the farmer's income, reducing the rate of deforestation and in sequestration of carbon from the atmosphere.

14. The State of Tamil Nadu therefore shall stand benefited by adopting these tested agri-silviculture models for the interest and benefit of the tree growing farmers in the State, in view of the current market price of the economically valuable trees for the planting in the farmlands which are as follows:

Species	Utility	Price Support Rate/mt	Industry Associated
<i>Teak</i>	Timber	Rs.20000	Suresh Timbers, Elumalai, Madurai
<i>Gmelina</i>	Timber	Rs.8000- 10000	
<i>Casuarina Species</i>	Paper	Rs.4900	Tamil Nadu Newsprints and Papers Limited, Karur. Seshasayee Paper and Boards Ltd., Erode.
<i>Ailanthus excels</i>	Match Splints	Rs.6500	Vasan Match Works, Vellore The Ideal Splints and Veneers, Coimbatore
<i>Melia dubia</i>	Paper	Rs.4400	Tamil Nadu Newsprints and Papers Limited, Karur. Seshasayee Paper and Boards Ltd., Erode
<i>Melia dubia</i>	Plywood	Rs.9000	Century Plyboards (I) Ltd.,
			Chennai Ambiply Panels and Doors, Mettupalayam Sri
			Ranga Ply Industries, Mettupalayam Asian Timber Industries, Pollachi.

**Source: Forest College and Research Institute, Mettupalayam, Coimbatore*

List of species suitable for varied industrial utility

Sl.No	Product	Suitable
1	Timber	<i>Teak, Gmelina, Swetenia</i>
2	Pulpwood	<i>Casuarina, Melia</i>
3	Plywood	<i>Melia, Swietenia, Neolamarckia cadamba</i>
4	Matchwood	<i>Ailanthus, Anthocephalus cadamba</i>
5	Dendro Biomass	<i>Casuarina, Melia.</i>
6	Firewood and Charcoal	<i>Acacia</i>

**Source: ISFR 2021*

15. In general, properly implemented participatory initiatives in forest land restoration and raising on plantations on private land, are effective in improving biodiversity status and people's livelihoods and awareness on various environmental issues. However, interventions under biodiversity conservation projects have frequently failed to connect the aspects of livelihood development with conservation. This has resulted in a broad impression of these projects as rural development projects or just another government handout, rather than inspiring a sense of reciprocal commitment to conservation. Therefore, when the funds run out or are not distributed equitably, there is a natural sense of dissatisfaction that causes a setback to the project's sustainability. The methodology employed in Mission interventions shall be the integration of conventional ecological knowledge systems with scientific concepts and adaptive management methodologies. Without these, socio ecological considerations achieving biodiversity conservation outcomes shall not be possible.

16. Improving the genetic quality of the seeds through the certified seed sources such as mother trees/plus trees and the quality of harvesting, handling, testing and storage practices of such genetically superior seeds shall be adopted for production of quality planting stock. The Genetics Division located in the Coimbatore District shall be the nodal agency for collection of quality seeds from the plus trees identified by the Division with the help of the indigenous communities. We have been talking about the use of the traditional and indigenous knowledge in the biodiversity conservation from very long time but the same has not been applied under the field conditions. Under the Green Tamil Nadu Mission, locating the Plus trees of the native and climate resilient species of the State shall be undertaken by the Genetics Division, Coimbatore and the seeds collected from the Plus / mother trees identified with the help of the local / indigenous communities shall be made a regular practice. After sorting out, grading & treatment of the seeds collected from the identified mother trees / plus trees, the seed shall be supplied to all the Departments / Organizations for raising of

quality planting material from the seed origin.

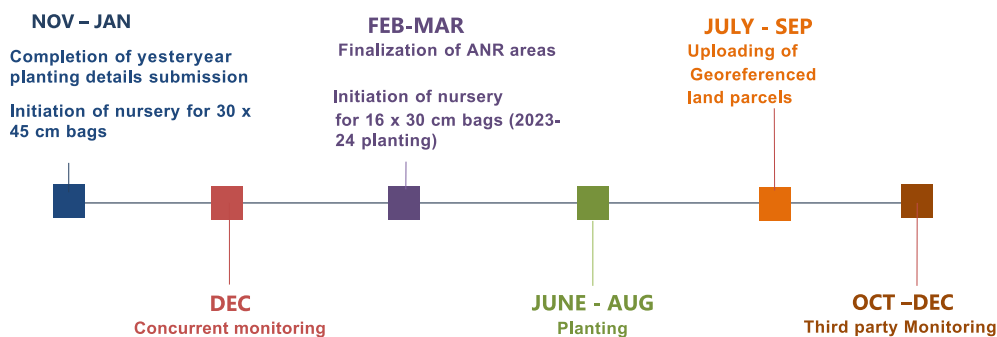
The details of the seed source shall be as per the following table:

Species	Location	No. of Plus trees/ mother trees identified area wise (geo-coordinate location)	Quantity of seed collected species wise	Seed collected by whom (tribal/ local community / forest official)	Total seed stock species wise	No. of person days generated (Green employment)	Total quantity of seeds distributed (Species wise, District wise)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

A model nursery complex containing the seedlings of different species raised from the Plus trees/ mother trees shall be established by the Genetic Division, Coimbatore. The objective of the Model nursery apart from production of quality planting stock through the adoption of Model nursery techniques shall also be to impart training on the nursery techniques to different user groups like Forest department, Forest Development Corporations, other Government Departments, NGOs, Forestry students, Farmers, SHGs, and other stake holders. A model nursery shall be established by the Genetics Division, Coimbatore in every District with the variety of seeds collected from the superior trees of the climate resilient and native species as a demonstration nursery under the changing climatic conditions i.e. increased temperature and drought conditions.

17. Definition of environmental conservation outcomes that the project interventions are meant to achieve is extremely important and should be done in the planning phase by the District Green Committees this would help the implementing agencies and participants understand what are the environmental benefits of project implementation. For the Sustainable Forest land restoration and promoting biodiversity Conservation efforts outside the forest areas, it is essential that the Government Institutions like Department of Agriculture & Farmer's welfare, Government of Tamil Nadu, Department of Horticulture, Government of Tamil Nadu, Department of Veterinary Science, Government of Tamil Nadu, Research and Development wing of the Forest Department, Tamil Nadu Agricultural University, the Forest College and Research Institute, a constituent college of Tamil Nadu Agricultural University, Coimbatore are closely associated to ensure multi-sectoral integration for the sustainability of the Greening project. Institutes and Organization like Institute of Remote Sensing, Anna University, Chennai, Madras School of Economics, Chennai, the Madras Institute of Sustainable Development, Chennai, other private geo-tech companies, local communities and academic institutions shall also be involved in the "Real time monitoring of the Greening project".

18. Sustainability of any Greening project may definitely require sanctioning of funds for timely raising of the seedlings as well as for timely planting activities for its overall success. Therefore, the schedule of activities as suggested below scrupulously followed, otherwise it may jeopardize the entire Greening mission:



19. Establishing monitoring and evaluation mechanisms to determine whether or not the interventions were successful is linked to the determination of outcomes. The aforementioned Institutions indicated for monitoring are required to collect baseline data and develop environmental indicators for project success that are particular to the site-level and the planned intervention.

20. Prior to the implementation of the planned intervention, it would be urgently required to consolidate and clearly demarcate Protected Areas and Reserved Forest boundaries in order to implement the Green Tamil Nadu mission inside the traditional forest areas without dispute.

21. Careful site selection is crucial and should be based on detailed knowledge of environmental characteristics such as terrain, soil, drainage patterns, and vegetation type; ideally, this information should be gathered using a GIS or other spatial information or mapping technology. The project's objectives for forest land restoration as well as for private and institutional land greening

would be undermined by the haphazard site selection process.

22. Public-private partnerships (PPPs) with well-established norms and risk-sharing requirements have a rather extensive history in other industries, primarily for massive infrastructure projects. The Green Tamil Nadu Mission utilises these PPP frameworks for the possibility of using them to direct investment towards large scale revegetation/re-Afforestation projects in the State.

23. It is now widely acknowledged that Reforestation, Afforestation, and Restoration of degraded landscape on a scale never before seen in the State are required to fulfil a number of urgent demands, including the reduction of widespread salinity and the preservation of biodiversity. Government funding alone could not finance the establishment of this magnitude of revegetation, as recent natural resource management initiatives have shown. However, if the policy settings are favourable, it is realistic to predict that the private sector would become a substantial investor in terms of either funding or pooling resources for landscape repair projects that produce viable returns. Due to reduced and more variable rainfall, a large portion of the territory that needs to be reforested is unsuitable for intense plantation development, but it may be appropriate for new types of multi-purpose forestry. A key challenge for this form of forestry is how to direct investment into areas where it is most needed.

24. Existing financial, legal and policy mechanisms is required to be evolved for undertaking major reforestation initiatives under PPP mode. Therefore, general PPP guidelines and precedents developed in other sectors could be applied to the development and implementation of multi-purpose forestry programmes that achieve "public good" goals like landscape repair and private sector investment returns from timber production and carbon sequestration within the State, which can be utilised as a carbon offsetting project for the Co2 emissions from the fossil fuel based

electronic generations. Due to their capacity to draw consistent payments that raise the internal rate of return for forestry projects, long-term carbon markets are most likely to provide as a strong impetus for multipurpose reforestation.

25. It is evident that public or private investment in environmental restoration plantings is necessary to protect biodiversity, prevent erosive processes, and improve the amount and quality of water. Deforestation is a historical error that we cannot reverse, but we may lessen its effects by extensive restoration work, which, if done negligently, could endanger critical species, communities, ecosystems, and eventually biodiversity.

26. Considering that even small patches, sacred groves, or even individual trees have been proven to be valuable as habitat, multiple-purpose forestry will need to be more sensitive to the importance of remnants (*Lindenmayer 2001*). More research and development should focus on possibilities like enhancing direct seeding in arable landscapes, combining direct seeding of pioneer species with precise planting of preferred plantation species in alternate rows or blocks, improving methods for enhancing natural regeneration, aerial seeding of steeper slopes, and aerial "bombardment" of seedlings using spear-tube technology/Drone technology.

27. Fortunately, markets demonstrate an extraordinary capacity to value a wide variety of intangibles including brand names, patents, and R&D in process. The key challenge is determining the monetary value of the environmental services that any forestry project provides (Binning et al, 2002, P.3.) There has been some progress in this area since carbon markets are booming and ecosystem services are starting to become part of policy makers' vocabulary. The design of a large-scale investment vehicle that could capture economic benefits of ecosystem services is necessary (Brand 2001). This would assist achieve goals for Natural Resource

Management while fostering different regional economies.

28. Due to the worldwide structure of the market, the commodity's standard characteristics, and the relative ease of its measurement, carbon sequestration is the easiest of the potential ecosystem services to assess. In order to promote innovation and efficiency, government incentive payments used to be focused on explicit outcomes or outputs (e.g., CO₂ sequestered area regenerated/revegetated) rather than inputs.

29. Invasive species management

- (a) For the effective Invasive alien species management, the creation of web-based or other information and technology transfer tools to disseminate disturbance ecology and invasive species, establishment techniques for native species, species habitat (native Community) relationships, and genetic range shall be a mandatory requirement
- (b) Working with strategic partners for developing seed banks of native plant materials shall be used for weeding out the existence of invasive species.
- (c) Creating and enforcing a State policy on the management of invasive species that takes into account the most up-to-date research on the advantages of utilising native species over non-native ones in ecological restoration and rehabilitation.
- (d) Compilation, highlighting, and sharing of information about existing restoration and rehabilitation successes throughout the State about the Invasive Species Management.
- (e) Identifying and coordinating the rehabilitation and restoration needs with research and development like value addition of the

Invasive Species.

- (f) Prioritizing and developing native plant stock that is resistant to invasive insects and pathogens.
- (g) Collaborating with the strategic partners to promote education and awareness about growing nurseries and planting the preferred native plant species.
- (h) Evaluation and monitoring of the results with the help of GIS based application for assessing effectiveness of restoration action.

