



**HAL**  
open science

## Impacts of Public Policies and Farmer Preferences on Agroforestry Practices in Kerala, India

Sylvie Guillerme, B.M Kumar, A. Menon, Christelle Hinnwinkel, Eric Maire,  
A.V. Santhoshkumar

► **To cite this version:**

Sylvie Guillerme, B.M Kumar, A. Menon, Christelle Hinnwinkel, Eric Maire, et al.. Impacts of Public Policies and Farmer Preferences on Agroforestry Practices in Kerala, India. *Environmental Management*, 2011, 48 (2), pp.351-364. 10.1007/s00267-011-9628-1 . halshs-01020762

**HAL Id: halshs-01020762**

**<https://shs.hal.science/halshs-01020762>**

Submitted on 8 Jul 2014

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

# Impacts of Public Policies and Farmer Preferences on Agroforestry Practices in Kerala, India

S. Guillerme · B. M. Kumar · A. Menon ·  
C. Hinnewinkel · E. Maire · A. V. Santhoshkumar

Received: 10 January 2010 / Accepted: 24 January 2011  
© Springer Science+Business Media, LLC 2011

**Abstract** Agroforestry systems are fundamental features of the rural landscape of the Indian state of Kerala. Yet these mixed species systems are increasingly being replaced by monocultures. This paper explores how public policies on land tenure, agriculture, forestry and tree growing on private lands have interacted with farmer preferences in shaping land use dynamics and agroforestry practices. It argues that not only is there no specific policy for agroforestry in Kerala, but also that the existing sectoral policies of land tenure, agriculture, and forestry contributed to promoting plantation crops, even among marginal farmers. Forest policies, which impose restrictions on timber extraction from farmers' fields under the garb of protecting natural forests, have often acted as a disincentive to maintaining tree-based mixed production systems on farmlands. The paper argues that public policies interact with farmers' preferences in determining land use practices.

**Keywords** Agrobiodiversity · Farmers' perception · Farming practices · Trees outside forest · Landscape dynamics

## Introduction

Agroforestry combines biophysical stability and socioeconomic adaptability which are critical for a vibrant and diversified agriculture that addresses both ecological and socioeconomic concerns. There is an accumulation of scientific evidence about the environmental functions of agroforestry, such as its role in biodiversity conservation, regulation of physical and chemical fluxes in ecosystems, and mitigation of pollution (Nair 2008). Kerala (between 8°18' to 12°48' N and 74°52' to 77°22'), a small but highly populated state located in peninsular India (Fig. 1), has a long history of agroforestry, especially homegardening (e.g., see the travel accounts of Ibn Battuta, the Persian traveler, 1325–1354; Randhawa 1980). Contemporary studies also highlight the importance of agroforestry in Kerala (Guillerme 1999; Peyre and others 2006; Kumar 2007).

Of the total geographic area of Kerala, about 58% is under agriculture (MoA 2000). Trees and shrubs are present on most agricultural lands, except in the paddy (*Oryza sativa*) fields. Dominant agroforestry types of Kerala include shaded commercial crop production systems involving cacao (*Theobroma cacao*), coffee (*Coffea* spp.), tea (*Camellia sinensis*), spices etc., silvopastoral systems with fodder grasses in association with commercial trees, and homegardens. Such tree based systems generally encompass many disparate and intricate species-mixes, often specific to topographic, geomorphological, and edaphic niches (Kumar 2007). The dominant agroforestry practice of Kerala, however, is the tropical homegarden,

---

S. Guillerme (✉) · B. M. Kumar · E. Maire  
UMR 5602—CNRS, GEODE (Geography of the Environment),  
Université Toulouse II, 5 Allées Antonio Machado, 31058  
Toulouse cedex 9, France  
e-mail: sylvie.guillerme@univ-tlse2.fr

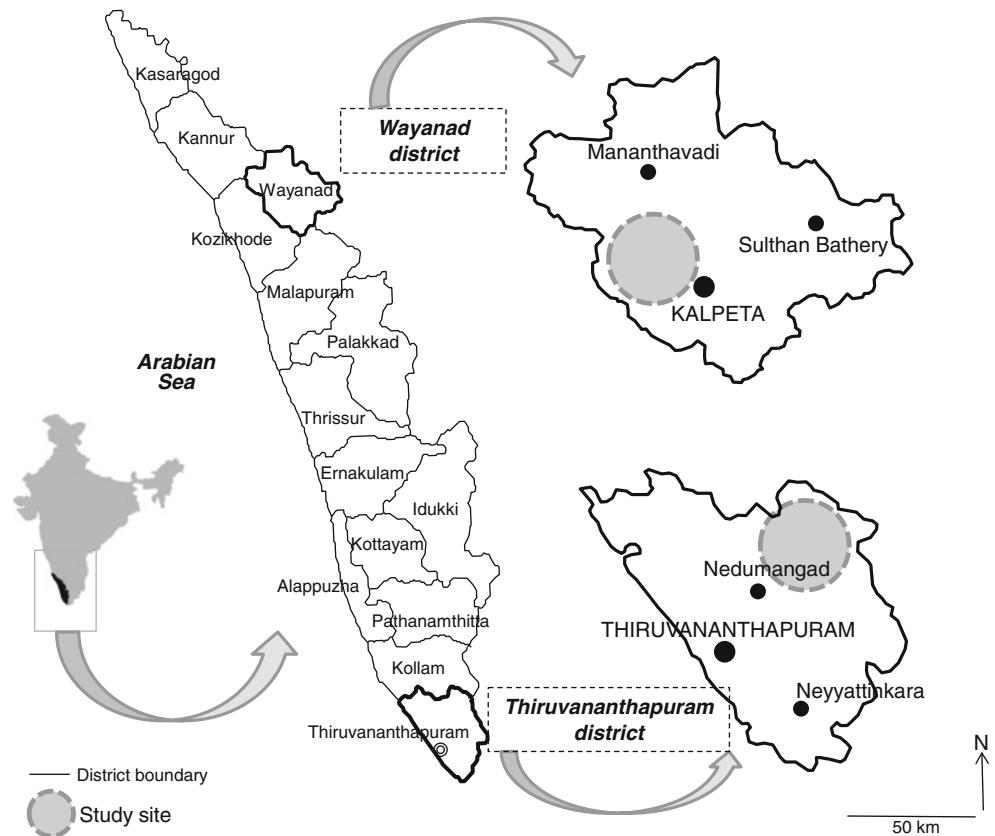
B. M. Kumar · A. V. Santhoshkumar  
College of Forestry, Kerala Agricultural University, KAU P.O.,  
Thrissur 680 656, Kerala, India

A. Menon  
Madras Institute of Development Studies (MIDS), 79 2nd Main  
Road, Gandhinagar, Adyar, Chennai 600 020, India

C. Hinnewinkel  
Université de Lille 1, Laboratoire TVES, Av P. Langevin,  
Université Lille 1, 59655 Villeneuve d'Ascq, France

S. Guillerme · C. Hinnewinkel · E. Maire  
French Institute of Pondicherry, Puducherry, India

**Fig. 1** Map of Kerala showing the study locations



which represents an intimate, multistory combination of various trees and crops, sometimes in association with domestic animals, around the homestead (Kumar and Nair 2004).

