Trees Outside Forests in Tamil Nadu, India – An Overview

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Abstract— The tree resource outside the forest (TOF) is a highly diverse and locally different natural renewable resource. In many regions they play a prominent role in securing rural livelihoods viz., provision of small timber, firewood, fodder, fruits, medicinal value, etc. Agroforestry systems are multifunctional systems that can provide a wide range of economic, socio cultural and environmental benefits. Agroforestry can be particularly important for smallholder farmers because it generates diverse products and services on a limited land area. Agroforestry practices in Tamil Nadu (TN), India, have existed since time immemorial and are evidenced in all parts of the state with less or no scientific management. Agroforestry research is a new field that is getting momentum in recent times due to popularization of industrial agroforestry. In the present context, to meet the national target of forest cover (33%) and to reduce pressure on natural forests, agroforestry plays a vital role and provides additional income to the farming community. This article aims to provide an insight into agroforestry practices in TN, including reasons for opting them, problems faced, etc. It also provides information on agroclimatic zone-wise tree species and agroforestry systems being practised by farmers.

Keywords— Forests, agroforestry models, ToF.

I. INTRODUCTION

Trees outside forests (ToF) in India, mainly growing on private land, are the main source of wood in the country for industry and domestic wood fuel. Growing trees outside forests (ToF) presents a significant environmental and economic opportunity in India. India has several enabling policies and schemes that embed a range of monetary and non-monetary incentives for scaling up ToF through interventions such as agroforestry. Key benefits include improved livelihoods, jobs and income generation, enhanced soil health, biodiversity conservation, carbon sequestration, and increased resilience of local communities (GoI, 2014). The National Agroforestry Policy (2014) of India, which was the first of its kind in the world, has identified several strategies to promote agroforestry in India. In India, there is a scope for ToF/agroforestry in an area of over 50 M ha which can provide food, fuel wood, fodder, and non-timber forest produce (NTFP) by planting of multipurpose trees. India has several enabling policies and schemes embedding a range of monetary and nonmonetary incentives for the scaling of ToF through interventions such as agroforestry. India has several enabling policies and schemes embedding a range of monetary and nonmonetary incentives for the scaling of ToF through interventions such as agroforestry (Duraisamy *et al.,* 2022). TOF not only provides environmental services, but also economic gains, as about 65% of the country's timber requirement is met from the trees grown outside forests (Dhillon *et al*., 2018).

As of now about 25 M ha area is under Agroforestry land use in India and supports almost half of the demand of fuel wood, two third of small timber, 70-80% wood for plywood industry, 60% raw material for paper pulp and 9-

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11% of green fodder requirement of livestock. Although, current average biomass productivity in India is less than 2 $tha^{-1}yr^{-1}$ but it can be enhanced to 10 $tha^{-1}yr^{-1}$ through careful selection of compatible tree crop combination not only to bridge the gap in demand and supply but also to make country surplus in plywood, paper pulp and small timber. Deep tree roots also help prevent soil erosion. Agroforestry systems can also be used as carbon sinks within an environment, and to an extent, help counter the effects of continued deforestation on the carbon cycle. The productivity of trees outside forests is very high in comparison to natural forests and in-addition trees grown have market demand. TOF supplies approximately 49% of the fuel wood and 48% of the timber annually (Rai and Chakraborty, 2001). With too high productivity, it may be assumed that an area of 3 m ha planted with superior material with rotation of 8 yrs can meet all the national wood demands. There are several challenges that impede implementation, such as lack of quality planting material; technical capacity and knowledge gaps; market and finance gaps; and inadequate attention to issues around land and tree tenure, gender, and social inclusion (ICFRE 2020).

This paper deals with the choice of species preferred by the farmers, existing tree species in the farm fields of Tamil Nadu, reasons for opting tree species in farm lands, constraints faced by the farmers in ToF, etc. are discussed in detail.