Major invasive species in the state inside the RFA/Green wash in Tamil Nadu		
S.No	Species	Estimated Extent
1	<i>Lantana Camara</i>	1,154
2	<i>Chromolaena odorata</i>	220
3	<i>Solanum elaeagnifolium</i>	66
4	<i>Ageratum conyzoides</i>	44
5	<i>Cuscuta spp.</i>	31

**Source: ISFR 2021*

30. Use of Modern Technology and Innovations

Monitoring forest activities and ensuring the sustainable use of resources can be made much easier with the assistance of smart sensors (also known as Green bots or sensor nodes). In order to solve the challenges of sustainable forest management, the internet of things' (IoT) potential, particularly the employment of smart sensors or "green bots," shall be helpful. Even though India has promoted renewable energy sources as a way to reduce carbon

emissions, climate change continues to present significant obstacles to the nation's development. One of the main causes is that efforts to combat climate change have largely ignored forest conservation and restoration. On the other hand, activities like logging, both legal and illegal, deforestation for development, and people-induced forest fires have proven harmful to the objectives stated by official climate-action declarations. The Internet of Things (IoT) has not yet been extensively tested in the field of forest management, but technology-driven smart sensors, also known as "green bots" or "sensor nodes," may hold the key to preserving State forests while also supplying information that will aid in efficient analysis and promote sustainable forest management and conservation techniques.

31. A Forest fire monitory system shall be developed in the State for predictive analysis of the forest fires in order to prevent the degraded of the forest area and reduction in Green House Gas emission. Finally, by identifying key areas of afforestation and promoting afforestation activities. Eventually, green bots or sensor nodes can increase forest connectedness, enhancing biodiversity and extending native species' habitats. To sense the environmental parameters in the forest in a real-time setting, sensor nodes shall be planned to get embedded in the various trees. Typically, the wireless connection module and environmental sensors are incorporated into the sensor node. The major challenge in a forest environment is wireless connectivity; to get over this, a wireless personal network (WPAN) may be incorporated into the architecture. WPAN-based IEEE 802.15.4 Zigbee module is considered a wireless communication module in the sensor node for transmitting the environmental data from the forest environment. Zigbee communicates the data to the gateway node where the availability of internet connectivity enables the gateway node to log the data into the cloud server over IP and general architecture. The sensory technology and wireless communication protocol encourage monitoring and communication of the sensory data from the forest to the cloud server. IP and Transmission control protocol (TCP)

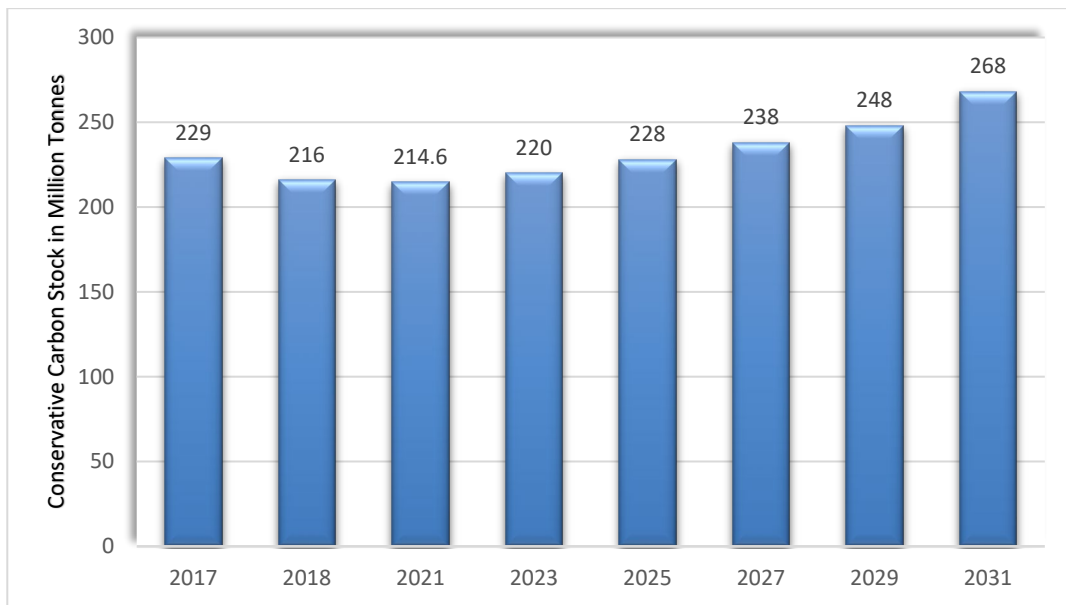
based forest monitoring system for monitoring the Carbon dioxide (MQ 135), Hydrogen (MQ 2), Methane (MQ 4), Carbon monoxide (MQ 9) in the forest (Gigli and Koo, 2011; Xiaojiang et al., 2020; Schneider et al., 2011). Low Earth Orbit satellite is integrating with IoT for monitoring and communicating the forest in the country of Indonesia (Ratnam et al., 2019). The source shall be Tamil Nadu under Green Tamil Nadu Mission.

Integration of IoT in MFP Cycle

32. The sensor node is interfaced with environmental sensors, a camera, an RFID reader, a barcode reader, a LoRa modem, and GPS. IoT-based devices are also embedded at the sensor node and integrated into the processing and packaging facilities. The internal atmosphere of the packaging/processing unit is monitored by environmental sensors, monitors factors like temperature, smoke, and humidity. A crucial natural resource that maintains the environmental parameters is the forest. Increased airborne emissions of greenhouse gases are a result of forest degradation. The earth's living organisms are negatively impacted by this. The major causes of the destruction of the forest are fire incidents and tree harvesting. Another element associated with the forest is wildlife.

33. Tribal people who living in the forest are also facing trouble in terms of livelihood due to the degradation of the forest. Therefore, real-time technology that detects the events in the forest environment in real time is needed in order to improve the vegetation, safeguard species that is in risk of extinction, and improve tribal people's quality of life. Real-time monitoring could be implemented using IoT by integrating IoT devices into the forest. We have addressed this with the traditional MFP cycle being transformed into a digital platform using an IoT-based strategy. The authorities have the chance to analyse the entire cycle on a digital platform due to the IoT solution for the MFP cycle and it enables them to formulate policy to increase the sales of the MFP products.

34. Presently the State of Tamil Nadu's has 214.6 million tonnes of carbon stored in its forest cover which is 2.98% of Country's carbon stock. Under the Green Tamil Nadu Mission, the State proposes to add 50-60 MT of Carbon stock in its forest by the year 2031-32 by increasing the forest & tree cover as well as by improving the growing stock and assisted natural regeneration works inside the recorded forest area of the State.



It is projected that due to intensive afforestation and restoration works, the carbon stock can be build up to about 260 - 270 MT, by the year 2031 from a base year of 2019 wherein the carbon sequestration in its forest cover of Tamil Nadu was 216 MT. Carbon capture potential of 30 indigeneous tree species have been estimated by accounting amount of CO₂ consumed per milli second in a unit of leaf. The averaged CO₂ sequestration potential of trees is appended below which are proposed to be planted in the Urban & Peri urban area, i.e. Industries, Temples, Schools, Colleges, Police & Defense establishments, Road sides etc.,

Sl.No	Species	Carbon Sequestration Potential (U Mol M-2s-1)
1	<i>Dalbergia latifolia</i>	16.36
2	<i>Dalbergia sissoo</i>	14.71
3	<i>Pterocarpus santalinus</i>	14.05
4	<i>Syzygium cumini</i>	12.14
5	<i>Butea monosperma</i>	11.84
6	<i>Cassia fistula</i>	11.315
7	<i>Terminalia bellerica</i>	10.435
8	<i>Mitragyna parvifolia</i>	9.69
9	<i>Ficus bengalensis</i>	9.18
10	<i>Neolamarckia cadamba</i>	9.155
11	<i>Thespesia populnea</i>	8.99
12	<i>Ficus religiosa</i>	8.18
13	<i>Terminallia catappa</i>	8.17
14	<i>Pongamia pinnata</i>	8.035
15	<i>Gyrocarpus jacquini</i>	7.61
16	<i>Ficus retusa</i>	7.445
17	<i>Gmelina arborea</i>	7.41
18	<i>Acrocarpus jacquini</i>	7.32
19	<i>Tamarindus indica</i>	7.315
20	<i>Terminalia arjuna</i>	6.9
21	<i>Mimusops elengi</i>	6.81
22	<i>Albizia saman</i>	6.66
23	<i>Bixa orellana</i>	6.28
24	<i>Tecoma stans</i>	6.06
25	<i>Pterocarpus marsupium</i>	5.55
26	<i>Azadirachta indica</i>	5.435
27	<i>Swietenia macrophylla</i>	5.39
28	<i>Aleurites fordii</i>	5.05
29	<i>Bauhinia purpurea</i>	4.91
30	<i>Melia azedarach</i>	4.51

The individual tree carbon sequestration potential can be used in calculating the total carbon sink created as the Forest and Institutional lands for trading the carbon with an overall objective to earn the carbon credits for the local communities and the State Government Institutions through voluntary carbon market in future.

The sale of carbon credits shall provide farmers supplementary income while they nurture their agri-silvicultural plantations". As on date, the carbon market trend indicates that the base price of 6 US dollars per Verified Emission Rates (VER) (one metric tonne of CO₂ removed from the atmosphere) is being given as a carbon credit for sequestering a tonne of carbon on the farmlands which has the potential to increase in future keeping in view the vibrancy in the international carbon markets in future.

35. Capacity building for officers and field staff on how to quantify carbon pools in above-ground biomass and below-ground biomass of trees, dead wood, leaf litter, and soil organic carbon as well as how to analyse data of such pools, use of GPS technology, etc. would also become as important deliverables of the Mission. This will enable the Department to gain expertise and built its capacity to understand carbon trading systems and become fully independent organizations in Measuring, Reporting and Verifying (MRU system) the carbon stock for the benefit of the local communities and Institutions, saving the future costs of carbon stock measurement and trading.

36. Forest Resource Accounting for Improving the management and conservation of Eastern Ghats

Eastern ghats are endowed with one of the diverse varieties of flora and fauna and are spread over a vast area on the east coast of India starting from Nilgiris in Tamil Nadu to Sunderbans in West Bengal. An important and integral component of the maintain range is the forests; therefore, the conservation of forests - both flora and fauna assumes a greater importance and so do their management. An important aspect of the conservation and management of forests is an assessment of the economic value of the resource being conserved and basing their management on such valuation and the costs of conservation. The physical accounts of forests - cover, classification, density and composition - are to be documented first, to the extent possible, in a forest resource accounting exercise. The

functions of forests then need to be defined to step into economic valuation using appropriate methods. This may require taking the help of ecologists (taxonomists), sociologists, economists and anthropologists for identification. Economic valuation of functions of the forest shall be taken up for the important functions identified from the above and economic valuation shall be undertaken to make an assessment of the respective economic values of the functions rendered by forest resources within the State including mountain range of Western / Eastern Ghats. The economic valuation methods that may be applied to measure the benefits rendered from the functions of forests shall be as per the accepted methodologies wherein Total Economic Value (TEV) = Total Direct Value (TDV) + Total Indirect Value (TIV)

37. The monetary valuation of the ecosystems services (marketed and non- marketed products shall be undertaken under the Mission for the monetary valuation of the ecosystem services (marketed and non marketed products) for arriving the total economic value (TEV) of the forest ecosystems. The following aspects would be given priority despite knowing the fact that it is going to be challenging task under the Green Tamil Nadu Mission. Under the Mission, the following ecosystem goods and services (marketed and Non - marketed) shall be evaluated for the long term benefits that would be accruing on account of the ecological restoration process.

Flow of Ecosystem benefit Services (Marketed and Non-marketed)

Adaption measure	Adaption function	Social and cultural benefits	Economic benefits	Biodiversity Conservation	Climate Change mitigation
Mangrove Conservation	Protection against storm surges, sea level rise and coastal inundation	Provision of employment options (fisheries and prawn cultivation); Contribution to food security	Generation of income to local communities through marketing of mangrove products (fish, dyes, medicines)	Conservation of species that live or breed in mangroves	Conservation of carbon stocks, both above and below-ground
Forest Conservation and sustainable forest management	Maintained nutrient and water flow, Prevention of land slides	Opportunities for: Recreation Culture protection of indigenous people and local communities	Potential generation of income through Ecotourism, Recreation Sustainable logging	Conservation of habitat for floral and faunal species	Conservation of carbon stocks; Reduction of emission from deforestation degradation
Establishment of diverse agro silviculture system in agricultural land	Diversification of agricultural production to cope with changed climatic condition	Contribution to food and fuel wood security	Generation of income from sale of timber, fire wood and other products	Conservation of biodiversity in agricultural landscape	Carbon storage in both above and below ground biomass and soils
Conservation of medicinal plants used by local and indigenous communities	Local medicines available for health problems resulting from climate change or habitat degradation, e.g., malaria, diarrhea, cardiovascular problems	Local communities have an independent and sustainable source of medicines Maintenance of local knowledge and traditions	Potential sources of income for local people	Enhanced medicinal plant conservation ; Local and traditional knowledge	Environmental services such as bees for pollination of cultivated crops.