There are about 6.3 million predominantly small operational holdings in Kerala (average size 0.24 ha in 2000–01) covering a total area of 1.2 million ha (MoA 2001). About 80% of these holdings are homegardens (Kumar 2006), where both naturally occurring wild plants and deliberately introduced plants abound (Kumar and others 1994). Despite their ecological and socioeconomic importance, traditional agroforestry systems including homegardens have been subject to conversion linked to socioeconomic changes (Guillermé 1999; Peyre and others 2006). The rapid increase in the state's population between 1941 and 1971 resulted in a high pressure on the land. Due to an acute scarcity of food grains around the 1950s, the state policy was oriented towards growing more food crops. With increasing emphasis on industrial models of agricultural development, fragmentation of land holdings due to demographic pressures driving land use intensification and, to some extent, decreasing appreciation, traditional agroforestry systems declined (Jose and Shanmugaratnam 1993; Kumar and Nair 2004) and monocultures of commercial crops became dominant in Kerala.

Government policies play a vital role in providing incentives and disincentives to farmers to invest in tree farming and other agroforestry practices including homegardening. Case studies from Kerala regarding the impact of public policies on tree farming and agroforestry dynamics are, however, rare. Nevertheless, a plea was made in a 2001 Workshop on Cultivation of Bamboos, Rattans, and Timber Trees in Private and Community Lands to review and amend outdated or conflicting laws and harmonize them in view of the new challenges of rising wood requirements of society and increasing pressures on remaining natural forests (Mohanan and others 2002).

This paper attempts to address the following question: What are the impacts of forest, land tenure, and agricultural public policies on agroforestry systems with special reference to tree farming in Kerala? Important sub-questions are: What are the dynamics of agroforestry in Kerala? What are the main policies involved in tree planting on private lands? Why do farmers (not) grow trees? We argue that there is no policy for agroforestry in Kerala and that existing sectoral policies of land, agriculture, and forestry contribute to promoting plantation crops such as rubber (*Hevea brasiliensis*) instead of agroforestry systems, even among the small and marginal farmers. Indeed, farmers' practices are guided by a large variety of factors including

economic, demographic, social, and cultural factors (Seabrook and others 2008), besides for the land characteristics. Public policies interact with farmers' preferences in determining crops and land use practices.

## Materials and Methods

This research was conducted in the districts of Wayanad and Thiruvananthapuram in Kerala (Fig. 1), which were selected to have contrasting conditions (Table 1) with regard to the size of holdings, composition of the population, and the relative importance of agroforestry as a source of income.

### Land Use and Social Characteristics of the Study Sites

Wayanad district, a plateau located in the northern part of the state (Fig. 1), is in the highlands (altitude: 700 to 2100 m) of Kerala and has been the abode of several indigenous communities. The livelihoods of the indigenous people have been predominantly land- and forest-based (Kjosavik and Shanmugaratnam 2007). Peasants migrating from the Malabar plains to the forested tracts of Wayanad in the 1780s started homestead cultivation with pepper (*Piper nigrum*) and several other spices (Menon 1962). The multi-strata 'garden land homesteads' and the upland plots prevalent at the study site have evolved over a long period of time under variable planting and/or extraction regimes (Kumar and Takeuchi 2009). The first coffee plantations appeared

~1838. Coffee was produced along with pepper, coconut (*Cocos nucifera*), and arecanut (*Areca catechu*) in agroforestry combinations. Tea plantations were developed in several areas from 1892 onwards (Nair 1911), and crops such as cardamom (*Elettaria cardamomum*), pepper, cinchona (*Cinchona officinalis*), and arecanut were also introduced, though to a lesser extent. Wayanad remains highly forested (with a forest cover of 78% of the total area: FSI 2005) and very rural with 85% of the population depending on agriculture and related activities for their livelihood. The district has the highest average size of holdings (0.58 ha: Table 1). However, 94% of the holdings are below 2 ha (DES 2006). Farmers cultivate high value crops, predominantly spices, and plantation crops such as tea, coffee, and cardamom, mostly in agroforestry combinations. A coffee based cropping system is most prevalent in Wayanad and occupies 32% of the total cropped area (DES 2006).

Thiruvananthapuram, the southern most district of Kerala (Fig. 1), was also densely forested till the seventeenth century (Ward and Conner 1863). Bourdillon (1893) underlined that from the 1840s onwards the cultivated area expanded to the eastern parts of the district due to population increase. New settlers introduced paddy cultivation and animal husbandry (cattle, buffaloes, and goats). Other prominent practices included planting coconut, pepper, cassava (*Manihot esculenta*), banana (*Musa* spp.), cashew (*Anacardium occidentale*), arecanut, tamarind (*Tamarindus indica*), etc. in association with forest trees, which remained after forest clearing. The Europeans introduced rubber in certain parts of Travancore in 1902. By 1914,

**Table 1** Selected agricultural and socioeconomic indicators for Kerala state, and the districts of Thiruvananthapuram and Wayanad

Parameters	Kerala	Thiruvananthapuram	Wayanad
Average size of holding during 2000–01 (ha) <sup>a</sup>	0.24	0.11	0.58
Proportion of marginal farms (<1 ha) to total (%) <sup>a</sup>	95.25	99.0	86.44
Proportion of small farms (1–2 ha), to total (%) <sup>a</sup>	3.37	0.78	8.8
Population decadal growth rate, 1991–2001 (%) <sup>b</sup>	9.4	9.8	16.1
Proportion of scheduled tribes to total population (%) <sup>b</sup>	1.1	0.6	17.4
Literacy rate (%) <sup>b</sup>	90.9	89.3	85.2
Proportion of cultivators to total workers (%) <sup>b</sup>	7.0	3.7	18.6
Agricultural laborers to total workers (%) <sup>b</sup>	15.8	13.0	3.5
Forest cover to total area (%) <sup>c</sup>	28.4	45.12	78.7
Density of population, 2001 <sup>b</sup> (number per km <sup>2</sup> )	819	1476	366
Share of net state domestic product, primary sector, 2001 <sup>d</sup> (%)	25.84	17.3	51.3
Share of net state domestic product, tertiary sector, 2001 <sup>d</sup> (%)	53.72	61.3	41.6