II. MATERIALS AND METHODS

Study area: This study was conducted in Tamil Nadu and it is a very important cultural center and its geographical coordinates are 11.1271 N and 78.6568 E. Tamil Nadu is mostly dependent on monsoon rains and thereby is prone to droughts when the monsoons fail. The climate of the state ranges from dry sub-humid to semi-arid. The state has two distinct periods of rainfall viz., South west monsoon from June to September, with strong southwest winds and North east monsoon from October to December, with dominant northeast winds. The annual rainfall of the state is about 945 mm. Mean annual maximum temperature for Tamil Nadu is 32.2°C and mean annual minimum temperature is 22.6°C. The predominant soils of Tamil Nadu are red loam, laterite, black, alluvial and saline soils.

Sampling procedure and Survey method: A questionnaire was prepared for collecting information from the study area of different districts of Tamil Nadu. Using this questionnaire, relevant information was collected from 1500 farmers, comprising each 500 of marginal, medium and large farmers' category which were randomly selected

from the study area. Data were recorded from these selected farmers from June - December, 2022. In conformity with the set objectives of the study, a set of preliminary survey schedules has been designed for collection of data for the study. Thus, the final survey schedule has been prepared in a simple manner maintaining logical sequences and necessary adjustments.

Data analysis: The collected data was analysed by 'Garrett scoring Technique' (Garrett and Woodworth, 1969) and presented in the results and discussion part.

III. RESULTS AND DISCUSSIONS

1. Tree species maintained under ToF in Tamil Nadu

During the survey it was recorded that, more than 30 tree species are being planted and maintained under ToF in Tamil Nadu. Farmers are planted the tree species mainly for timber, small timber, NTFP, green manure, fuel wood, fodder, fruits and raw material for wood based industries (Table-1). Among different uses, maintaining for NTFP scored 32% followed by timber purpose (26%), green manure (19%) and least for fuel wood and medicine (3%).

Farmers in TN are practising ToF mainly to meet their day-to-day needs and for economic upliftment. The trees which are commonly grown under agroforestry in TN are *Ailanthus excelsa*, *A. lebbeck*, *Delonix alata*, *Tectona grandis*, *Pongamia pinnata*, *Azadirachta indica*, *Tamarindus indica*, *Thespesia populnea*, *Tamarindus indica*, *Mangifera indica*, *Achras zapota*, *Emblica officinalis*, *Sesbania grandiflora*, *Syzygium cumini*, *Eucalyptus*, *Acacia leucophloea*, *Casuarina equisetifolia*, *Pithecellobium dulce*, *Ailantus exelsa*, *Albizia lebbeck*, *Bamboo*, etc. Teak is an important timber species commonly found in farm bunds (Teaknet, . *A. lebbeck* is an important fast-growing tree mostly found in bunds in the state, having multi-utility for making moulds, in the carving industry, etc. (Kannan, 2010) Trees like neem and pungam are commonly planted mainly for medicinal and small timber purposes (Prabakaran *et al.,* 2019). Horticultural species like mango, guava, banana, sapota, amla, papaya pomegranate, lemon, etc. are considered as an ideal option and are common in all the agro-climatic zones of TN. The climatic and edaphic factors are favourable for fruit tree cultivation. Integration of horticultural species in farmlands helps in efficient utilization of natural resources and generates adequate income, provides employment and improves livelihood.

ToF emerges as an effective tool for improvement of the rural economy due to low investment, high profitability and high income-generating practices. Numerous agroforestry systems and combinations of annual crops are

practised by the farming community in TN and many multipurpose trees are found compatible in various agro-climatic regions of the state. Trees like teak, *Casuarina*, sandal, *Ailanthus*, bamboo, amla, etc. are among the most suitable species, which can be grown under ToF with minimal crop yield reduction. Appropriate tree–crop arrangements can indicate which combination is better in terms of profitability and acts as a feasible option that provides livelihood security to the rural community with less supervision and inputs. These ToF combinations and systems help increase the economy of the farmers, provide food security and make them self-sufficient. The ecosystem services generated from ToF adoption will help ameliorate the micro-climate of farmlands to promote climate-resilient crops. These ToF programmes will be an effective tool for climate mitigation and adaption mechanism to counter climate change, and act as a sink for greenhouse gases (Dobriyal *et al.,* 2012). Table-3 indicates that non-availability of agricultural labour (ranked first in four agro-climatic zones) and higher returns from tree components (ranked first in two agro-climatic zones) registered higher mean score and ranked among other reasons for adoption of agroforestry systems in different agro-climatic regions of TN. The other important reasons are less attention needed for tree species, less risk and fewer inputs compared to crops. Apart from the above reasons, climatic vagaries also play a vital role in the adoption of agroforestry systems among farmers throughout the state (Saravanan, 2017).