(a) The rate of loss of all natural habitats, including forests, shall be brought down by 75% with a base year of 2019 and where ever feasible shall be brought close to zero along with the degradation and fragmentation by 75%, by the end of 2030-2031.

(b) By 2030, areas used for agriculture and forestry must be maintained sustainably to ensure biodiversity protection and a minimum 50% increase in pollination services from the base year of 2019. This will improve the production of food and fruits..

(c) By 2030, at least 50% of all terrestrial, inland water, and coastal and marine areas, particularly those that are particularly important for biodiversity and ecosystem services, shall be conserved through well-managed protected area networks, other effective area-based conservation measures, and integration into the larger landmasses and seascapes.

(d) Enhancing ecosystem resilience and biodiversity's contribution to carbon stocks through conservation and restoration, including restoring roughly 60 to 70 percent of

degraded ecosystems, can help with climate change adaptation and mitigation as well as desertification prevention.

(e)Bee, bird, and fly pollination, which affects 35% of global agricultural production, is quite significant. Similar to bees, other pollinators like birds and bats are essential to the production of food since they boost the yields of 87 of the most important crops in the world and have an impact on 35% of global crop production, according to the Food and Agriculture Organization (FAO). According to a study in the International Research Journal of Natural and Applied Sciences, the majority of food crops in India require insect (primarily bee) pollination. These crops include oilseeds (sunflower, safflower), vegetables (carrot, coriander, cucumber, onion, etc.), and fruits (apple, almond, apricot, peach, etc.). Pollinators are essential to the growth of these crops.

Anticipated Yield increase due to bee pollination

Crop	Yield increase (in percent)
Mustard	43
Sunflower	32-48
Cotton	17-19
Lucerne	112
Onion	93
Apple	44

With the loss of biodiversity, growing stock and the "bees populations are under great threat from the combined effects of climate change, intensive agriculture, pesticides use, and pollution," (Jose Graziano da Silva, a Brazilian-American agronomist and former director – general of the FAO). The declining number of pollinators, however, threatens crops that

are dependent on them as about 50 million hectares of crops across India depends on pollination by bees. Through the restoration of degraded forest land, around 150 million bee colonies that are needed to increase the yield of the food crops (wild & domesticated) shall be attempted in the State under the mission which comes around pollinating three colonies per hectare. According to the study by the Tamil Nadu Agricultural University, Coimbatore, in 2014, there were only 1.2 million colonies of bees which is highly inadequate for improving the yield of the food crops, therefore the number bee colonies shall be studied or the recent data if available with the Tamil Nadu Agriculture University shall be obtained and attempt shall be made to increase the bee colonies for improved pollination process and accompanied biodiversity enrichment.

38. The Studies on Forest ecosystem services valuation in Maharashtra has indicated based on the global meta-analysis study of Costanza et al 2014, that in addition to carbon sequestration, these are other important ecosystem services like Gene pool protection (Rs. 91,020/hectares/year), Biological control (Rs. 660/ha/year), provisioning of habitat and Refugia for wildlife (Rs. 2,340/ ha/year), Pollination (Rs. 1800/ha/year), Gas regulation (Rs. 720/ha /year), waste assimilation (Rs. 7,200/ha/year), which are non-marketed products but carries lot of weight towards the sustenance of human lives. Similar studies for various ecosystem good and services (marketable and non- marketable) has been conducted for the Kaziranga Tiger Reserve, Assam for which the component wise ecosystems valuation is as follows:

Valuation of Ecosystem goods & services

S. No.	Ecosystem Services	Value (in millions / Year)
(i)	Standing Stock	21,400.00
(ii)	Gene-pool Protection	3,490.00
(iii)	Carbon Storage	990.00
(iv)	Carbon Sequestration	17.37
(v)	Biological Control	149.72
(vi)	Pollination	86.79
(vii)	Habitat/Refugia	5,730.00
(viii)	Recreation	21.50
(ix)	Gas Regulation	26.05
(x)	Waste Assimilation	234.45

39. The InVEST software can be used for quantifying the carbon Storage and Sequestration, Climate Regulation Model, the water yield, Sediment Retention, avoided Dredging and water purification Model. The results of the InVEST exercise are envisaged to assist in identification of ecosystem service hotspots within the protected area which can be used for the other forest area also, for valuation of the ecosystem good and services. The study on the ecosystem valuation of the 16 Tiger Reserves in the country has adopted value + approach, wherein the 'VALUE' represents all benefits for which monetary economic valuation is possible and conducted, while the + represents all those benefits for which economic valuation is currently not possible either on account of lack of accepted methodologies, knowledge and/or understanding. The economic values derived in the study are thus conservative. The valuation of ecosystem flow and benefits shall be undertaken for the restored degraded forest areas by involving the Indian Institute of Forest Management, Institute of Ecological Sciences, Bengaluru and other Reputed Scientific Institutes as one of the probable deliverables of paramount importance, under the Green Tamil Nadu Mission.

40. Utilization of biomass like invasive weed such as *Lantana camara* which has invaded into about hectares of forest cover in the State has a greater advantage of discovery of clean, renewable energy sources for reduction of deforestation and loss on indigenous trees. The study by Centre for Environmental Sciences, Addis Ababa University, Ethiopia has indicated that charcoal and briquette produced from *Lantana camara* (root, stem, branches, leaf) were found as quality sources of energy as all the charcoal and briquettes have higher calorific value (7483.99 cal/gm, 6525.54 cal/gm), high fixed carbon content (66.44%, 53.89%), low volatile matter, low moisture, and low ash content. As a source of energy *Lantana camara*, briquettes deliver clean energy that reduces indoor air pollution and respiratory infectious diseases that occur due to release of smoke during cooking or burning. The *Lantana camara* has the potential to solve the rural and urban household energy needs by supplying of clean renewable energy in the form of charcoal and briquettes. Similar briquetting materials can be obtained from farmlands (lops and tops of tree grown on the farmlands) with a potential of setting up of 10 MW Dendro-biomass based clean power generation in each of the block of Tamil Nadu.

A proposal for converting the *Lantana camara* in to the briquettes as the value-added product has already been approved by the then State Planning Commission, Government of Tamil Nadu under TANII scheme (Government Order issued) for value addition of *Lantana camara* briquettes by involving the local tribal communities and their capacity building in the briquetting technology with an ultimate objective of restoration of local biodiversity as well as for improving the livelihood of local communities.

41. Total anticipated Revenue and expenditure on harvesting of *Arthrocephalus*, *Dalbergia sissoo*, *Swietenia mahagoni*, *Red sanders* and *sandal wood*, *Casuarina*, *Melia dubia* and *Teak* (Rs. in-cr.), by

the farming communities in a period of 10 years.

Sl. No	Species	Revenue (Rs. in cr)	Expenditure (Rs. in cr)
1	<i>Melia dubia / Casuarina</i>	25032.5	7875.63
2	<i>Teak</i>	10612.37	499.84
3	<i>Dalbergia sissoo, Anthocephalus, Swietenia mahagoni, Red sanders and Sandal wood, etc</i>	15474.6	195.07
Total		51119	8570.54

The planting of *Acacia nilotica* (Karuvel) on the tank fore plantations on the Panchayat tank may yield an additional Rs.5000 crore (conservative estimate). The Panchayats are expected to get Rs.2438 crore (Projected revenue as the Panchayat revenue share, in a period of 8-10 years, and Rs.812 crore shall be the revenue share for the Government.

42. There are many different agricultural activities that can maintain and possibly expand carbon stocks while simultaneously assisting in the conservation and sustainable use of biodiversity, in addition to the possibilities for forest-based climate change mitigation. The use of conservation tillage and other sustainable cropland management techniques, sustainable livestock management techniques, agro-silviculture systems, the reduction of drainage systems in organic agricultural soils, better fertiliser management practises, increased use of organic fertilisers, and the preservation or restoration of natural water sources and their flows, including wetlands, are some important examples of agricultural activities that can provide multiple benefits. For instance, restoring damaged cropland soils may boost soil carbon storage, crop yields, and help preserve agricultural biodiversity, including soil biodiversity. The global sequestration potential through increasing soil organic carbon via improved agricultural practices is estimated to be 1-6 Gt C/yr, which also shall be taken into account in the year 2030 as an achievement of the State of Tamil Nadu for offsetting the carbon emissions from fossil fuel land electricity generations in

order to facilitates the achieving of net zero emissions of Co2 by the year 2030.

43. Urban and Peri-urban forestry

- a. Urbanization is considered inevitable because of increasing population pressure on the urban areas. It is essential to maintain an intricate balance between the green & blue infrastructure and the grey infrastructure. The gray infrastructure has been causing temperature rise in the urban & peri urban areas particularly the metropolitan areas which has been scientifically proven in several studies like the one published in Journal of Environmental Quality during the November 2015 wherein the Urban Heat Island (UHI) was talked about in detail. The article mentioned about the adverse effects of UHI in Mexico City and how it has affected human thermal comfort, human productivity and morbidity during the peak summer period.

- b. The situation is no different in several metropolitan cities across the Globe due to increased concretization in the urban areas. The UHI mitigation by vegetation with emphasis on urban trees which can increase tree transpiration shall be a crucial part of UHI mitigation. On the contrary we are losing the urban trees and its geographical coverage. The ISFR 2021 shows that only 5% of Chennai total GA is covered with trees which are much less compared to Mumbai, Delhi or Hyderabad. The only city which is closes to 33% urban areas under tree cover is Mumbai where about 25% is under forest and tree cover. Under the Green Tamil Nadu Mission, the tree planting in urban & peri urban areas with native & climate resilient species shall be accorded priority in order to mitigate the UHI effect as also to improve the air quality by planting native trees having moderate to high Air Pollution Tolerance Index (APTI). The UHI effect shall be dealt scientifically through multi-disciplinary approach that will require urban developers, ecologists, architects, engineers,

climatologists, geographers and sociologists for holistic urban planning for more sustainable cities in the State.

- c. The role of trees in mitigating urban temperature has been widely studied by *K.Sathiameena, Narasimhan. D and Pari R* inside the Government Arts College, Salem where several heritage trees have been found existing in the College which has completed 165 years in educational services. It was observed in the study that *Ficus benghalensis, Ficus religiosa, Azadirachta indica and Samanea saman* have been found to be best shade providing trees. The two main causes of the temperature reduction generated by these trees are direct shading and evapo-transpirational cooling (Monteiro et al 2019). The study added that the two main problems that cities worldwide are currently dealing with are urban-induced heat and climate change.
- d. Despite all the studies conducted by various Scientists and scholars on the role of native trees in urban heat island (UHI) mitigation these have seldomly been followed in other cities of Tamil Nadu. The following species which have influence on the temperature is therefore suggested for following it for other cities of the State for UHI mitigation:-

S.No	Botanical name	Vernacular Name	Temperature (°C) 12' noon			
			More vegetation area		Less vegetation area	
			Inside	Outside	Inside	Outside
(i).	<i>Albizia lebbbeck L. Benth</i>	Vagai maram	32	48	34	48
(ii).	<i>Azadirachta indica (A. Juss.)</i>	Veppa maram, Vembu	28	46	30	46
(iii).	<i>Couroupita guianensis (Aubl.)</i>	Nagalingam maram	42	46	30	46
(iv).	<i>Delonix elata (L.)</i>	Vaadha narayana	32	46	36	48
(v).	<i>Delonix regia (Hook)</i>	Cemmayir-Konrai	32	46	36	48
(vi).	<i>Eucalyptus tereticornis Sm.Spec.Bot.</i>	Thaila maram	36	46	40	48
(vii).	<i>Fiscus benghalensis L., SP.Pl</i>	Aalamaram	28	48	30	48
(viii).	<i>Fiscus religiosa L., S.P.Pl.</i>	Arasa maram	29	48	32	48
(ix).	<i>Holoptelea integrifolia (Roxb.)</i>	Aavi maram	40	44	40	44
(x).	<i>Mangifera indica. L.SP.Pl</i>	Mamaram	38	48	38	48
(xi).	<i>millettia pinnata (L.)</i>	Pungai Maram	38	46	40	46
(xii).	<i>Mimusops elengi L.SP.Pl</i>	Magizham boo maram	40	46	40	48
(xiii).	<i>Peltophorum pterocarpum (D.C.)</i>	Perung-Konrai	32	48	36	48
(xiv).	<i>Pithecellobium dulce (Roxb). Benth.</i>	Kodukkapuli maram	44	46	46	48
(xv).	<i>Samanea saman (Jacq.) Merr.J.</i>	Thoongumongi maram	28	46	32	46
(xvi).	<i>Spathodea campanulata P.Beauv., Fl.</i>	Thaneervitan Kaai maram	36	46	38	46
(xvii).	<i>Syzygium cumini (L) Skeels Bul.Bur.Pl.</i>	Naval maram	36	44	42	48
(xviii).	<i>Tamarindus indica (L).</i>	Puliya maram	32	48	36	48
(xix).	<i>Terminalia catappa L. Mant. Pl.</i>	Inguti Maram	40	48	42	48
(xx).	<i>Thespesia populnea (L.) Sol. ex. Correa</i>	Poovarasu maram	44	46	42	48