Sources: <sup>a</sup> Agricultural Census 2000–01 (available at <http://agcensus.nic.in/cendata/StateT1table2.aspx>, accessed 19 October 2009)

<sup>b</sup> Census of India 2001 (available at <http://www.censusindia.net>; accessed 6 November 2010)

<sup>c</sup> Forest cover includes all lands having tree canopy density of more than 10% that can be interpreted from satellite data: Land Use Statistics, Ministry of Agriculture, Government of India, available at <http://www.fsi.nic.in/sfr2005/Chapter%208/Kerala.pdf>; accessed 6 November 2010

<sup>d</sup> 1999–2000 at constant prices; Human Development Report 2005: Kerala. Centre for Development Studies, Thiruvananthapuram (available at [http://www.planningcommission.gov.in/plans/stateplan/sdr\\_pdf/shdr\\_kerala05.pdf](http://www.planningcommission.gov.in/plans/stateplan/sdr_pdf/shdr_kerala05.pdf); accessed on 6 November 2010)

rubber became a very successful crop in this region (George and others 1988). Overall, Thiruvananthapuram district has the smallest size of holdings in the state, and a very high population density (Table 1). However, most people do not depend on agriculture entirely for livelihood anymore. In view of this, agroforestry has declined and lost some of its characteristic species and genetic diversity.

### Survey Method

In order to highlight the diversity, complexity, and dynamics of agroforestry in Kerala, a systematic approach was adopted that focused on the diachronic and multi-scale dimensions of agroforestry. Research questions and problem statements evolved during the investigation process in order to empirically build knowledge (concept of plausibility: Olivier de Sardan, 1995). The fieldwork reported here includes observations, interviews (two sets), and secondary data collection.

A first set of data was collected in 2008 at the *taluk* level (administrative subdivision) in Kalpetta and Mananthavady in Wayanad district and in Nedumangad *taluk* of Thiruvananthapuram district. This included open individual interviews with key informants from the state forest and agriculture departments (district, *taluk*, and *panchayat* [lowest echelon of local self government] levels), local officials of the Rubber Board of India, Kerala State Land Use Board, and the village *panchayat*, as well as local teachers and elderly people. We also conducted eleven focal group meetings of farmers at Nanniyode and another five at Pozuthana, each with 5 to 15 farmers, in order to elicit information on the evolution of farming practices, local agrarian history, tree species dynamics, and present and past public policy issues. This was supplemented by secondary data collection on agriculture, land use, and forestry at the level of *panchayats*.

As a follow up to the exploratory field surveys, a second set of 70 semi-structured household interviews was conducted in 2009. The farm was adopted as the unit of analysis to understand the diversity of agroforestry practices, as farmers' decisions are made at this scale. It was conducted along with more general participatory observations. Two *panchayats*, reflecting the agrarian background of the respective districts, were selected for this purpose: Pozhuthana in Wayanad, and Nanniyode in Thiruvananthapuram (Fig. 1). Nanniyode had previously been studied in 1994 (Guillermé 1999) and was revisited in 2000 and 2009 to capture the changes in agroforestry practices. Both *panchayats* are located on the forest fringes. Thirty-five household interviews were conducted per *panchayat*. The households surveyed were randomly selected but care was taken to include disparate categories based on holding size, socioeconomic status, and time of settlement (Table 2).

**Table 2** Main characteristics of the villages and households sampled in Kerala during 2009

Parameters	Nanniyode	Pozhuthana
Extent of area (km <sup>2</sup> )	38.8	71.3
Number of inhabitants	28624	17397
Average elevation (m)	100	640
Time of settlement		
<10 years	6 (17.1)	4 (11.4)
10–30 years	13 (37.2)	15 (42.8)
>30 years	16 (45.7)	16 (45.7)
Religion		
Muslim	4 (11.4)	5 (14.3)
Christian	6 (17.1)	12 (34.3)
Hindu	25 (71.5)	18 (51.4)
Size of holding		
<0.5 ha	25 (71.5)	20 (57.1)
0.5–1 ha	6 (17.1)	7 (20.0)
1–2 ha	3 (8.6)	6 (17.1)
>2 ha	1 (2.8)	2 (5.8)
Activity of the household members		
Full time farmers <sup>a</sup>	5 (14.3)	6 (17.1)
Part time farmers <sup>b</sup>	30 (85.7)	29 (82.9)

<sup>a</sup> Full time farmers denote a household where all the adult members are engaged in agriculture

<sup>b</sup> Part time farmers denote a household where at least one of the members gets income from off-farm activity. *Paranthetical values* are percentages. Number of households sampled were 35 each

We also ensured that different households did not belong to the same lineage (*tharawad*). The aim of these interviews was to highlight the agricultural practices and to capture the major issues that impacted tree growing and caused landscape level changes in agrobiodiversity.

The dataset from the first interviews was used to reconstruct the land use history at the *panchayat* level based primarily on the respondent's knowledge of such events and processes, which was refined using the data from the farm level surveys. We also undertook an analysis of public policies in Kerala related to tree growing, specifically various forest, agriculture, and land tenure laws. We referred to the original texts of the laws and cross-checked them with information collected during the interviews on land use dynamics and farmers' practices.

## Results

### Agroforestry Dynamics of the Study Areas

Based on the respondents' feedback during the first set of interviews, the principal changes in agroforestry systems of

Kerala over the past 50 to 80 years can be summarized as: decline in the diversity of indigenous multipurpose trees and shrubs, introduction of exotic fast growing multipurpose trees wherever possible, and declining diversity of herbaceous components such as traditional vegetable crops and ornamental plants owing to the conversion of agroforestry systems (including homegardens or their parts) to monospecific production systems.

Between 1930 and 1950 the Travancore and Malabar regions (two of the three provinces which formed Kerala state in 1956; the other being Cochin) witnessed significant demographic growth, which was reflected in our case study *panchayats* of Nanniyode and Pozhuthana. Cultivation practices initially were extensive and trees like *Terminalia paniculata*, *Artocarpus hirsuta*, *Calophyllum inophyllum*, and *Careya arborea* were abundant on the farmlands. However, in the 1940s to 1960s, as part of the “grow more food” campaign for food crop expansion and intensification, many of the areas with significant tree growth (e.g., homegardens, the land parcels traditionally set apart for production of green manure, fodder, fruits, nuts, and timber) were cleared. Food crops or plantation agriculture systems were established in such areas, instead.