Jambulingam and Fernandus (2005) reported that, farmers in TN State integrate numerous species of multipurpose trees and shrubs on their farmlands in close association with agricultural crops and/or livestock. The dominant among them are *Borassus flabellifer, Tamarindus indica, Ceiba pentandra, Acacia leucophloea* and *A. nilotica*. These woody perennials are better able to cope with poor growing conditions. Their increasing integration on farmlands represents a strategy to minimise risk of crop failure. Some species (e.g. *Prosopis juliflora* and *Delonix elata*) are deliberately used to ameliorate infertile or saline soils in order to permit the growing of annual crops. In addition to producing fuel wood, charcoal, fruit and fodder and providing many service functions, these species require only fewer inputs and give the farmer a choice of management options in the event of poor crop growth. Farmers in TN State integrate numerous species of multipurpose trees and shrubs on their farmlands in close association with agricultural crops and/or livestock. The dominant among them are *Borassus flabellifer, Tamarindus indica, Ceiba pentandra*, *Acacia leucophloea* and *A. nilotica*. These woody perennials are better able to cope with poor growing conditions. Their increasing

integration on farmlands represents a strategy to minimise risk of crop failure. Some species (e.g. *Prosopis juliflora* and *Delonix elata*) are deliberately used to ameliorate infertile or saline soils in order to permit the growing of annual crops. In addition to producing fuel wood, charcoal, fruit and fodder and providing many service functions, these species require only fewer inputs and give the farmer a choice of management options in the event of poor crop growth.

Jharia *et al.,*(2013) also reported that, other than *Eucalyptus,* some other MPTs including *Terminalia arjuna*, *Terminalia tomentosa*, *Albizia procera*, *Mangifera indica*, *Butea monosperma*, *Zizyphus mauritiana,* *Azadirachta indica* and *Gmelina arborea* are also planted in the farm bunds. Farmers of Gujarat preferred and retains tree species of *Acacia nilotica, Acacia catechu, Dalbergia sissoo, Mangifera indica, Zizyphus mauritiana* and *Gmelina arborea* along with crops. In Bihar, *Dalbergia sissoo, Litchi chinensis* and mango are frequently grown on field, but for boundary plantation, *Sissoo* and *Wendlandia exserta* are most commonly used. Farmers of Sikkim, grow bamboo species (*Dendrocalamus strictus*, *Bambusa bambos*) all along the irrigation channels (Jhariya *et al.,* 2015). Pohjonen and Pukkala (1990) revealed that, *Eucalyptus globulus* trees are unpalatable to goats, sheep and cattle, thus they have a distinct advantage as boundary planting in Ethiopia.

2. Types of ToF Systems preferred by farmers of Tamil Nadu

During the survey, it was observed that, most of the farmers (45%) are interested to maintain the trees under agroforestry models compared to under bund planting (32%), home gardens (15%) and least in other forms (8%) (Fig-1). Also, it was observed that, 36% of farmers are interested in maintaining ToF for supply of raw material for wood based industries. Mostly farmers are interested in planting of *Casuarina, Eucalyptus, Melia dubia, Ailanthus excelsa*, *Neolamarckia cadamba*, *Gmelina arborea*, etc. under block plantation as a raw material for wood based industries followed by timber purpose (28%), small timber (11%), fodder (10%), green manure (8%) and least for NTFP purposes (7%) (Fig-2).