Further the list of heritage trees which are climate resilient native trees and have been surveyed in Salem city have been known for lowering the surface air temperature by providing shade and through evapo-transpiration. The evapo-transpiration from these climate resilient shade trees has shown to reduce peak summer temperature by -17 degrees C to -13 degrees C. The canopy cover of 10% has been found associated with approximately 1 degree C temperature difference (*Karim and Wolf, 2007*). The list of heritage trees which can be included in the urban planning process in other cities for further mitigating the UHI effect are as follows:

AIR POLLUTION TOLERANT TREES

Sl.No	Species	Air pollution tolerance index (APTI)
1.	<i>Pongamia pinnata</i>	13.4
2.	<i>Aegle marmelos</i>	13.35
3.	<i>Azadirachta indica</i>	13.25
4.	<i>Ficus religiosa</i>	13.1
5.	<i>Ficus benghalensis</i>	12.67
6.	<i>Tamarindus indica</i>	12.52
7.	<i>Holoptelea integrifolia</i>	12.39
8.	<i>Terminalia catappa</i>	8.91
9.	<i>Polyalthia longifolia</i>	8.81
10.	<i>Tectona grandis</i>	8.77
11.	<i>Thespesia populnea</i>	8.77
12.	<i>Cassia montana</i>	8.45
13.	<i>Ficus glomerata</i>	8.41
14.	<i>Prosopis spicigera</i>	8.3
15.	<i>Cordia monoica</i>	8.13
16.	<i>Eucalyptus globulus</i>	8.07
17.	<i>Tabebuia rosea</i>	8.06
18.	<i>Pisonia morindifolia</i>	8.05
19.	<i>Samanea saman</i>	8.00
20.	<i>Ficus elastica</i>	7.89
21.	<i>Swietenia mahagoni</i>	7.83
22.	<i>Grevillea robusta</i>	7.82
23.	<i>Albizia lebbeck</i>	7.72
24.	<i>Nyctanthes arbor-tristis</i>	7.63
25.	<i>Melia azedarach</i>	7.61

26.	<i>Mangifera indica</i>	7.58
27.	<i>Mimusops elengi</i>	7.55
28.	<i>Aralia foliolosa</i>	7.45
29.	<i>Wrightia tinctoria</i>	7.28
30.	<i>Gmelina arborea</i>	7.09
31.	<i>Acacia nilotica</i>	6.84
32.	<i>Syzygium cumini</i>	6.66
33.	<i>Simarouba glauca</i>	6.57
34.	<i>Acacia melanoxylon</i>	6.52
35.	<i>Psidium guajava</i>	5.83

Similarly identification of air pollution tolerant tree species in Tirupur district was studied by *S. Paulsamy and P. Senthillumar* where industrial and automobile pollution has been the leading cause of release of enormous quantity of air pollutants. The authors made an attempt to identify air pollution tolerant species based on Air Pollution Tolerance Index (APTI). Out of the 35 tree species analysed, seven species namely *Aegle marmelos*, *Azadirachta indica*, *Ficus benghalensis*, *Ficus religiosa*, *Holoptelea integrifolia*, *Pongamia pinnata* and *Tamarindus indica* secured higher APTI value which is required to be given priority for plantation programmes under Green Tamil Nadu Mission for abatement of air pollution in and around industrial complexes and also new urbanized areas. The species wise air pollution tolerance index (APTI) of various tree species is suggested below for planting in the urban areas for improving the air quality.

44. Urban greenery is assuming greater significance in the era of climate crisis like increased air & land surface temperature and air quality deterioration. In order to ensure the fulfillment of SDG no.6 i.e. sustainable cities and lifestyle, urban greenery is required to be an integral and inseparable part of the urban planning so as to improve the environmental quality, quality of life, sustainable urban development, carbon sequestration, reducing air & noise pollution, providing recreational opportunities to the urban and peri-urban people. Trees in the urban areas play a pivotal role in removal of air pollution in gaseous form (*e.g. ozone, sulfur dioxide, and nitrogen*

dioxide and nitrogen dioxide). Trees in urban environment also mitigate pollution by blocking the airborne particles, which go again into the atmosphere or washed off by rain or dropped to the ground with leaf and twig fall (Nowak et al., 2006). Indirectly, trees can reduce the air temperature through direct shading and evapo transpiration in the summer season, thus reducing the air pollutants from the process of generating energy for cooling purposes. Reduced air temperature lowers the activity of chemical reactions, which produce secondary air pollutants in urban environment (Taha, 1996; Nowak et al., 2000; Yang et al., 2005). Several environmental benefits have been attributed to the urban greening which are as follows:-

- a) Pollution abatement
- b) Mitigation of urban heat island effects.
- c) Carbon sequestration and climate change mitigation
- d) Improving air and water quality and reduction in raise Pollution quality
- e) Reduction in volatilization of bitumen and reduction in heating / cooling for saving of investments in the energy sector
- f) Architectural enhancement of buildings, Green landscaping for mitigating stress and urban glare
- g) Improving mental health and quality of urban life
- h) Opportunities for outdoor recreation and enjoyment
- i) Contribution to mitigating quality of human health improving the urban habitat for bird life

45. *Mangifera indica*, which had the greatest Air Pollution Tolerance Index, was determined to be the best species for being reasonably tolerant of air pollutants, while *Artocarpus* spp., which had the lowest APTI, was found to be the most sensitive. The tolerant (*Mangifera indica*) and sensitive (*Artocarpus* species) plants are utilised as sinks for air pollutants and bio-indicators, respectively. APTI and expected performance index (API) values were used by Rai and Panda (2014) to determine whether or not a particular tree species would be suitable for planting along Mizoram state's dirty roadways. As a result, it was determined that *Ficus bengalensis*, *M. indica*, *Psidium guajava*, *F. religiosa*, *Artocarpus*

heterophyllus, and *L. speciosa* were ideal, in the order indicated, for roadside plantation in polluted areas of northeastern India that could be reproduced in the State of Tamil Nadu.

Three commonly grown hedge species, Bougainvillea spectabilis, Duranta plumeri Jacq., and Nerium indicum Mill., had their particulate abatement capacity (PAC) assessed.

46. To determine how different plant species react to urban air pollution, a second, two-year study was carried out in Varanasi, India. Study subjects included the tree species *Carissa carandas*, *Delonix regia*, and *Cassia fistula*. At various locations, the quantity of air pollution was correlated with reductions in plant height, basal diameter, canopy area, biomass, chlorophyll, ascorbic acid, and nitrogen content in leaves. It was discovered that *Carissa carandas* are more tolerant of pollution than the other two species (Pandey and Agrawal. 1994).

47. Software models like as UFORE (Urban Forest Effects model developed by USDA Forest Service Northeast Research Station) and CITY green (made by American Forests, 2004) that can assist in quantifying not only the air pollutant removals by plant species in urban environments but also in quantifying the structure of urban forests, e.g. species composition, number of trees, sizes, and their locations need to be explored by calling EoI. This will assist city planners in assessing current green spaces and determining the necessity of planting more trees and enhancing urban forestry in India (Govindarajulu, 2014). According to the literature now in use, there is currently no study from Indian cities utilising these or comparable models that may be used in the State of Tamil Nadu under the Green Tamil Nadu Mission setting an unique example in the Country in using the Urban forestry/plantations as a real time pollution abatement mechanism.

48. Comprehensive research database on urban forestry in the

country is still lacking. To compete with other kinds of city budgets, it is essential for urban forestry to raise its public profile and publicize its multiple contributions to the public at large (*Chaudhry and Tewari, 2011*), which can later be monetized by way of scientific studies, in order to emphasize upon the quantum of flow of ecological benefits to the society as a whole.

MONITORING AND EVALUATION

(i). Third party monitoring (midterm and final) on the outcomes like increase in the growing stock inside the Recorded Forest Area, Green waste areas, farmland and all other lands as mentioned in Para (-) alongwith the carbon sequestration, in the biomass, litter and soil and the revenue benefits generated to the small and marginal farmers shall be undertaken by reputed institutions, selected as per the existing norms and regulations in force.

(ii). In addition to the capturing of geo-coordinates of the individual tree planted under the Green Tamil Nadu Mission (Geo-tagging land parcel, there are other performance indicators which also need to be monitored involving the third party like NABARD Madras School of Economics, Institute of Ecological Sciences, Bengaluru, Madras Institute of Sustainable Development, Chennai, Institute of Remote Sensing, Anna University, Chennai, SACON, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu Water Investment Company, Chennai and other reputed institutions. Such performance indicators which need to be monitored on biennial basis by way of GIS/Remote Sensing and the ground truthing shall be as follows.

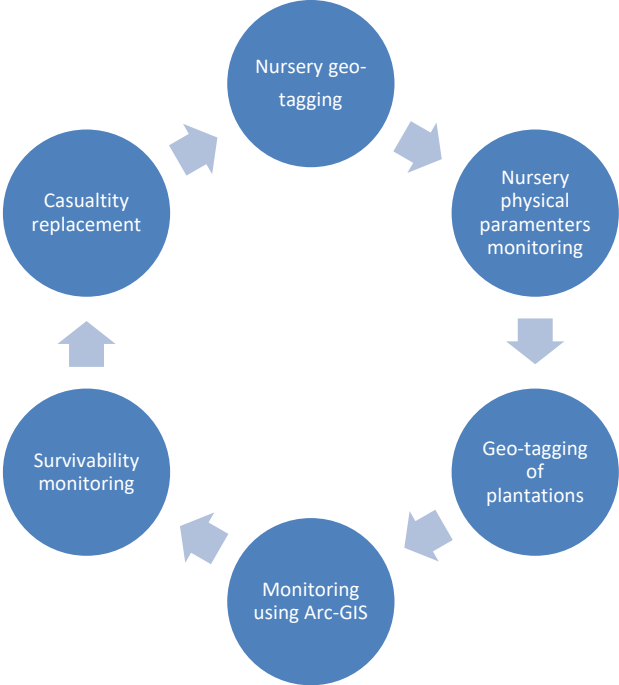
S.No.	Parameters	Indicators
(i)	Increase in forest and tree cover-survival & growth of planted seedlings / success of the assisted natural regeneration works by the local tribals and other forest dwellers. Increase in carbon sequestration potential of the natural forests and Tree outside forests.	<ul style="list-style-type: none">● Above ground biomass carbon● Below ground biomass carbon● Soil organic carbon● Forest litter.

(ii)	Increase in water yield and e-flow to the nearby stream, and the major river system of TamilNadu.	<ul style="list-style-type: none"> Water retention in the farm ponds, water holes, checks dam and the percolation ponds, and its flow to the nearby streams.
(iii)	Rate of reduction of sediment flow to the downstream water bodies.	<ul style="list-style-type: none"> Sediment retention through vegetative method gabionic structures, Checkdams and gully plugging.
(iv).	Increased number of activities that are based on a sustainable framework	<ul style="list-style-type: none"> Increased number of beneficiaries taking up livelihood activities with conservation outcomes; for example collection of seeds from genetically superior trees, setting up of plant nurseries People forming groups to ensure sustainable extraction of non-timber forest products.
(v).	Increased incomes coupled with sustainable use of natural resource	<ul style="list-style-type: none"> Number of individuals / Communities taking up assisted natural regeneration works. Linking employment generation under NREGA with habitat improvement activities, such as restoration of degraded pastures and grazing lands, development of folder banks on community lands, soil and moisture conservation measures Performance linked green amount received per Individual / Community through DBT
(vi).	Better return of investments	<ul style="list-style-type: none"> Increased access to nearby markets by developing market linkages and incorporating principles of supply chain management w.r.t non-timber forest products Development of new markets for which skills and input resources are to be upgraded Promotion of value addition of natural products instead of trading in natural

		resourcesbased raw materials
(vii)	Capacity Building	<ul style="list-style-type: none"> ● X number of beneficiaries trained in new livelihood activities, such as, ecotourism, nature guide, adventure activities, nursery practices, forest fire prevention etc. ● Stakeholders trained in accounting, business practice for small enterprises and for federating to negotiate for a better market price
(viii)	Conflict Management	<ul style="list-style-type: none"> ● Legal awareness of rights and responsibilities ● Endorsement of action plan by community to implement the provisions of Schedule Tribe and Forest dwellers Act
(ix)	Equitable benefit sharing arrangement of NTFP, Carbon Credits and other resources	<ul style="list-style-type: none"> ● Incentives for communities ● Policy interventions ● Rules of engagements

Third party monitoring and evaluation shall be an important key for the successful implementation of Green Tamil Nadu mission. Since plantation operations take years to yield visible results, concurrent monitoring from the stage of species selection, nursery to planting and maintenance shall be a prerequisite for long term success of the Mission. The land parcels of the nurseries and plantations shall be geo-tagged and uploaded on Green Tamil

Nadu Mission web portal (www.greentnmission.com) with necessary physical parameters to ensure real time monitoring of the operations and also shall act as a database for future references. It is proposed to ensure the monitoring using Arc GIS, as the arc GIS platform provides for creating, updating and managing real time data and helps to collect data and non-spatial information directly from the field. The ground truthing of the Arc GIS data shall be done by Geomatics centre of the forest department from time to time to ensure the data accuracy. Accuracy assessment shall be carried out after the plantations are mapped by converging and verifying the data from ArcGIS and ground truthing.