The first rubber plantation in Nanniyode was established in the 1950s (much later than elsewhere in Travancore), promoted by the Rubber Board of India. At the beginning, rubber was cultivated in the less fertile lands and on the top of hills, where cassava productivity was low. In order to establish rubber plantations, most or all the trees on the plot had to be felled. In that process, occurrence and abundance of several local varieties of fruit and nut yielding trees, as well as timber trees like *T. paniculata*, *C. arborea*, *Bridelia retusa*, *Dalbergia latifolia*, *Terminalia tomentosa*, *C. inophyllum*, etc. declined substantially (Table 3). This tendency was also noticed in Pozhuthana as a result of coffee cultivation. However, as coffee needs shade to grow, not all standing trees were removed. Moreover, the pressure on land at Pozhuthana was not as high as it was at Nanniyode.

The 1970s witnessed profound population increases, agrarian reforms, and new agricultural technology. Main technological changes included introduction of high yielding varieties of crops and fruit trees, as well as commercial crops, which gradually replaced the local varieties even in agroforestry systems. New social and cultural values (consumerism and western style of living) evolved in Kerala at about that time. The economy became more cash crop oriented and new needs in the rural society appeared, mostly in terms of better education for children, comfortable housing, more diversified food, modern goods, and the like.

Coincidentally, the prevalent extensive agroforestry systems (e.g., homegardens, other tree-crop mixtures) were gradually transformed—intensified or replaced by the

introduction of monospecific food crops (e.g., cassava), commercial crops (rubber, coffee, pepper, etc.) and fast growing exotic species such as silver oak (*Grevillea robusta*), mangium (*Acacia mangium*), or mahogany (*Swietenia macrophylla*). This in turn led to sharp reduction in the frequency and occurrence of many indigenous timber and firewood yielding tree species like *C. arborea*, *T. paniculata*, etc. in the landscape (Table 3). Along with the change in the upland cropping systems, the wetlands also registered a progressive decline in paddy cultivation (Fig. 2), as it became increasingly unprofitable.

Since the 1990s, the emphasis on education and a more pronounced consumer culture has resulted in the desire for more cash, which in turn accelerated the pace of commoditization of the traditional land use systems. Consistent with this general trend, in Nanniyode the area under rubber increased substantially, mainly because of the support extended by the Rubber Board. Between 1990 and 2007, the area under rubber in Nanniyode *panchayat* increased by 70% from about 500 ha in the 1990s to 850 ha in 2007 (Nanniyode *krishi bhavan*, Department of Agriculture, pers. commn, 2009). About 80% of the farmers at Nanniyode whom one of the authors met in 1994, and revisited in 2000 and 2009, had either retained their rubber cultivation, expanded it or started it afresh on lands which were traditionally under agroforestry. Rubber has spread even into the homegardens, an area that traditionally farmers preferred to plant with other crops (like banana, tubers, vegetables, etc) and fruit trees. In Pozhuthana, a similar phenomenon was observable in terms of coffee and pepper cultivation, even among the small and marginal farmers.

Table 3 highlights the decline of timber and fruit trees in the study areas. Implicit in this is a process of simplification of the agroforestry systems including homegardens. Farmers also adopted more intensive crop and tree management practices to boost income levels. This is consistent with the findings of Kumar and others (1994) who reported that a vast majority of homesteads have been converted into small scale coconut or rubber plantations or have moved toward cropping systems with only a few crops. Furthermore, many indigenous trees have nearly disappeared in Nanniyode, while more are remaining in Pozhuthana as shade trees for coffee. In both cases expansion of commercial trees or fast growing exotics was readily observable. Government policies also contributed to these changes, as explained below.

#### Main Policies Shaping Farmers' Practices Since the 1950s

Public policies relating to land tenure, agriculture, and forest and their impact on tree growing with special reference to the study sites are summarized in Table 4. The



**Table 3** Evolutionary trends in the occurrence of dominant trees in the homegardens of Nanniyode and Pozhuthana *panchayats* of Kerala (India) since the 1950s

Botanical name	Common name (English/Malayalam)	Decreasing <sup>a</sup>	Stable <sup>b</sup>	Increasing <sup>c</sup>
<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	Wattle, acacia			X
<i>Acacia mangium</i> Willd.	Mangium			X
<i>Albizia lebbek</i> Willd.	Siris tree/ <i>vaka</i>	X		
<i>Anacardium occidentale</i> L.	Cashew/ <i>kashumavu</i>	X		
<i>Aporosa lindleyana</i> (Wt.) Bail.	<i>Aporosa/vitti</i>	X		
<i>Areca catechu</i> L.	Areca tree/ <i>kamuku</i>			X
<i>Artocarpus heterophyllus</i> Lamk.	Jackfruit/ <i>plavu</i>		X	
<i>Artocarpus hirsuta</i> Lamk.	Wild jack/ <i>anjili</i>		X	
<i>Bridelia retusa</i> (L.) Spreng.	Kasi tree/ <i>mulluvenga</i>	X		
<i>Calophyllum inophyllum</i> L.	Alexandrian laurel/ <i>punna</i>	X		
<i>Careya arborea</i> Roxb.	Kumbi tree/ <i>pezhu</i>	X		
<i>Ceiba pentandra</i> (L.) Gaertn.	White silk cotton tree/ <i>panji</i>	X		
<i>Cocos nucifera</i> L.	Coconut/ <i>thengu</i>			X
<i>Dalbergia latifolia</i> Roxb.	East Indian rosewood/ <i>veetti</i>	X		
<i>Eucalyptus citriodora</i> Hook.	Eucalytus/ <i>ukkali</i>			X
<i>Grevillea robusta</i> A. Cunn. ex R. Br.	Silver oak			X
<i>Hevea brasiliensis</i> (Willd. ex A. Juss.) M.-A.	Para rubber			X
<i>Lagerstroemia microcarpa</i> Wt.	Venteak/ <i>venthekku</i>	X		
<i>Macaranga peltata</i> (Roxb.) M.-A.	<i>Vatta</i>	X		
<i>Mangifera indica</i> L.	Mango tree/ <i>mavu</i>		X	
<i>Pterocarpus marsupium</i> Roxb.	Indian Malabar kino tree/ <i>venga</i>	X		
<i>Swietenia macrophylla</i> King.	Mahogany			X
<i>Tamarindus indica</i> L.	Tamarind tree/ <i>puli</i>	X		
<i>Tectona grandis</i> L.f.	Teak/ <i>thekku</i>	X		
<i>Terminalia paniculata</i> Roth.	Kindal tree/ <i>maruthu</i>	X		
<i>Terminalia tomentosa</i> (DC) W. & A.	Sain tree/ <i>karimaruthu</i>	X		

Based on the householders' experience, group interviews, and interviews of elderly people regarding the evolution in Nanniyode and Pozhuthana *panchayats* of Kerala. This list, not exhaustive, concerns with the main trees mentioned