The ToF in TN has received significant attraction due to the participation of various wood based industries like pulp and paper, match, plywood, biomass power and timber which resulted in development of massive plantation development programme. The pulpwood based ToF model has prioritized only two species viz., Casuarina and Eucalyptus. Wood based industries promoting through contract farming with minimum support price for the wood produced from ToF and at present the pulpwood

based industrial ToF model covered more than a lakh ha area covering about 75,000 farmers (Parthiban and Cinthiya Fernandaz, 2017). During the survey, about 28% of the farmers are interested in growing trees species of timber value and facing some issues like non availability of quality planting material, felling and transportation, etc. This is in tune with Ghosh Mili Sinha Bhaskar (2018) revealed that the potential of ToF for timber production is not being realized due to the absence of a uniform nationwide policy related to management, harvest, transit and marketing of timber from ToF. We further describe how the ambiguity and cumbersome nature of existing policies pose as constraints for farmers who want to grow and benefit from ToF.
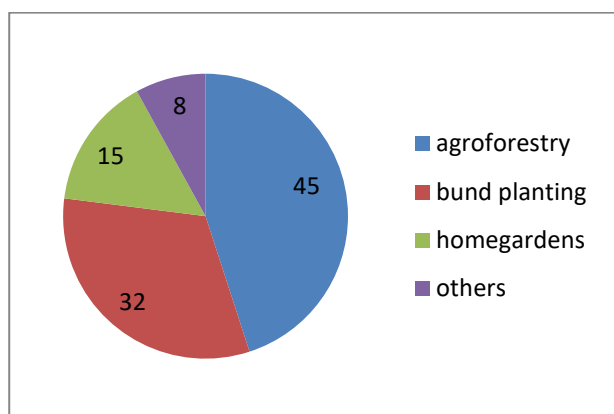

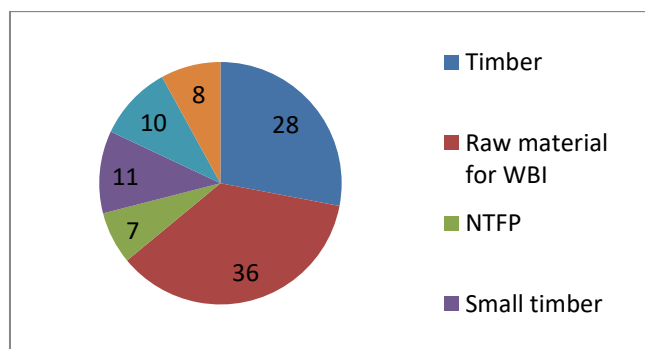*Fig-1. Types of ToF preferred by the farmers of Tamil Nadu*

Fig-2. Species preferences under ToF in Tamil Nadu

3. Reasons for opting ToF in Tamil Nadu

The reasons were obtained from farmers and ranked based on 'Garrett scoring Technique' and presented in Table-2 & 3 and Fig.2. During survey, reasons were given to farmers and asked them to rank for opting ToF. The farmers were classified in to marginal, medium and large farmer category and noted the reasons for maintaining trees under ToF. Marginal farmers expressed that, meeting their daily needs from trees ranked 1st followed by higher income and

future investment with the mean score of 59.84, 56.24 and 54.81 respectively. Least score of 47.13 was given for the last rank with the reason for efficient land utilization. Medium farmers are expressed that, higher income is the prime reason for maintaining trees in farm bunds with the mean score of 60.42 followed by future investment and promotion of ToF with the mean score of 58.36 and 54.68 respectively. Least score was given to efficient land utilization with the mean score of 49.81. With reference to large farmers' category, future investment recorded 1st reason for adoption of bund planting with the mean score of 62.56 followed by higher income (59.61) and promotion of ToF (55.71). Meeting day to day needs reason registered least score of 45.47 in large farmers' category. Bargali *et al.,* (2004) reported that, small landholders preferred only bamboo and Eucalyptus for bund and boundary plantations to meet their household requirements. Medium and large farmers preferred a number of species as they are into commercial production and they have better resources in the state of Chhattisgarh. Depommier *et al.,* (2002) articulated that the needs and strategies of small farmers usually correspond to subsistence agriculture with low inputs and, interestingly, a high level of diversification, which includes tree products and services. The multipurpose use of species partly satisfies the basic needs of poor farmers. Saravanan (2021) revealed that, non-availability of agricultural labour (ranked first in four agro-climatic zones) and higher returns from tree components (ranked first in two agro-climatic zones) registered higher mean score and ranked among other reasons for adoption of agroforestry systems in different agro-climatic regions of Tamil Nadu.