Projected Number of Seedlings in Crore and the Area (in sq.kms)
(for 10 year period under Green Tamil Nadu Mission)

Year of Planting	Number of Seedling in (crore)	Projected area of Planting (in sq. kms)
2021-22 & 2022-23	2.5 crore	10,000 hectares

2023-24	7.5 crore	30,000 hectares.
2024-25	15 crore	60,000 hectares
2025-26	25 crore	1,00,000 hectares
2026-27	25 crore	1,00,000 hectares
2027-28.	25 crore	1,00,000 hectares
2028-29	25 crore	1,00,000 hectares
2029-30	25 crore	1,00,000 hectares
2030-31	25 crore	1,00,000 hectares
2031-32	25 crore	1,00,000 hectares

In addition there will be in situ assisted natural regeneration of native seedlings inside the forest areas to an extent of 4000-4500 sq. kms wherein about 100-125 crore seedlings shall be grown.

The cost of raising, planting and maintenance of the seedlings is not being provided here as the voluntary participation of the Industries, Voluntary Organizations, communities and individuals shall be promoted in the planting and maintenance of the seedlings .The expenditure details of the raising and planting activities shall be made available on the web portal of the Green Tamil Nadu Mission (www.greentnmission.com) for all the years in order to ensure the fairness and transparency in the implementation of the Green Tamil Nadu Mission.

OPERATIONAL GUIDELINES FOR THE GREEN TAMIL NADU MISSION

1. Background & Objectives

(i). Trees and forests are a critical resource required for human existence and are important carbon sinks. The trees help in the pollution abatement and few trees have been found to be high in air pollution tolerance index. The forests and trees absorb carbon dioxide from the atmosphere and store the carbon in its over and underground biomass and soils. Carbon sequestration by forests has attracted much interest as a mitigation approach, as it has been considered a relatively inexpensive means of addressing climate change though the growing of forests and trees are not the major solution for mitigating the adverse impact of climate change.

(ii). Forest management practices that improve the biodiversity carbon sequestration include:

- a) afforestation, reforestation and forest restoration;
- b) increase of tree cover through agroforestry, urban forestry and tree planting in rural landscapes;
- c) enhancement of forest carbon stocks (in both, biomass and soils) and sequestration capacity through the modification of forestry management practices.

(iii). Trees Outside Forests (TOF) include agroforestry systems on agricultural lands, trees on the urban and rural landscape and along roads, rivers and human settlements. While contributing to environmental sustainability, trees also provide income and a range of goods and ecosystem services for rural households, thus contributing to food security and poverty eradication. The

contribution of trees outside forests to climate change mitigation can be increased by promoting agroforestry systems and urban forestry. Trees outside forests can also have an important role in climate change adaptation, through diversified land-use practices, livelihoods and sources of income, Trees on the farmlands have been proved to be beneficial in enhancement of agricultural productivity and buffering against weather-related production losses, enhancing resilience against climate impacts in farming systems.

(iv). Deforestation and forest degradation, whether due to human activities or natural causes, result in loss of biodiversity and carbon stock reductions besides the greenhouse gas emissions, having direct impact on the loss of forest goods and services, threatening livelihoods, environmental functions and other socio-economic values. Sustainable Forest Management endeavors to rectify such deleterious impacts that cause forest degradation, and ultimately deforestation. Forest threats include fires, pests and diseases, poor management and harvesting, overexploitation, grazing and other disturbances. Therefore, the forest management measures shall have to be adapted to the specific threats of the site. Forest management activities that conserve and enhance the biodiversity and carbon stocks in forests include:

- a) Sustainable practices of Forest Management and use (SFM);
- b) Integrated Fire Management;
- c) Management of Forest Health and Vitality;
- d) Management of Forest Biodiversity;
- e) Management and Extension of Protected Areas.

In forests, biological diversity, in particular the genetic diversity,

allows species to adapt continuously to evolving environmental conditions (including climate change), to maintain the potential for selection and improvement to meet future needs and changing end-use requirements, and to support ecosystem functions. Biodiversity is key to resilience of forest ecosystems to climate change, and the conservation of forest carbon stocks is secondary in nature.

(v). The biodiversity that forests preserve is the foundation for the vast number of products and services they offer, making them one of the most significant repositories of terrestrial biological diversity. In a variety of ways, forest trees and shrubs play an important part in the day-to-day activities of rural communities. They provide wood and non-wood products, help conserve soil and water, and serve as a storehouse of aesthetic, moral, cultural, and religious values.

(vi). Several studies suggest the inclusion of forests and trees, which are sometimes disregarded as readily available carbon removal solutions, is crucial to achieving the global mitigation targets. These solutions include replanting, better forest management (IFM), and reduced deforestation and forest and other land degradation. With regard to enhancing soils, improving air quality, water quality, biodiversity, and supporting human livelihoods, forests and trees hold considerable promise for achieving the aims of climate mitigation.

(vii). The Government of Tamil Nadu has initiated the Green Tamil Nadu Mission under the leadership of Hon'ble Chief Minister of Tamil Nadu. Under the said Mission, the forest and tree cover increase is proposed from 23.7% to 33% in a period of 10 years to make the State a climate resilient State. All the Government Departments, District Administration, Public sectors, Private sectors, Institutions, Farmers, NGO's individuals, Media houses shall play a pivotal role in the Mission and the Mission Director, Green Tamil Nadu Mission shall be the Nodal Authority for spearheading the Green Tamil Nadu Mission and shall appraise the progress on the

Mission to the State Green Committee.

(viii). The Green Tamil Nadu Mission which is a flagship scheme of the Government of Tamil Nadu and the Mission envisages to sustainably manage and improve its forest and tree cover recognizing its key role in biodiversity conservation and the climate change adaptation and mitigation. The State plans to augment the efforts of the Union of India in facilitating the commitments made under the Bonn Challenge and sequestration of carbon in its forests and tree cover to offset the carbon emissions from the Industries, Transport and Energy sectors by adopting two-pronged strategy as below.

- a) Forest land restoration by encouraging planting of indigenous/native species which locally adapt to rainfall and temperature extremes and promote biodiversity which is critical in addressing the livelihood and concern of climate change.
- b) Increasing Tree cover outside conventional forests for improving income opportunities of farming communities, creating additional carbon sink and minimizing the air pollution impacts.

(ix). The Green Tamil Nadu Mission shall be implemented with following broad objectives:

- a) Increase the Forest and Tree Cover in the State from present 23.7% to 33% by the year 2030-2031 as per the National Forest Policy, 1988 and as per the vision of the Government of Tamil Nadu, through afforestation activities on the degraded forest landscape and tree planting activities outside the forest areas.

- b) Expand tree cover on farmlands to complement agricultural crops. Build a robust data base on farmers and the growing stock in their land for developing a strong institutional marketing linkage for tree growers to enhance income opportunities.
- c) Improving the growing stock and biodiversity within the recorded forest area through Community Public Private Participation (CPPP model)].

(x). Under the "Green Tamil Nadu Mission", the role of Agroforestry would be instrumental in getting closer to the objectives of achieving 33% geographical area under Forest and the Tree cover as per the Operational Guidelines under the National Mission for Sustainable Agriculture (NMSA). The trees growing under the Mission on the farmlands under agro-forestry campaign shall be exempted from felling and transit permits except for sandalwood and Rosewood.

2. Green Tamil Nadu Mission And REDD+ Objectives

(i). The potential role and cost-effectiveness of forest and tree conservation, degraded land restoration and REDD+ in Climate change mitigation and adaptation has been scientifically prove through several national and the global studies. The Green Tamil Nadu Mission envisages the role of forests and trees in the carbon stock enhancement, increase of tree cover in farming systems (agroforestry), rural landscapes and cities, enhancement of carbon stocks and sequestration capacity through management practices, like conservation of forest biodiversity, forest health and vitality, forest fires invasive species. The Mission will also include adaptive land use planning and management, strengthened coping

mechanisms, diverse employment and livelihood prospects related to forest tree management, and adaptive management methods.

(ii). Transparent Monitoring, Reporting and Verification (MRV systems) are key pillars for REDD+, improving forest management practices for enhancing productivity and quality of forests to reach the desired objective of achieving 33% of target of achieving forest & tree cover in the State shall also be the maintaining of the Green Tamil Nadu Mission. Emphasizing on the REDD+ activities shall be helpful in curbing emissions from deforestation and forest degradation and in conserving and enhancing the forest cover and the forest carbon stocks. Depending on their age, health, vulnerability to wildfires and other disturbances, and how they are maintained, forests can either be net sources or sinks of carbon. Therefore, scientific forest management will play a greater role in the mission as a technique for reducing carbon emissions, as well as boosting the density of the forests and the livelihood of local, indigenous communities, as well as communities living downstream. Therefore, under the Green Tamil Nadu Mission, sustainable Forest Management for improving the quality and productivity of the forests shall also be promoted and supported for forest ecosystems as they have important environmental, economic and social functions.

3. Current Status Of Forest And Tree Cover In The State And The Way Forward

(i). At present, the State of Tamil Nadu has a forest & tree cover of 26,419 sq. kms and 4424 Sq. kms of tree cover as per the Indian State Forest Report 2021, which is 23.7% of the TGA. Under the Green

Tamil Nadu Mission, it is proposed to raise the quality planting material and nurture the natural growth of the seedlings inside the Recorded Forest Areas through assisted natural regeneration works by employing the local communities so for achieving the target of 260 crore of indigenous species over an area of 12000 sq. kms in a period of 10 years in order to bring the forest and tree cover in the State from 23.76% to 33 % of the TGA. The Mission aims to increase the green cover on farmlands, fallow lands, educational institutions, temple lands, sacred groves, industrial areas, tank foreshore, Padugai areas, degraded forest landscape through massive tree planting activities in a phased manner achievevely involving all the stakeholders like Government Departments, Private sectors, NGO's Communities, Resident Welfare Association, Educational institution, Farmers and Panchayats. For achieving the target, 82 species (mostly native species) have been identified for planting inside the degraded forests and other landscape throughout the State. The Mission shall follow the Bottom-up approach in planning, finalisation of targets and planting.

(ii). Qualitative improvement of forest and tree cover in moderately dense forests (2000 sq. km), open degraded forests (4000 sq. km), degraded grassland (300 sq. km) and wetlands (100 sq. km), eco-restoration/afforestation of scrub, mangroves and abandoned mining areas (10 sq. km), urban/peri-urban lands (2000 sq. km) and agro-forestry/social forestry (5000 sq. km) shall be the overall mission objectives for a period of 10 years i.e., by the end of year 2030-31.

4. Raising Of Nurseries:

The availability of quality planting material is the prerequisite of successful take off of the Green Tamil Nadu Mission and timely raising of nurseries are considered very important in supply of seedlings for massive planting throughout the State. There are currently about 350 nurseries in the State under the control of Forest department. However to meet the increased demand of seedlings requirements from the year 2023-2024, the DGCs shall involve SHGs, under NREGA, JFMC's, tribal communities, educational institutions, public and private institutions, farmer's consortium etc. for enhancing the capacities of the nurseries and for raising mostly native seedlings as per the District target and agro-ecological zones. The nursery raising capacity of the Forest Department shall also be enhanced from present 1.7 crore to 10 crore each year with effect from 2022-2025. The forest Department shall identify additional land for raising the good quality nurseries. The identified land parcels for raising shall be geo tagged and approved by the DGCs. The nursery raising shall be according to the Standard Operating Procedure (SOP) of the Forest Department and schedule of activities shall be strictly adhered for production of quality stock in time. The nurseries that are raised by other Departments/ Organizations/ Individuals shall be supervised and guided by the Forest Department for production of quality seedlings, so that the Impetus of the Mission is more on the planting of quality planting material than the number of seedlings planted year wise.