<sup>a</sup> Trees becoming scarce on private lands

<sup>b</sup> Trees showing a global stability

<sup>c</sup> Trees having significantly expanded on private lands

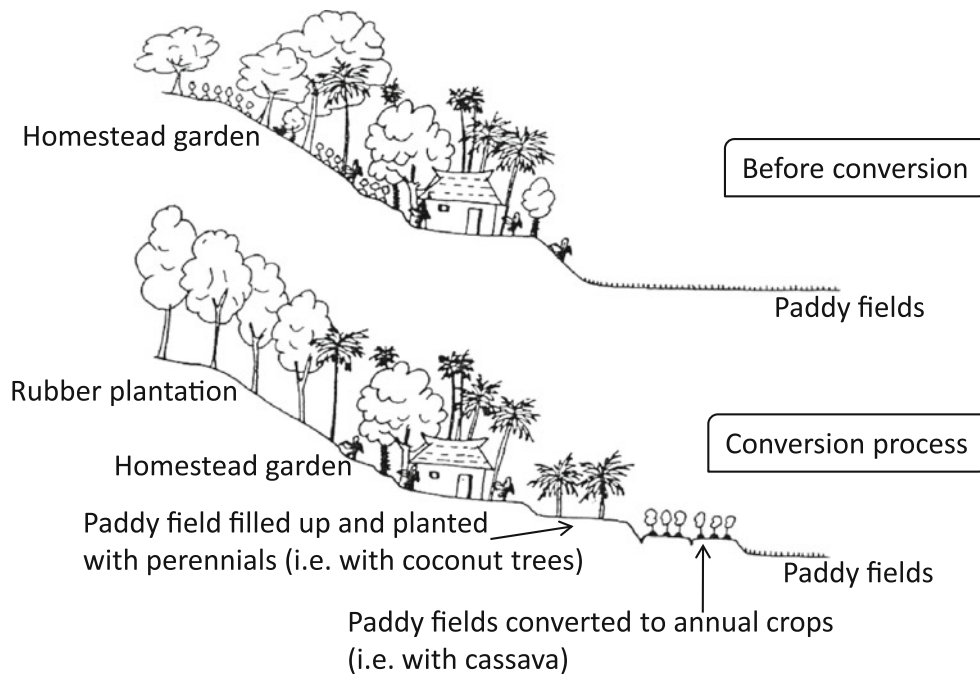
coverage is not exhaustive but rather highlights those aspects that the respondent farmers specifically mentioned.

### Laws Impacting Land Redistribution

The Kerala Land Reforms (KLR) Act of 1963 was aimed at imposing a land ceiling (8 ha maximum for a five member family) and redistributing the surplus land to the landless farmers. However, certain kinds of land uses were exempted from the purview of this Act (e.g., private forests and plantations such as coffee, rubber, tea, or cardamom). In Nanniyode, the impact of these agrarian reforms was modest. Only a total of 180 ha of surplus lands were redistributed among ~950 families. This is because many landowners, to escape the provisions of this regulation and

avoid being dispossessed, started growing rubber which was exempted, at the expense of traditional agroforestry systems. As tree mixtures are not permitted by the Rubber Board (one of the conditions to get subsidies), other tree species were felled.

The Kerala Private Forest (Vesting and Assignment) Act, 1971 (KPFVA), aimed at distribution of private forest lands to small farmers and agricultural laborers after vesting it from their erstwhile owners, is another legislation that is relevant in this context. This Act was more important in the northern parts of the state (Wayanad), where large areas of private forest were owned by the local landlords (*jenmis*), compared to the southern and central regions. For example, 58% of the total extent of forests in the two Forest Divisions of Wayanad district (318 km<sup>2</sup>) is



©S.Guillherme,2011

**Fig. 2** Land use changes at Nanniyode, Kerala since the 1970s. The traditional paddy (*Oryza sativa*) cultivation in the lowlands is gradually disappearing. It starts with fallowing the fields for one or more seasons, which is followed by draining the land and planting annual crops such as cassava (*Manihot esculenta*) or banana (*Musa* spp.). The next phase

is planting woody perennials like coconut (*Cocos nucifera*), arecanut (*Areca catechu*) or even multipurpose trees after filling up the land. On the uplands, plantations and buildings are replacing traditional agroforestry systems

vested forests, and in Thiruvananthapuram Forest Division this is just 1% of the area (4 km<sup>2</sup>). This Act also exempted lands that were principally under tea, coffee, cacao, rubber, cardamom, and cinnamon (*Cinnamomum zeylanicum*), and as a result, considerable land area was converted to these crops. In the area surveyed in Wayanad, most of the private forestlands were converted into coffee and tea plantations and the original forest tree cover was cleared or significantly opened up, to escape the provisions of the law. The new land use pattern that emerged following the promulgation of this regulation still had some species mixtures (e.g., commercial crops in association with shade or support trees), even if species diversity was less than that of the forest ecosystems which preceded them.

#### Laws Promoting Commercial Tree Plantations and Agriculture

Agricultural legislation too has been promoting commercial crop production especially in the upland areas of Kerala. Government of India laws such as the Coffee Act of 1942, the Rubber Act of 1947, and the Tea Act of 1953, which feature provisions for technical and financial assistance to the growers through the creation of specific commodity boards are a case in point. Although only large farmers were planting rubber in Nanniyode in the 1960s,

from the 1980s onwards even small farmers have started growing it. The subsidy for planting rubber as a monocrop, and the high price for rubber latex, were major incentives. In addition to the above referenced national laws, there have been state level schemes that supported cash crop production (coconut, pepper, and coffee) and paddy cultivation. While rubber and paddy are grown in monoculture, other crops are often grown in agroforestry systems. Indeed, the government agencies responsible for the production and management of these crops did not preclude the occurrence of “non crop” tree species within the stand, as was the case with rubber.

Land development legislation also was aimed to promote agriculture. Examples of such laws include the Kerala Land Utilization Order, 1967. Besides promoting food crop production [paddy, sugarcane (*Saccharum officinarum*), vegetables, cassava, yam (*Dioscorea* spp.), groundnut (*Arachis hypogaea*), tea, coffee, cardamom, and pepper], this order made provisions preventing land from being fallowed or being converted to non-food crops and uses. It seems to have helped maintain a natural tree cover in the coffee plantations of Wayanad, both because coffee requires tree shade and the law prohibits coffee conversion to other land uses.