4. Level of domestication and extent of adoption of ToF in Tamil Nadu

The main determinants of adoption were age of farmers, household size, educational level, farm size, farming experience, income, access to credit and extension contacts. All these variables, except age of farmers, affected the adoption rate of agroforestry technologies positively (Sangeetha *et al.,* 2016). The level of domestication and extent of adoption of agroforestry (Table 4) reveals that farmers are well aware of the type and quality of planting materials and they prefer quality planting materials especially high-yielding clones which will give more productivity than seed-source seedlings. They are also knowledgeable about intercropping activities and size of pits for various tree components, including horticultural species. Also, they give equal importance for weeding and time of planting which is important for the establishment of tree components; it also reduces irrigation cost. Table 4 reveals that farmers are less attentive towards soil working, mulching and plant protection measures;

they consider, these activities to be non-remunerative and as adding more cost in the maintenance of agroforestry systems.

5. Constraints faced by the farmers in adoption of ToF

The major constraints faced by the tree-growing farmers are presented in Table-5. These are divided into five major categories, *viz.* labour, inputs, technology, marketing, loan/credit and others. It shows that, non-availability of agriculture labour and their wages play a vital role in the adoption of tree farming. For tree farming-related activities, farmers can manage with a few labourers when it is necessary. Non-availability of quality planting materials or difficulty in accessing them also plays a major role and farmers depend mostly on local nurseries for planting stock, normally poor in quality, which will not give good returns in the future. Farmers also face constraints in the application of fertilizers and protection measures for tree components. Unlike in agriculture, for tree species, no or little information is available on establishment and management strategies (precision silvicultural techniques). This leads to poor management of the tree components resulting in yield and returns. Also, forestry extension strategies are not clear and reached among farmers compared to agriculture extension activities. Both aspects need to be strengthened for the welfare of tree-growers and greater adoption of tree farming. One of the major problems faced by the tree growers is the non-availability of loan (for establishment and maintenance period) and insurance (during crop failure due to biotic, abiotic factors and climate vagaries) facilities. Further, non-availability of marketing structure, linkage with other stakeholders, etc. are also major constraints faced by tree growers. We need to address the above problems for greater adoption of tree farming and higher economic returns to the farming community. Sangeetha *et al.,* (2016) revealed that, lack of QPM is viewed as the most critical constraint faced by famers in the adoption of agroforestry species with 3.62 mean rank followed by the lack of capital with mean rank of 3.21.

6. Strategies and challenges in the promotion of agroforestry in TN

ToF is playing a vital role in maintaining natural resources and increasing overall productivity with minimizing risk against the vagaries of weather. Multipurpose tree species are the choice to integrate with annual crops/vegetables/ medicinal plants or with grasses. Although agroforestry is practised in India since ancient times, it has not gained importance due to dependency on multi-institutions and multi-disciplinary approach (Dhyani and Handa, 2014). The NAP-2014 has indicated the way forward to promoting ToF among various stakeholders. There should

be proper coordination between various stakeholders of ToF like researchers, extension workers, industries, farmers etc. India is a land of variability in terms of climate, soil, etc. Hence location-specific and economically sound agroforestry systems need to be developed. Agroforestry land use has great potential in providing ecosystem services; hence, these services should be quantified as accurately as possible. The sustainable land-use system approach is required at this juncture to overcome uncertainty of the monsoon and frequent natural calamities, and to maintain food security. Usually, lack of scientific knowledge, institutional approach and negative attributes of tree components (viz. long rotation, shade effect, opportunity cost, etc.) discourage farmers from adopting tree farming. However, recent developments in the production, processing and consumption sectors have generated interest among farmers to adopt agroforestry systems holistically for higher economic returns. The present probable area under agroforestry in India is estimated to be 25.32 m ha, or 8.2% of the total geographical area of the country (Dhyani, 2014). Despite encouragement for growing trees on farmlands, the farmers of TN have to deal with many constraints and limitations related to agroforestry. The difficulty in felling, harvesting, transit pass and marketing (rights on cutting and selling of wood), and insecure regulation discourage them to cultivate trees.