In this regard the District Green Committee may encourage use of silt from Panchayat / PWD tanks to ensure availability of quality earth which would also facilitate de-silting of tanks / reservoirs free of cost. The use of the quality silt shall be instrumental in raising the

quality planting stock which is a pre-requisite for raising quality plantations under the Green Tamil Nadu Mission. The inclusion of this in the guideline will facilitate departmental officers to procure quality earth judiciously.

Instructions for raising and planting of seedlings
under the Green Tamil Nadu Mission

1. The availability of quality planting material is the prerequisite of successful take off of the Green Tamil Nadu Mission and timely raising of nurseries are considered very important in supply of seedlings for massive planting throughout the State. The nurseries that are raised by other departments / organizations / individuals shall be supervised and guided by the Forest Department for production of quality seedlings, so that the impetus of the Mission is more on the planting of quality planting material than on more number of seedlings planted year wise.

2. The Green Tamil Nadu Mission is a flagship Mission of the State Government and all the works undertaken under the Mission should be exemplary in nature based on prescriptions followed in the Old Forest Working Plans. It should be kept in mind that for sustainably managing the natural forests and for raising tree outside the Forests, science based evidences are must for making the Green Tamil Nadu Mission a landmark Mission. There are no better solutions for the mitigation and adaptation of the adverse impacts of the climate change than improving the quality and productivity of the natural forests which the Forest Department has not been following from almost a decade. The planting of inferior quality seedlings, lack of planting of site specific seedlings and late planting of the seedlings have been the reasons for poor survival of the seedlings in the field conditions under all the Forestry schemes which should be avoided in the Green Tamil Nadu Mission.

3. In view of the aforementioned fact, following instructions are issued for ensuring raising of quality planting stocks for the planting under the Green Tamil Nadu Mission.

- i) The nurseries for 30X45 bags which may be 25-30% of the total targets fixed for the particular year, should be raised compulsorily between November – January. Accordingly the estimates for the above mentioned bag size should be submitted to the Mission Director, Green Tamil Nadu Mission latest by 30th November / 15th December of that year for timely release of the funds.

- ii) The planting of the seedlings of large bag size i.e., 30×45 should be planted in the urban, semi urban areas, degraded forest landscape, villages and panchayat lands when the seedlings have become 16-18 months old in order to ensure 90% survival in the field conditions. Henceforth the planning for the District Annual Action Plan for the Green Tamil Nadu Mission should be undertaken keeping in view the age of planting of the taller seedlings in the above mentioned landscapes. The Forest Department should play a major role in providing the technical guidance to the District Green Committees and the Departments/Organisations/Individuals engaged in the raising and planting activities.

- iii) The raising of seedlings in the 16×30 cms bag size should be completed by January of every year and estimates for raising of the nurseries shall be sent latest by 15th December. Such seedlings should be utilised for planting in the farmlands, bunds of tanks, water bodies, protected campus of Institutions

and establishments, homestead planting, temple lands, sacred groves.

iv) The planting of the seedlings of all bag sizes should be compulsorily be completed latest by 2nd week of August of the particular year in order to ensure >90% survival and for timely replacement of the casualties and it's survival. In case planting is to be delayed beyond 2nd week of August due to field conditions, the reasons for the same should be recorded in the nursery and plantation journals. Under no circumstances, the planting should be delayed beyond August.

v) All the nurseries should be raised through procurement of genetically superior seeds from the Genetics Division of the Forest Department or Institute of Forest Genetics and Tree Breeding, Coimbatore or directly from the local communities and the seeds should be sown / dribbled in the mother beds before transplanting these to the appropriate size bags for ensuring production of quality planting stock. The technical guidance for the production of the clonal seedlings of the trees suitable for the farmlands should be taken from the IFGTB, Coimbatore/Forest College and Research Institute, Mettupalayam. The Deputy Conservator of Forests, Genetics Division, Coimbatore should ensure the supply of viable and superior quality of seeds collected from the Mother trees to the Districts for raising of the quality planting material.

vi) Mixture of cow urine, cow dung, horse gram, jaggery (in ratio of 250 ml: 250 gram : 250 gram i.e., 1:1:1:1 and 250 gram should be prepared in the Nursery and kept it for 15 days for its adequate fermentation before applying the said mixture

after diluting it with 50% water, once in 15 days to all the seedlings for the best growth and development of the seedlings. Other nutrients like biofertilizers and vermicompost may also be used as being followed as normal nursery practices.

vii) The Assisted Natural Regeneration of the seedlings of root stock origin should be identified through extensive field perambulations by the ground level field staff and the local tribal communities for nurturing those seedlings by climber cuttings, light soil working (weed removal) around the seedlings and other cultural operations prescribed in the Forest Working Plans. The estimates for Assisted Natural Regeneration works with geo referenced maps of the proposed degraded areas should be received latest by March of the particular year so that the Assisted Natural Regeneration works are commenced by May and completed by August of the particular year. Wherever it is found feasible as per the site conditions that micro forest ponds may have to be created for improving the water yield inside the degraded landscape for improving the ground water table and for mitigating the human wildlife conflict situation. The same may be included under the Assisted Natural Regeneration estimates. Keeping in view of the fact that 11,000sq kms of forest cover is between 0.1 to 0.4 density classes, in the State of Tamil Nadu it is anticipated that 800 to 2000 seedlings can be treated under Assisted Natural Regeneration category for improving the density and growing stock of the State's Forest which has been degrading over the years as per the Indian State of Forest Reports of the Forest Survey of India, Dehradun. The local communities

should be involved in the Assisted Natural Regeneration /AR works inside the degraded forest landscape and green employment generated out of the said works should be duly accounted for in the plantation journal (Assisted Natural Regeneration /AR category). The Assisted Natural Regeneration works (restoration of degraded forest area with the help of local communities shall also be undertaken through the private sector investment without giving as fallow land as part of such land on lease / transfer basis. The carbon credits generated out of the said Assisted Natural Regenerated works with the private sector investment, shall be shared between the Government, private investors, the local communities as per the Government approval.

viii) The seedlings should be supplied free of cost to the Farmers, Charity Organisations, Trust and Government Departments. All such seedlings should be planted and uploaded on the web portal of the Green Tamil Nadu Mission (www.greentnmission.com) or else the, cost of raising of the seedlings should be recovered from the concerned if it is not planted by the procuring entity. The taller seedlings ie 18 months age seedlings should be charged as agreed to by the District Green Committee so as to ensure, the same degree of sustainability in raising of seedlings.

4. Planting Activities:

(i). The potential areas of planting Inside and Outside the Recorded Forest areas would include the following:

- a) Degraded forest landscape (scrub, open, moderately dense forest and very dense forest area)
- b) Planting in a line or in strips alongside the roadside (National Highway, State Highways, District Roads, Panchayat Roads or approach roads connecting to the villages, and avenues inside the cities and town;
- c) Planting in housing colonies along avenues, canal bunds, and tank bunds;
- d) Block planting along the river bank and tank shoreline areas;
- e) Barren revenue hillocks;
- f) Block planting in community land or abandoned wasteland;
- g) Mosaic block or scattered planting within government buildings;
- h) Premises of hospitals and dispensaries;
- i) Premises of all educational institutions, including public and private schools, colleges, and universities;
- j) Boarding Hostel campuses administered by Social Welfare, Tribal Welfare, BC Welfare, Women & Child Welfare Departments and residential Schools;
- k) Religious Institutions (Temples, Mosques, Churches and Gurudwaras);
- l) Open space in Bus Depots, Bus Shelters, Railway Stations and margins of parking lots etc.
- m) Industrial Estates, and areas under various industrial houses and factories;
- n) Neyveli Lignite Corporation mining reclaimed area and other Power Sectors vacant land.
- o) Jail campuses, Fire Stations, Police Stations, Battalion areas, and open spaces in Cantonment and Defence establishments;

- p) Water supply conduit margins, filter beds, Reservoirs etc.
- q) Planting in Housing Colonies and Homestead areas;
- r) Cremation grounds, burial grounds, graveyards etc.;
- s) Planting on Field bunds and farm lands of farmers;

(ii). Remote sensing and artificial intelligence will be utilised to identify land parcels (unused land having potential of reforestation / tree planting). Selection of site and site-specific planting being the most important factor for determining the success of plantations, adequate care shall be taken in this regard. The tree planting activities shall be undertaken as per the agro climate zones available in the State as it has been scientifically proven that planting of wrong species and the wrong site selection have been the major cause of past failures of plantations throughout the Country. The Green Tamil Nadu Mission shall also allow taking up of plantation in difficult soils wherein land amelioration and reclamation can be taken up as per the evidence-based science and as per the approved estimates by the Circle level officials so that maximum survival is achieved. The identification of land parcels within the districts shall be finalized by District Green committee involving the line departments and other stakeholders. In order to have a proper advance planning, three-year District Plan shall be developed in advance by all Districts, with geo tagged proposed land details earmarked for planting in each District. The target for achieving 33% of forest and tree cover by way of raising and upbringing of 260 seedlings and the annual target shall be based on the District Annual Action Plan (DAAP) for the particular year and the greening activities shall be taken up strictly as per the DAAP.

(iii). The planting programme shall be as per the following protocol in addition to the Standard Operating Procedure of the Forest Department

- a) Identification of the planting site,
- b) Carrying out pre-planting tasks include clearing the site and digging pits,
- c) Selection of the species as per agro-ecological zone,
- d) Identification of the nearest nursery from where the plants can be sourced for planting,
- e) Deployment plan for transporting the plants to the planting site,
- f) Agencies / Officials in charge of the on-site planting,
- g) Agencies or institutions or Officials in charge of the protection and maintenance of the plants, identification of degraded forest scape for undertaking assisted natural regeneration works for the struggling / stunted seedlings and the root stock. The baseline study and geo-tagging of such places, seedlings, root stock shall be done for concurrent monitoring and auditing purposes.
- h) District-level concurrent monitoring of the whole planting work, and
- i) Documentation of the site-wise planting with geo-coordinate details and uploading on the GTM portal for continuous monitoring of growth and development of the seedling.

(iv). The planting (artificial regeneration) outside the forest area shall be more of a voluntary nature and the NGO's, communities, households, educational Institutions, shall be involved in the voluntary planting of the quality seedlings under the supervision &

guidance of the Forest Department and experts who have knowledge of the planting methodologies. The seedlings raised by the Forest Department / other Government Departments shall be made available to the farmers free of cost as has been practice under the JICA funded Tamil Nadu Biodiversity Greening Programme Phase –I. The seedlings to other stakeholder's i.e., common public, NGOs, media house, Institutions, Government departments shall be either at the subsidized rate @ Rs.6 per seedlings or free of cost as decided by the State Government.

(v). The socioeconomic well-being of the communities along the forest edge is impacted in a variety of ways by forest degradation. Sustainable Forest Management therefore needs to be brought under the *de facto* control of local communities including the tribal population and other forest dwellers. Communities will become more invested in the preservation and management of natural forests, as they continue to participate in forest conservation efforts and benefits from forests start to flow to these communities. The local level institutions in the form of JFMC's, SHC's, local communities, tribals, other forest dwellers shall be effectively utilised for sustainable management of forests. Increasing the local community's incomes through the wise use of the existing natural resources while giving the other environmental advantages and ecosystem services peripherally flow in themselves shall be given the prime importance. The Assisted Natural Regeneration works will be centred on the identification of potential sites and species, community interaction and relationship-building, and communication with relevant stakeholders, including the private sectors.. To generate the community's interest, capacity building on regeneration survey and cultural operation shall be undertaken for

sustainability of the ANR works. Potential degraded forest area shall be identified where the JFMCs exist in the cluster and where the ANR could be initiated. An important type of forest inventory under the Green Tamil Nadu Mission is Regeneration Survey/Assessment. This survey is a perspective one for decision making as to how much of the area under question is successfully established or not. The data obtained after this survey prescribe the treatment under ANR. Even though the survey is time consuming one all forest divisions have to evaluate the same before taking up of ANR works. The community members' initiative to restore native species in the nearby forest or on community lands shall be provided technical support from the Forest Department. As part of the artificial regeneration works, the community members shall also take on responsibilities for seed collection, seed grading, seed treatment, seed sowing (or dibbling), daily care of the plantation site, protection, and regular monitoring activities.