Certain provisions or loopholes in the laws enacted for promoting agriculture indirectly contributed to tree



**Table 4** Major legislations in Kerala (India) with implications for tree planting and agroforestry

Acts and Rules	Relevant sectors	Aimed at	Main features	Impacts (based on the results of the present survey and published information)
The Kerala Land Reforms Act, 1963 (available at <a href="http://www.kslb.kerala.gov.in/act_rules/Kerala%20Land%20Reforms%20Act,%201963.pdf">http://www.kslb.kerala.gov.in/act_rules/Kerala%20Land%20Reforms%20Act,%201963.pdf</a> . Accessed on 6 November 2010)	Land tenure	Distribution of land among landless laborers and tenants Prescribing an upper limit on the size of individual holdings (land ceiling)	Upper limit of 8 ha for a five member family Private forests and plantations (coffee ( <i>Coffea</i> spp.), rubber ( <i>Hevea brasiliensis</i> (Willd. ex A. Juss.) M.-A.), tea ( <i>Camellia sinensis</i> (L.) Kuntze) or cardamom ( <i>Elettaria cardamomum</i> (L.) Maton Engl.) etc. exempted. Amended in 1969, 1971, 1976, 1981, and 2005	Accelerated fragmentation of holdings, and negatively impacted tree farming and agroforestry Frequency and occurrence of timber and fruit trees on the landscape declined (Table 3)
The Kerala Land Utilization Order, 1967 (available at <a href="http://clr.kerala.gov.in/pdf/actsrules/land_utilisation_order_1967.pdf">http://clr.kerala.gov.in/pdf/actsrules/land_utilisation_order_1967.pdf</a> . Accessed 6 November 2010)	Agriculture	Increasing food production; prevent agricultural lands from being fallowed; and check its conversion to other uses	Intended to achieve food security in the state	Conversion of agricultural lands, including the tree species-rich traditional homegardens, for other purposes, continues unabated Paddy land conversions indirectly promote tree planting, but transforming homegardens into commercial plantations would reduce the abundance of multipurpose trees
The Kerala Private Forests (Vesting and Assignment) Act, 1971 (available at <a href="http://Thiruvananthapuram.gov.in/pdf/act/forest_Vesting.pdf">http://Thiruvananthapuram.gov.in/pdf/act/forest_Vesting.pdf</a> . accessed 6 November 2010)	Forest/agriculture	Vesting of all private forests in the state and assigning such vested forests to farmers and agricultural laborers Increase agricultural production and promote welfare of the agricultural population	Tea, coffee, cacao ( <i>Theobroma cacao</i> L.), rubber, cardamom, and cinnamon ( <i>Cinnamomum zeylanicum</i> Blume) plantations exempted	Transferring the control of private forests to the public sector although was desirable, resulted in massive deforestation and illicit felling of timber from the erstwhile private forests
The Kerala Restriction on Cutting and Destruction of Valuable Trees Act, 1974 (excerpts available at <a href="http://www.keralaforest.org/index.php?option=com_content&amp;view=article&amp;id=199&amp;Itemid=13">http://www.keralaforest.org/index.php?option=com_content&amp;view=article&amp;id=199&amp;Itemid=13</a> ; accessed on 6 November 2010).	Forest/agriculture	Control indiscriminate felling of trees and destruction of forests	Restriction to cut three species: Sandalwood ( <i>Santalum album</i> L.), teak ( <i>Tectona grandis</i> L.f.), rosewood ( <i>Dalbergia latifolia</i> Roxb.)	A disincentive for tree planting on private lands Repealed in 1986 with the promulgation of the Kerala Preservation of Trees Act

Table 4 continued

Acts and Rules	Relevant sectors	Aimed at	Main features	Impacts (based on the results of the present survey and published information)
The Kerala Forest Produce Transit Rules 1975 (available at <a href="http://www.keralaforest.org/images/pdf/kfptr.pdf">http://www.keralaforest.org/images/pdf/kfptr.pdf</a> . accessed on 6 November 2010)	Forest	Regulating import, export, and transport of timber and other forest produce	Prescribes a pass issued by Forest Department to transport timber or other forest produce excepted for exempted trees Although there is an exemption category consisting of 61 species, which does not require pass, most of the commercially valuable timber trees are covered under this rule, curtailing the movement of timber originating from private lands	A disincentive for undertaking planting of timber trees on private lands
The Kerala Preservation of Trees Act, 1986 (available at <a href="http://www.keralaforest.org/images/pdf/kpta.pdf">http://www.keralaforest.org/images/pdf/kpta.pdf</a> . accessed 6 November 2010)	Forest/agriculture	Restricting indiscriminate felling and destruction of trees	Permission required for harvesting ten tree species on private lands: sandalwood: teak, rosewood, irul ( <i>Xylocarpus</i> (Roxb.) Taub.), thempavu ( <i>Terminalia tomentosa</i> (DC) W. & A.), kampakam ( <i>Hopea parviflora</i> Bedd.), chempakam ( <i>Michelia champaca</i> L.), chadachi ( <i>Grewia tiliaefolia</i> Vahl), chandana vempu ( <i>Cedrela toona</i> Roxb. ex Willd.), cheeni ( <i>Tetrameles nudiflora</i> R.Br)	The cumbersome procedures involved in getting permission for harvesting trees on private lands act as a major disincentive against tree planting by farmers (Kumar and Peter 2002) Repealed in 2005
The Kerala Promotion of Tree Growth in Non-Forest Areas Act, 2005 (available at <a href="http://www.keralalawsect.org/keralacode/act46_2005.html">http://www.keralalawsect.org/keralacode/act46_2005.html</a> . accessed 6 November 2010)	Forest/agriculture	Promote cultivation of trees in non-forest areas Encourage owners of non-forest land to plant trees on their lands	Relaxed the provisions of the Kerala Preservation of Trees Act, 1986. However, the individuals concerned should file a declaration for cutting teak, rosewood, irul, thempavu, kampakom, vellakil ( <i>Dysoxylum malabaricum</i> Bedd.), and ebony ( <i>Diospyros malabarica</i> (Descr.) Kostel.)	Promotes planting of multipurpose trees on private lands
The Kerala Promotion of Tree Growth in Non-Forest Areas (Amendment) Act, 2007 (available at <a href="http://www.keralaforest.org/images/pdf/act20070001.pdf">http://www.keralaforest.org/images/pdf/act20070001.pdf</a> . accessed 6 November 2010).	Forest/agriculture	Regulate tree felling in notified areas and of certain selected species such as sandal	Amended the provisions of the original Act limiting the relaxations to owners of non-forest lands in non-notified areas	The Kerala State Forest Department's control over extraction of sandal trees on private lands was reintroduced through this amendment, which however is inconsistent with the need to raise sandal wood production in the country (Dhanya and others 2010)

planting especially in the wetlands. Small scale conversions of paddy fields (up to 0.02 ha) for house construction is generally permitted by law. However, all respondents in this study considered paddy cultivation as a non profitable activity, and paddy field conversions are widespread in spite of the interdiction (Fig. 2). The farmers plant trees and palms on their paddy fields primarily to enhance profitability. They either make use of the provision for conversion of up to 0.02 ha of paddy field for house construction or expect that conversions with already established trees would ultimately be regularized.