IV.   CONCLUSION

We are in the era to feed various stakeholders such us people, wood based industries, etc. Practising of agriculture alone will not fulfil the small and marginal farmers' needs due to climatic vagaries, increasing pressure on practising agriculture, declining size of land holdings and conversion of agricultural land to non agricultural purposes. To overcome these problems, agroforestry is a solution that will improve the livelihood of the farming community through cluster approach and value chain models by bringing all the stakeholders under one common platform. Incorporation of trees/livestock within the farmlands will generate adequate income and generate rural employment (approximately 145 man day's ha^{-1}). The central and state government research institutions, SFD and wood-based industries are promoting agroforestry and farm forestry at a large scale in TN with precision silvicultural techniques and assured price mechanism. These initiatives will not only fulfil the domestic and economic needs of the farmers, but also provide several environmental benefits. Moreover, promoting ToF by the merging of various ongoing central and state government schemes, will give a boost to the

farmers and bring more area under tree cover (agroforestry). Finally, agroforestry practices are needed to maintain the natural (forest) resources and agrarian identity at the national level.

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Table-1: List of tree species planted and maintained under ToF in Tamil Nadu

Tree species	Family	Main uses								
		Timber	Small timber	NTFP	Green manure	Medicine	Fuel wood	Fodder	Fruits	WBI
Casuarina equisetifolia	Casuarinaceae	--	--	--	--	--	*	--	--	*
Tectona grandis	Lamiaceae	*	--	--	--	--	--	--	--	--
Azadirachta indica	Meliaceae	--	*	*	*	--	--	--	--	--
Pongamia pinnata	Fabaceae	--	--	*	*	*	--	--	--	--
Lannea coromendalica	Anacardiaceae	--	--	--	*	--	--	*	--	--
Eucalyptus spp.	Myrtaceae	--	--	--	--	--	--	--	--	*
Thespesia populnea	Malvaceae	--	*	--	--	--	--	*	--	--
Ceiba pentandra	Malvaceae	--	--	*	--	--	--	--	--	--
Ailanthus excels	Simaroubaceae	--		--	--	--	--	--	--	*
Albizia lebbeck	Fabaceae	--	*		*	--	--	--	--	--
Borasus flabellifer	Arecaceae		--	*	--	--	--	--	--	--
Mangifera indica	Anacardiaceae	*	--	--	--	--	--	--	*	--
Emblica officinalis	Phyllanthaceae	--	--	*	--	--	--	--	--	--
Delonix alata	Fabaceae	--	--	--	*	--	--	*	--	--
Tamarindus indica	Fabaceae	--	--	*	--	--	--	--	--	--
Sesbania grandiflora	Fabaceae	--	--	--	*	--	--	--	--	--
Bamboo spp.	Poaceae	--	*	--	--	--	--	--	--	--
Santalum album	Santalaceae	--	--	*	--	--	--	--	--	--
Melia dubia	Meliaceae	--	--	--	--	--	--	*	--	*
Neolamarckia cadamba	Rubiaceae	--	--	--	--	--	--	--	--	*
Gmelina arborea	Verbenaceae	*	--	--	--	--	--	--	--	--
Pterocarpus santalinus	Fabaceae	--	--	*	--	--	--	--	--	--

Anacardium occidentale	Anacardiaceae	--	--	--	--	--	--	--	*	--
Pterocarpus marsupium	Fabaceae	*	--	--	--	--	--	*	--	--
Dalbergia sissoo	Fabaceae	*	--	--	--	--	--	--	--	--
Dalbergia latifolia	Fabaceae	*	--	--	--	--	--	--	--	--
Haldina cordifolia	Rubiaceae	*	--	--	--	--	--	--	--	--
Swietenia macrophylla	Meliaceae	*	--	--	--	--	--	--	--	--
Syzygium cumini	Myrtaceae	--	--	*	--	--	--	--	--	--
Artocarpus hetrophyllus	Moraceae	--	--	--	--	--	--	--	*	--
Callophyllum innophyllum	Calophyllaceae	--	--	*	--	--	--	--	--	--