(vi). The preference shall be given for augmenting the natural regeneration as well as artificial rejuvenation of valuable and endemic / threatened species inside & outside the Recorded Forest Areas, so as to ensure long term benefits to the local communities and for augmenting work production of high value endemic / endangered like *Pterocarpus santalinus* (Red sanders), *Santalum album* (Sandal) and *Dalbergia latifolia* (Rose wood) based upon the agro-climatic zones. The farmers shall also be encouraged to grow high value trees like Sandal, Red sanders and the Rose wood and there shall be no restriction on felling and transport of tree grown on the Private lands under the Green Tamil Nadu Mission subjected to the condition that the certificate of ownership issued by the Village Administrative Officer of the taluk is shown on the record of proof for the origin of the wood produce. The felling of sandalwood

grown on the private land shall be regulated by Tamil Nadu Sandalwood Trees Patta Land Rules, 2008. The list of the other species to be planted and the guidelines for implementation shall be followed from the Mission document for the 'Green Tamil Nadu Mission'. The District Green Committee with the consultation of technical Department may also plant other tree species based on preference of the farmers and agro-ecological requirements. The Forest Department shall provide technical advice and expertise on species selection and planting for specific sites. Under the said Mission, all the lakes and Panchayat tanks which are restored or being restored are to be planted with *Babul (Acacia nilotica)*, and other riparian species as decided by the local Forest Department with the approval of the District Green Committees. Under the Mission, the Municipalities shall prepare plan for Memory Garden in their respective jurisdiction where the people can come and plant saplings in the memory of their beloved ones.

(vii). There is a need for efficient and low-cost restoration and rehabilitation using ANR techniques in the face of the rapid loss of forests and biodiversity. ANR is not only economically advantageous; it also aids in establishing local communities' livelihood prospects, strengthens biodiversity conservation, and aids with carbon sequestration. Therefore, the assisted natural regeneration inside the degraded forest landscape shall be accorded priority for rejuvenating the viable root stock for counting as a seedling/ plants under the Mission. The natural regeneration of indigenous seedlings inside the degraded forest landscape that have been cleared of the invasive spp shall be counted towards the overall seedlings target fixed for 10 years. The baseline data for the available & potential root stock shall be carried out by the local field officials of the Forest Department and super checked by the District

Forest Officer (25%) and the Circle level officials (10%) as a regular cultural operation and the seedlings germinated / naturally grown to the trees size shall be duly accounted for under the Mission. The assisted natural regeneration of prioritized native species including the high native trees i.e., Sandal, Rose wood, Red sanders etc. with active involvement of the local communities through low-cost techniques shall be helpful in protection of the natural regeneration of native seedlings from fire and grazing and other anthropogenic factors. In order to maintain the biodiversity of the area it is important that the species taken up for natural regeneration are native and climate resilient and therefore prioritizing the native species in a participatory manner shall be linked to the resource management with the economic interests of the community for success of the ANR works. This will not only enable the community to play a greater role in the management of ANR-related activities, but it will also guarantee the intervention's sustainability and scalability beyond the project's duration.

(ix). Adoption of intensive in-situ soil and moisture conservation (SMC) works in the treatment areas based on the watershed principle is required to support the enhanced recruitment of seedlings on the forest floor and to increase plant growth and survival rates. The proposed strategy for ANR and gap planting inside the degraded forest landscape shall be for augmenting the growth and productivity of the natural forests wherever the restoration potential i.e. site conditions are found favourable. Keeping in view the fact that the State of Tamil Nadu has 11,792 sq. kms of open forests i.e. between canopy density of 10-40% and 11,034 sq. kms of moderately dense forests i.e. between the canopy density of 40-70% and both the open forests and the moderately dense forests have been stagnating above 10,000 sq. kms since the

last 10 years, the quality & productivity (growing stock) of the natural forests shall be accorded the highest priority and every attempt shall be made to transform the scrub, open forests and the moderately dense forests based upon the site suitability into the moderately dense and very dense forest respectively for enhancing the Climate change mitigation and adaptation capacities of the natural forests. The district wise patches shall be communicated to the Circle Officials/ District Forest Officers for undertaking the peripheral plantations either by raising or through assisted natural regeneration in order to increase the forest cover in the State. The District Forest Officer's shall be specifically instructed to take up the artificial or assisted natural generation works on the peripheries to increase the forest cover since the artificial regeneration/assisted natural regeneration inside the 42,372 patches across the State shall not lead to increase in the forest cover. The extent of increase in the forest cover shall be calculated by deriving the perimeter of the patches through the use of ArcGIS and the buffer area shall be kept all along the perimeter for clarity in the projected increase in the forest cover.

Forest Cover in different Patch Size Classes				
Sl. No	Patch Size Range in sq. km	No.of Patches	Area (sq. km)	% age
1	$\geq 0.01 \leq 1.0$	41,335	3,288	12.51
2	$> 1.0 \leq 10$	907	2,461	9.36
3	$> 10 \leq 100$	112	2,871	10.92
4	$> 100 \leq 500$	12	3,019	11.49
5	$> 500 \leq 1000$	0	0	0.00
6	$> 1000 \leq 5000$	6	14,642	55.72
	Total	42,372	26,281	100.00

*Source ISFR 2021

The Community Public Private Partnership (CPPP) model shall be adopted for restoration of degraded forest landscape and the MOU

shall be executed for restoration of the degraded forest and other landscape by the Private players involving the local communities and sharing of carbon credits (Government (20%), Community (40%), Investors (40%) that may be accruing from the restoration of degraded forest landscape or other degraded landscapes per the MOU and terms and conditions as approved by the Government.

(x). The Strategy for Developing in-Situ 100 – 150 crore Plants in a period of ten year in the Degraded Forest Landscape, through Scientific Methodologies and as per the Forest Working Plans, would be as follows:

- a) Improving the forest quality and productivity through assisted natural regeneration and the artificial regeneration for increasing the forest cover inside the degraded forest landscape.
- b) Encouraging the natural regeneration by ensuring rigorous regulation on the incidence of grazing and the spread of forest fires, with the help of local people. (The local communities and tribals, other forest dwellers shall be engaged as Natural Resource Management Assistants).
- c) Dibbling of seeds of indigenous forest species by scrapping / loosening the soil in patches, with the participation of local tribes and forest dwellers.
- d) Planting of tall saplings specific to the ecosystem in potential degraded gaps.
- e) Rejuvenating the viable rootstock through proper forestry practises such as coppicing and singling, removing diseased and dead plants, clearing crowded stumps, and giving preferential care in the form of soil work to the healthy saplings.

- f) Conducting of the base line studies for the assisted natural regeneration works forest beat wise and the geo-tagging of all those ANR seedlings to monitor its growth into a tree for proper accountability and transparency in the ANR works.
- g) The incentive of Rs.15/- per seedling is proposed to be provided to the tribals, other forest dwellers and the local communities for upbringing of the native seedlings through the root stock, coppice etc.
- h) Initial payment of Rs.3/- per seedlings is proposed to be made through the DBT to the Communities / Individuals for the first cultural operations of the naturally existing native species of root stock or natural seedlings of 2-3 feet height after the said seedling is geo tagged on the web portal of the Green Tamil Nadu Mission / Digital monitoring app.
- i) After the said seedling has grown up to 5-7 feet height, the second installment of incentive amount of Rs.4/- per seedlings shall be provided to the community/ Individual through the DBT.
- j) Once the assisted naturally grown seedlings attain the height of a tree and are protected from fire and grazing for a period of three years, final installment of Rs.8/- per seedlings shall be transferred to the community/ individual. The incentive amount for the assisted natural regeneration of the sandal seedlings is proposed three times i.e., Rs.45/- per seedling in the initial three year and upon maturity / harvesting i.e., after 20 years of the growth and protection, 10% of the sale amount per tree through DBT is proposed to made to the Communities/ individuals.

(xi). Through a number of initiatives run in conjunction with NGOs, village-level organisations like JFMCs, and the Forest Departments, millions of trees are planted every year in the Western Himalayas. However, the Government afforestation and restoration programs frequently involve high operational expenditures. Given the high plantation expenses previously indicated, a community-based, low-cost ANR strategy shall be adopted for achieving the targets of forest regeneration while utilising the available resources. This will increase the forest and tree cover from the current 23.79% to 33% by the end of the year 2030. The Mission shall target improvement of forests based livelihood for about million household living in and around forests. After being strengthened and updated, the existing JFMCs shall be crucial in attaining the aforementioned goals. Community-based low- cost ANR with active involvement of tribal communities, other forest dwellers and JFMCs, SHGs constituted under the JICA aided TAP phase I & Phase II projects for the natural regeneration of the degraded forest lands and the forest catchment areas as a Climate Change mitigation and adaptation measure improving the silt free water provisioning services to the downstream and plain areas. Therefore, there is a greater community stake in preserving and maintaining the forests, especially against anthropogenic fire, the involvement of local communities shall be promoted for sustainable forest management with a focus on local livelihoods (a major driver of forest description). Dibbling of seeds shall also be used as a low cost method for artificial regeneration of native species. The assisted natural regeneration shall be adopted for only those native species, where it is feasible to facilitate growth.

(xii). It is extremely important to ensure that the natural forests that are degraded regains the lost productivity in terms of the growing stock. The natural regeneration shall be assisted by the local and indigenous communities i.e., tribals and the other forest dwellers besides the voluntary participation of other entities particular the private players without any claims of rights on the usufructs except the carbon credit sharing as per the accepted Government norms.

(xiii). On the basis of the current watershed map, rigorous in-situ soil and moisture conservation efforts shall be supported by the ANR of seedlings on the forest floor to increase plant growth and survival rates. The in-situ SMC works shall be a part of the low-cost ANR methodology wherein the forest dwellers and the local communities shall be paid for the in-situ SMC works either through MNREGA or through the incentives from the Government or Private sectors. The proposed incentive amount paid from Government or Private sectors shall be on treatment area basis i.e in-situ SMC works @Rs.15/- seedlings cost which shall mean that the cost of ANR works shall include the in-situ SMC works undertaken by the local communities for improving the soil and moisture availability for the growth and development of the in-situ ANR seedlings. The in-situ SMC works shall be undertaken beat wise and shall comprise of desilting of natural streams, depressions etc for harvesting of the rainwater inside the forest areas. The said works shall be undertaken as a part of low cost ANR works inside the forest areas to supplement the Catch The Rain (CTR) campaign being implemented under the Jal Shakti Mission of the Government of India.

The Forest Department shall prepare a plan for the restoration of degraded forest patches beat-wise for the purpose of intensive monitoring of the progress in the work on the periodic basis (six

monthly basis) by the Circle / District level forest officials in addition to the third party monitoring by the selected agencies. The beat-wise restoration plan shall consist of treatment area on cluster basis (on 1:5000 scale map) along with the identification of drivers of degradation, benchmark study of the existing vegetation & SMC works with geo tagging of the works for uploading of the treatment area details on the www.greentnmission.com or on the monitoring app. The Annual treatment plan, shall include the list of management interventions with anticipated output (including the payment made to the indigenous or local communities for the ANR / SMC works) for the purpose of calculating the quantum of green employment generated out of the ecological restoration works like collection of seeds, NTFP's and the ANR / SMC works.

The 4227 Percolation Ponds and 28725 Check dams were constructed under the JICA aided TAP scheme. In addition, thousands of catch water drains and forest ponds have been constructed under various forestry schemes. Due to degradation of the forest catchment area, these water bodies have silted up badly due to sediment erosion from the forest catchment areas. The depletion of the water in these water bodies due to heavy siltation is probably one of the plausible reasons for the wild animals particularly the elephants to come out of the forest areas and create a conflicting situation with the human population on the forest fringe areas. These water bodies therefore need to be desilted using MNREGA funds. A separate proposal shall be prepared specifically for re-vegetation of forest catchment area, de-silting of the existing water bodies, locating and de-silting of natural jungle streams for an effective soil and moisture conservation measures within the forest landscape. Expert Institutions working in the field of soil and moisture conservation shall be engaged specially for this

interventions both in the western & and Eastern Ghats to improve the water provisioning services of the forests and for the protection of the Dams, Reservoirs and the water bodies located downstream.