#### *Laws to Protect Valuable Timber Trees*

Many laws and rules concerning trees have been enacted in Kerala (Table 4). These include the Kerala Restriction on Cutting and Destruction of Valuable Trees (KRCDVT) Act of 1974, the Kerala Forest Produce Transit (KFPT) Rules of 1975, and the Kerala Preservation of Trees (KPT) Act of 1986. While the first was passed in order to prevent indiscriminate felling of trees and destruction of forests, the second restricts import, export, and transport of timber and other forest produce. The KPT Act of 1986 was enacted repealing the KRCDVT Act. Specifically, it was aimed at regulating tree felling and associated changes in land use pattern by imposing restrictions on the harvesting of trees on private lands. Although this legislation had a laudable objective, it acted as a serious disincentive to tree planting, especially of the ten species mentioned in the Act (Table 4). The procedural hassles involved in getting permission for tree felling from the forest authorities were insurmountable. Some respondents commented that in order to avoid such problems, whenever the farmer notices regeneration of the trees species mentioned in the Act, e.g., sandal (*Santalum album*) and rosewood—instead of preserving it, they destroyed it. This law, however, was repealed when the state legislative assembly passed The Kerala Promotion of Tree Growth in Non-Forest Areas (KPTGNFA) Act, 2005, which gave landowners the right to cut trees on their farm without obtaining permission from the authorities concerned.

Although the KPTGNFA Act made it easier to harvest timber trees on private lands, it had an opposite effect compared to the policies relating to land tenure and agriculture, which encouraged cash crops. In practice, some farmers have admitted cutting down trees indiscriminately as they were afraid that the KPTGNFA Act would not remain in force for long. The relationship between laws regulating land use and people's practices is seemingly very complex. To add to this complexity, by an amendment in 2007, a new provision "notified areas" from where no tree shall be cut without prior permission, was added to this law, partly justifying the apprehensions of some farmers.

#### Farmers' Preferences Regarding Choice of Tree Species

Farmers' practices reflect the choices they make in order to adjust to the diversity of constraints and opportunities they face, including public policies, as well as their own aspirations. Plantation agriculture was the dominant land use activity at both study sites: e.g., rubber monoculture at Nanniyode and coffee based agroforestry at Pozhuthana. The push towards plantation agriculture concomitantly resulted in a reduction in the occurrence and abundance of several traditionally important indigenous multipurpose trees. Table 3 summarizes the changes in status of 26 tree species on the agricultural lands of the study areas over the past six decades. Besides the laws and policies (legal framework), a number of other factors influenced farmers' decisions regarding choice of trees and other species. These include:

- *Holding size*: Fragmentation of the holdings (due to inheritance and sale) led to reduced land availability per household, which necessitated increased productivity per unit area. In view of this, the respondents indicated their preference for fast growing trees with compact crowns to enable planting a greater number of trees per unit area. Yet another consequence of fragmentation was that large trees were increasingly becoming uncommon and were severely pruned when present, or at times cut and removed.
- *Labor scarcity and costs*: Non-availability and high costs of workers were major constraints particularly at Nanniyode because of its proximity to the state capital where better employment avenues existed. Labor was also a problem in Pozhuthana, but to a lesser extent because alternate employment opportunities were relatively less there. Scarcity of labor and its high costs generally promoted planting less labor-requiring timber trees.
- *Lack of resources*: Farming practices also depended on the occupation of the household members. For example, rubber plantations were established even by marginal farmers when they had alternative livelihoods to sustain till rubber trees were ready for tapping (~5 years). Off farm occupations were advantageous as they ensured financial stability, but were a constraint when people had to rely on external workers to carry out farm operations, forcing farmers to switch to timber trees. For example, in Nanniyode, although rubber remained the most popular cultivated tree, more people have recently started planting fast growing trees such as mangium which do not need much care and management—owing to scarcity of rubber tappers.

Some respondents also indicated that lack of institutional support mechanisms for financial assistance and

marketing timber products is yet another constraint in this regard, which hampers the adoption of tree farming. Crop raiding by wild animals (wild boar at Nanniyode and wild elephants at Pozhuthana) is a unique problem at these study sites, situated on forest fringes. However, this may not be a cardinal issue elsewhere. To escape from such damages, the farmers often avoid growing food crops, and plant timber trees, eucalyptus, rubber, or coffee. They also tend to avoid fruit trees, in turn affecting floristic diversity of the landscape.

The respondents generally pointed out that their main aim of farming is maximization of profits from a limited area of land in the shortest time span. And they expect trees to be planted on the farm, should ensure “profitability” (44% of the farmers), “fast growth” (37% of the respondents), and “multifunctionality” (fruits for domestic consumption and sale, leaves as green manure, feed for livestock, firewood, and timber for meeting own needs or as a reserve of capital: 28% of the respondents). Such preferences are usually based on the farmers’ economical, ecological, and social value systems.

## Discussion

Agroforestry in Kerala is being both intensified (e.g., intensive tree and crop management practices) and simplified (e.g., fewer species) as a result of current policies and because of the constraints (legal, technical, and socioeconomic) to grow trees and the general neglect of agriculture. The net result is the lower occurrence and abundance of many indigenous multipurpose trees in the landscape (Table 3). In a previous study analyzing the tree farming scenario in Palakkad and Malappuram districts of Kerala, Kumar and others (1992) also suggested that farmers are somewhat averse to plant more indigenous timber trees and multipurpose trees and identified lack of institutional support mechanisms, inadequate attention to land tenure questions, non-availability of quality planting stock, and policy constraints, as the reasons.

### Between Constraints and Opportunities: A Remarkable Capacity for Adaptation

Although the traditional agroforestry systems of Kerala (e.g., homegardens and mixed species production systems involving multipurpose trees) are sustainable production systems that conserve site resources and agrobiodiversity, these are not yet supported by comprehensive public policies. Moreover, there is little or no extension support or financial incentives for practicing such systems. Commodity centric agricultural policies and forest policies favoring exotic species in the past have adversely affected

the prospects of agroforestry as a land management system. This together with a general lack of awareness among the development agencies about the intrinsic worth of mixed species production systems has aggravated the situation.

Most public policies also do not take into account the environmental services rendered by agroforestry or even by the farmers. They focus on the most profitable and marketable crops or trees, neglecting the dimensions of domestic consumption and agrobiodiversity.