WBI = Wood Based Industries

Table-2: Reasons for opting ToF in different farmers categories of Tamil Nadu

Reasons	Marginal farmers		Medium farmers		Large farmers	
	Mean score	Rank	Mean score	Rank	Mean score	Rank
Meeting day to day needs	59.84 (1100*) 74%	I	52.83 (800) 53.3%	V	45.47 (679) 45.3%	VI
Higher income	56.24 (1035) 69%	II	60.42 (1189) 79.3%	I	59.61 (1050) 70%	II
Future investment	54.81 (960) 64%	III	58.36 (1120) 74.7%	II	62.56 (1189) 79.3%	I
Less risk and inputs	52.56 (930) 62	IV	57.45 (880) 58.7%	IV	48.25 (761) 50.7%	V
Promotion of ToF	49.63 (840) 56	V	54.68 (970) 64.7%	III	55.71 (970) 64.7%	III
Efficient land utilization	47.13 (720) 48	VI	49.81 (720) 48%	VI	52.37 (851) 56.7%	IV

* Value within brackets are frequency (*n* = 1500)

Table-2: Reasons for chosing ToF in different agro-climatic zones of Tamil Nadu

Reasons	North Eastern zone		North western zone		Western zone		Cauvery delta zone		Southern zone	
	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
Non availability of agricultural labour	56.64 (1290)*	I	57.61 (1230)	I	58.56 (1290)	II	57.81 (1230)	I	56.08 (1170)	III
Higher income from tree component	55.42 (1170)	II	56.32 (1110)	II	57.08 (1200)	I	61.08 (1320)	II	60.24 (1350)	I
Less attention needed for trees	53.92 (1050)	III	52.84 (1050)	III	55.67 (1110)	V	49.69 (930)	V	49.44 (900)	VI
Less risk	52.65 (930)	IV	48.59 (870)	V	51.93 (930)	III	55.11 (1125)	III	52.83 (1020)	V
Less inputs	50.28 (840)	V	50.63 (900)	IV	52.39 (1020)	IV	52.64 (1020)	IV	54.66 (1110)	IV
Climate vagaries	48.31 (720)	VI	46.55 (780)	VI	48.68 (840)	VI	45.21 (810)	VI	58.63 (1290)	II

* Value within brackets are frequency (*n* = 1500)

Table-4. Level of domestication and extent of adoption of ToF in Tamil Nadu

Reasons	North Eastern zone		North western zone		Western zone		Cauvery delta zone		Southern zone	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Knowledge on tree cultivation	315	21	300	20	270	18	495	33	255	17
Quality planting material	195	13	165	11	195	13	315	21	138	09
Site selection	450	30	420	28	510	34	570	38	360	24
Proper soil selection	420	28	405	27	450	30	675	45	555	37
Type of planting material	1050	70	1005	67	1095	73	1125	75	840	56
Time of planting	855	57	825	55	900	60	870	58	660	44
Proper spacing	630	42	615	41	735	49	795	53	600	40
Digging of pits in appropriate sizes	1200	80	1170	78	1185	79	1125	75	915	61
Soil mixture	270	18	240	16	225	15	255	17	165	11
Soil working	90	06	75	05	120	08	138	09	90	06
Intercropping	855	57	810	54	930	62	1050	70	765	51
Weeding	675	45	645	43	720	48	825	55	855	57
Mulching	45	03	45	03	75	05	45	03	30	02

Irrigation	150	10	120	08	240	16	375	25	210	14
Application fertilizer	255	17	240	16	225	15	435	29	330	22
Plant protection measures	75	05	60	04	105	07	150	10	120	08

Table-5. Constraints faced by farmers in adoption of ToF in Tamil Nadu

Constraints	Frequency	Percentage
Labour		
Non availability of agricultural labours	7425*	82.50
Higher wages	7575	84.17
Inputs		
Quality planting material	7088	78.75
Cost of inputs like fertilizers	4867	54.08
Cost for plant protection measures	2813	31.25
Technology		
Non availability of silvicultural techniques	7200	80.00
Poor extension strategy	7875	87.50
Marketing		
Non availability of market intelligence	8062	89.58
Monopoly in price fixation	6563	72.92
Price fluctuation in ToF products	7350	81.67
Loan/credit/insurance facilities		
Non availability of loan for ToF activities	8625	95.83
Non availability of tree insurance or less information	8550	95.00
Others		
Linkage with other tree growers association	6600	73.33
Linkages with State Forest Departments, Wood based industries, research institutions, etc.	7050	78.33
ToF products sale through federations/associations	7650	85.00

*Frequency (n = 9000 farmers)