In addition to the payment made to the indigenous / local communities for their contribution in improving the health of the degraded landscape the payment for the carbon credits out of the credits sold in the Voluntary Carbon Market shall also be worked out and shared with the local communities in the ratio of 40:40:20 (Government: Private Investors: Local Communities) or 75:20 (Private Investors: Local Communities) as approved by the Government for ensuring the equity and justice to the local Communities involved in the restoration of degraded forest landscape.

The beat-wise Annual Restoration Plan shall be compiled at the District level and after its approval by the District Green Committee shall be forwarded to the Mission Director, Green Tamil Nadu Mission, through the Circle level officials for onward submission to the Government for its final approval.

5. Web Portal Of Green Tamil Nadu Mission

A robust web portal www.greentnmission.com has been developed for online uploading of targets, review of progress of nursery plantation and monitoring of the entire Mission. The portal shall act as a database of all the potential areas that can be planted over a period of 10 years. This portal shall bring all the plantation activities taken up in the State on a common platform. The areas identified

shall be entered in the web portal and suitably allocated for different years for planning along with the scheme under which the areas shall be taken up for planting. The web portal shall be utilised for assigning planting year, beneficiary addition, nursery stock entry, planning and monitoring of nursery and plantation sites.

6. Estimate Preparation

The preparation of model estimates for the State shall be dispensed with and the estimated preparation shall be based on the approved list of activities communicated for adoption. The sanctioning of the nursery and planting estimates shall be based upon the scientific approach under the Mission i.e., specific to agro climatic zones, in order to ensure agro-climatic zone specific estimates for nurseries and planting activities. The estimates shall be prepared based on existing Forest Schedule of Rates (FSR), PWDSSR etc. The estimate proposed to be adopted in the Districts shall be approved by Conservator of Forests / Circle heads which in turn shall be placed in the District Green Committee for information and further discussions on its acceptance or modification of the estimates if required. The estimate shall be uploaded on the Green Tamil Nadu Mission web-portal. Site specific estimates shall be prepared for nurseries, plantations and for the assisted natural regeneration works.

7. Future Projection Data:

Global Climatic Models, also known as General Circulation Models (GCMs), are the primary tools for predicting the variability and changes in climate variables such as rainfall at the continental and global level . The mathematical modelling of extreme hydrological events, such as droughts or floods, as well as the assessment of

surface and subsurface water resources and their quality, all depend on rainfall data. The ability of a particular location to maintain a plantation or experience a drought index can be determined with the aid of GCM model rainfall data from IPCC AR5 or AR6. When there is more rainfall in the area, there will be less need for water, and when there is more rainfall in the area, there should be more emphasis on providing adequate water for good plant growth. Finally, by using future rainfall prediction models, the general public may understand which species can be grown in particular region. This model will also help in water requirement during maintenance of seedling. Relying on such models will help in saving government money during the implementation of Green Tamil Nadu Mission.

8. District Green Committees

In order to increase the green cover and to protect the standing trees throughout the State, the State Green Committee (SGC) and District Green Committees (DGC) shall have an important role in undertake the tree conservation in their Districts and shall monitor the records of standing trees on Public and Private lands, planting of seedlings under Green Tamil Nadu Mission on the digital platform with geo tagged, details. The DGC shall also regulate felling of trees and undertake of planting seedlings on public land and private lands as per the District Annual Action Plan (DAAP) approved by the District Green Committee. The District Green Committees shall conduct regular meetings (once in a month) for monitoring the progress of the plantations under Green Tamil Nadu Mission for achieving the plantation target for respective Districts. The DGC shall ensure active participation of all the Government Departments, Private sectors, Academia, NGOs etc. and all other

stakeholders for ensuring the success of the Green Tamil Nadu Mission. The District Green Committees shall identify the potential restoration sites in the districts that can be taken up for planting and shall include all such land parcels with geo-coordinates in the District Action Plan. The DGC shall coordinate with other departments in accounting of all the plantation activities under the Green Tamil Nadu Mission. Such details shall be entered in the web-portal of the GTM against the District targets. Further all the planting activities undertaken by any Government departments and private and individuals shall be carried out with the knowledge of DGC and shall be duly accounted in the web portal of Green Tamil Nadu Mission.

DGC will also assess the financial requirement for the whole programme in advance and shall mobilize the funds for the implementation of the Green Tamil Nadu Mission from the MNREGA, CSR of the Public / private sectors as well as through voluntary contributions by the private players. The plantation progress shall not be hampered due to dearth of funds.

Further to have an overall strategic planning, designing and implementation of Green Tamil Nadu Mission in all the districts, the District Collectors shall play a vital role through their effective leadership and co-ordination between the Government Departments, Private players and Individuals. The Green Tamil Nadu Mission has been envisaged as a people's movement and has an inbuilt system of ensuring highest degree of transparency & accountability on the part of implementing officials.

9. District Annual Action Plan (DAAP)

District Annual Action Plan shall be prepared for three years in advance by the District Green Committees. The Annual plan shall give importance to the identification of beneficiaries, involvement of various stake holders, in raising nurseries and plantations like public & private Institutions, NGOs, Trust, individual / household etc. and also assigning duties and responsibilities to the concerned Agencies / Institutions / Officers involved with the Mission. The DAAP shall mandatorily include the land parcels identified and marked on the GIS maps for taking up the restoration/ planting activities. The Revenue Poromboke lands identified as Kaadu porompoke shall be included in the DAAP for undertaking the afforestation works and shall be handed over to the Forest Department for protection and maintenance. The District Action Plan shall be uploaded in the Green Tamil Nadu Mission web portal for preliminary review by the Mission Director and for final review by the State level Green Committee. The preparation of District annual work plan shall be completed every year by 31st of August so that advance nurseries can be raised from October - November for the production of quality planting material at the right time as per the target fixed for the District.

A detailed timeline with specification of the timing for finishing each project component shall be included in the district action plan. The District Action Plan for each year along with necessary funds mobilized for the implementation of the Mission shall be placed in the State level Green Committee for information and further directions. The planting/restoration targets for the Districts under the Green Tamil Nadu Mission shall be strictly as per the District Annual Action Plan duly approved by the District Collectors.

10. Carbon Credit Under The Green Tamil Nadu Mission

The development of an additional 2.5–3.0 billion tonnes of carbon sink through an increase in forest and tree cover is not included in the revised India's Nationally Determined Contributions commitments before the United Nations Framework Convention on Climate Change (UNFCCC). The COP 26 held in Glasgow has recognised the forestry projects and the renewable energy projects as a carbon offsetting projects. The Union of India has proposed for achieving net zero carbon emission by the year 2070 and since the 50% of the carbon emission have to still come from the fossil fuel emission by the year 2030 as per the updated INDC submitted before the (UNFCC), the role of nature based solution (Nbs) i.e. forest and tree cover, wetlands, sea grasses, mangroves etc. cannot be undermined in achieving the net zero emission by the year 2070.

As per the ecosystem market place report where the market analysis of the rate of the carbon credits generated are done on period basis, the following are the carbon credits valuation

	2020			2021		
	Volume (MtCo2e)	Price (USD)	Value (USD)	Volume (MtCo2e)	Price (USD)	Value (USD)
Forestry and land use	57.8 M	\$5.40	\$315.4M	227.7M	\$5.80	\$1,327.5M
Renewable energy	93.8M	\$1.08	\$101.5M	211.4M	\$2.26	\$479.1M
Chemical processes / Industrial manufacturing	1.8M	\$2.15	\$3.9M	17.3M	\$3.12	\$41.2M
Waste disposal	8.5M	\$2.69	\$22.8M	11.4M	\$3.62	\$41.2M
Energy efficiency / fuel switching	30.9M	\$0.98	\$30.4M	10.9M	\$1.99	\$21.9M

Household community devices /	8.3M	\$4.34	\$36.2M	8.0M	\$5.36	\$43.3M
Transportation	1.1M	\$0.64	\$0.7M	5.4M	\$1.16	\$6.3M
Agriculture	0.5M	\$10.38	\$4.7M	1.0M	\$8.81	\$8.7M

- Note, these are annualized averages, EM data can be analyzed more granularly by day, month, quarter, year.
- Note, these are categories, EM data can be analyzed more granularly by project type and sub type.
- Source: ecosystem market place, a Forest Trends Initiative

In view of the above tabulated statement on the value of the carbon credits for various carbon offsetting projects, the importance of nature based solutions (Nbs) particularly the forestry and land use sector shall be playing a crucial role in climate change mitigation and adaptation which shall be given utmost priority under the Green Tamil Nadu Mission.

Under the Mission, the State of Tamil Nadu shall devise its mechanism of carbon credit sharing between the local communities, corporate sectors and the State Government, (suggested mode of sharing of carbon credits shall be State Government (20%), local communities (40%), investors (40%) with the concurrence of the Union of India if required. The State Government shall utilize the Voluntary Carbon Market (VCM) wherein the carbon credits are being traded based upon commercial, sustainability and marketing considerations. The above financial model shall be applicable for the carbon financing projects. With regards to the climate financing projects i.e., where the investors would be required to fund the restoration / re-forestation/ afforestation works, the financial model shall be arrived by keeping in view the total investments to be done by the

investors on the restoration of degraded landscape. The baseline studies about the present carbon sink are essential to claim carbon credits by third party certified auditors which measures the additionality factor for claiming the carbon credits. Keeping this in view, the baseline studies and the additionality factor shall be determined at the restoration sites by the Investors to be selected based on the Tamil Nadu Tender Transparency Rules 2000. The artificial Intelligence and Remote Sensing based technology shall be adopted for validated data on the accumulation of carbon in the biomass. Third party verification shall also be undertaken to ensure the validation of the Carbon credit generated at periodic intervals for the realization of the mandatory credit values under the carbon offsetting projects. The base price for the carbon credit i.e., per metric tonne of carbon shall be fixed by the State Government. However under the circumstance wherever the carbon credit per metric tonne fetches more price than the base price, the sharing of profit between the Investors and the State Government shall be on 50:50 basis. This will secure the financial interests of the Government and the local communities in the fluctuating carbon market (VCM). It will also ensured that the investors shall not pay the Government and the local communities less than the agreed base price of carbon.

11. Monitoring & Evaluation

Given the enormity of works and wide arrays of implementing agencies involved in the whole operation of 'Green Tamil Nadu Mission', it would be beneficial to establish a Third party monitoring mechanism at the District and State level. The overall programme shall be supervised by the State level Green Committee at the State level and accordingly Mission Director 'Green Tamil Nadu Mission'

shall be the Nodal Officer with regard to the 'Green Tamil Nadu Mission in terms of Implementation, Monitoring & Supervision of the Mission. The Additional Mission Director and the Project Technical Team of the Mission shall provide the technical and administrative support to the Mission Director, Green Tamil Nadu Mission for accomplishment of the goal and objectives of the Mission.

The District Green Committee shall constitute an internal monitoring team for supervision of the planting and felling in their District. The Chief Conservator of Forests/ Conservator of Forests shall constitute their independent monitoring team for supervision and monitoring of seedlings planted inside and outside the Recorded Forest areas out of Green Tamil Nadu Mission funds and other schemes of the Forest Department. The monitoring report shall be placed before the District Green Committees for information and necessary action wherever required and it should be uploaded on the Green Tamil Nadu Mission web portal for public scrutinizing (social audit). The District Collectors being the District head, their leadership and support for the Green Tamil Nadu Mission at the District level shall help in better functioning of District Green Committees towards achieving the goals and objectives of Green Tamil Nadu Mission.

The total funds spent toward the greening activities and the schemes under which the greening activities are to be undertaken shall be uploaded on the web portal of Green Tamil Nadu Mission www.greentnmission.com as a single period of communication and information.

The operational guidelines for the Green Tamil Nadu Mission shall be an intricate part of the Mission Document. The operating guidelines for the Green Tamil Nadu Mission shall periodically be revised in light of the experience gained through the first three years of the mission's implementation. The Green Tamil Nadu Mission being a flagship Mission of the Government of Tamil Nadu, every seedling planted under any of the Government schemes or by any Organization or Industries shall be duly accounted in the target fixed under the Green Tamil Nadu Mission. All the artificially and the naturally grown seedlings shall be counted towards the overall target of raising/ up bringing of 260 crores of seedlings i.e. 100 -150 crore of in situ regeneration inside the recorded forests area to planting of 160 crore seedlings outside the recorded forests areas including the Revenue porombokes which are kaadu poromboke in the revenue records. These restoration / planting activities shall be undertaken in a period of 10 years i.e., up to the year 2031-32. The operational guidelines of the Green Tamil Nadu Mission as well as the Mission Document for the Green Tamil Nadu Mission shall be revised based on the experience gained in the implementation as well as based on the inputs received from the Officials / Experts and Research Scholars from time to time.



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