In the global context of the challenges associated with food security, climate change mitigation, poverty alleviation, and preservation of environment and biodiversity, a reorientation of public policies in relation to agroforestry in Kerala is warranted as most of the small and marginal farmers of the state still rely on agroforestry homegardens for their subsistence. But the present policies do not generally enable the farmers in Kerala, although some farmers may take advantage of the same, to promote homegardens.

The survey confirms that recent trends in agrarian structure and the pressures of the market have had negative impacts on agroforestry and its sustainability in Kerala. Traditionally, the homegardens allowed product diversification for domestic consumption, besides generating cash income (Kumar and Nair 2004). Today, however, farmers rely more and more on commercial crops to meet the family’s rising expectations and growing income needs. Changes in the society and the new aspirations of people also influence the choice of trees in the homegardens (e.g., planting fast growing multipurpose trees).

Public policies affect farming either by putting constraints on choices or by providing new opportunities. Although biodiversity losses from the Kerala landscape are often discussed (e.g., KFRI 2005), the possible inappropriateness or counterproductive effects of public policies on it has been assessed only rarely. In a study to understand why farmers do not grow timber and fuelwood trees, Ouseph (2002) observed that the Timber Transit Rules and KPT Act are major constraints. He also highlighted that rubber is more profitable than other trees and that enabling policies for growing commercial crops such as rubber or coconut may dissuade farmers from growing timber and fuelwood species, which is consistent with our observations. While the KLR and KPFVA Acts contributed to develop rubber plantations in many locations, the KPT Act and the KFPT Rules have in general complicated the process of planting timber trees by imposing restrictions on cutting and transporting timber.

Farmers are, however, not simply passive recipients of policies. Often they take advantage of the time-gap between promulgation and implementation of a law—either by planting or removing species of their choice in such a way that they escape any unfavorable provisions of

a prospective law. Likewise, the differential outlooks of various sectoral policies present contradictory signals to them. For example, while agricultural policies encourage more productive crops and possibly the clearing of trees, forest policies aim at protecting the same trees. In the process, some farmers harvest trees or plant crops under the provisions of a certain policy prescription disregarding others. The risks and uncertainties associated with differential policy outlooks are outlined below.

- Tree planting being a medium to long term investment, any future shifts in public policy would affect its profitability. For example, if policy shifts introduce new restrictions on timber harvesting after tree planting is undertaken, it will adversely affect the farmers.
- Conflicting perceptions of policy makers and farmers: the livelihood perspective on trees by farmers and the sectoral approach by the government are not necessarily the same. Moreover, the laws enacted usually have long term objectives (e.g., protection of the environment, future timber availability), but most marginal farmers have short term plans (e.g., earn livelihood security).

Overall, legal and policy aspects provide an important framework for choice of trees (and crops) being planted, retained, or removed from the farm, hence shaping the agroforestry landscape. Nonetheless, such decisions are strongly influenced by economic opportunities, as observed by Lambin and others (2001). It is apparent from the tendency of the respondent farmers for risk avoidance in the context of a legislation that their preferences may have an overriding impact on what crop species are grown on the farm. The relationship between policy imperatives and farmers' preferences (based on cultural, economic, and social variables) are, however, complex and often inseparable.

#### Towards Policies Integrating Agroforestry

Until now there are no comprehensive national or state policies in Kerala which recognize agroforestry as a farming option contributing to agrobiodiversity conservation, environmental protection, and generating income and social recognition for the farmers. However, the Government of India announced its first comprehensive agricultural policy in 2000—the National Agricultural Policy (NAP). It aims to attain 4% annual growth rate over the period from 2000 to 2020 in the agriculture sector and attempts to encourage a farming systems approach, which is resource-efficient, equitable, demand-driven, and sustainable. Promoting biodiversity-based ecological farming (synonymous with agroforestry) has been included among its objectives. This suggests that revitalizing traditional

agroforestry system practices based on indigenous multi-purpose trees is probably on the national agenda.

The National Forest Policy of 1988 represented a major shift in focus by discounting the existing commercial orientation of Indian forestry in order to reverse the degradation of forest resources in India. It encouraged a massive people's movement for achieving these objectives and to minimize pressures on the existing forest resources by promoting trees outside forests. Consistent with this policy, the Kerala government encourages growing trees on private lands in order to protect forests and maintain ecosystem services. The recent KPTGNFA Act of 2005 was the first major step to favor agroforestry and cultivation of trees outside forest areas, thereby possibly increasing the vegetation cover, preserving biodiversity, reducing soil erosion, and increasing wood availability for industries.

The recent publication of a draft Kerala Forest Policy (<http://www.kerenvs.nic.in/legislation/State%20Forest%20Policy.pdf>, accessed 8 November 2010) can be considered as one step further in this direction. It is supposedly an attempt to enhance tree cover both inside and outside the forest and to meet the timber and non-timber demands of the society. The draft policy recognizes the importance of homestead forestry and advocates that the Social Forestry Wing of the Forest Department acting as facilitator to promote tree farming in public as well as on private lands. This policy, when implemented, would promote agroforestry by (1) providing technical assistance, other inputs, and marketing support, (2) encouraging tree planting on private lands by liberalizing felling and transport regulations with precautions to prevent indiscriminate felling of trees, (3) supporting agroforestry and farm forestry activities in the homesteads and tribal settlements, and (4) setting up organizations in areas outside the forests with a view to mobilize the public in massive tree planting and production programs.

#### Conclusions

Adoption of agroforestry practices in Kerala is generally determined by an interplay of farmers' preferences (mainly economic rationale) and public policies. Legal and policy instruments impacted land use practices in general and agroforestry in particular in three broad ways, (1) obvious positive effects on plantation agriculture, some of which may be agroforestry, e.g. subsidies, technical inputs, and market support to promote rubber, coffee, cashew, black pepper, and other cash/plantation crops, (2) oblique support to plantation agriculture, e.g., land tenure laws that restrict holding size under certain land use pattern (e.g., arable crops) but exempt commercial plantations may favor the latter, and (3) obstructive or negative effects on adoption of



commercial timber species such as teak, rosewood, sandal and the like in private lands (e.g., the forest laws aimed at protecting timber resources in the government forestlands hamper planting of timber trees by private individuals).

Even if the new policy proposed by the Kerala government shows some understanding of the farmer's problems, contradictions exist between the dichotomous approaches adopted in the agriculture and forestry sectors. Should state policies promote agroforestry and agrobiodiversity, a vertical integration across multiple layers of the government as well as horizontal co-ordination across policy areas may be necessary. The question in Kerala remains how to make agroforestry systems, having a high ecological value, more profitable in order to preserve and promote them for reasserting the value of agroforestry as patrimonial systems, and not considering only their diverse components individually. This raises challenges for policy makers of Kerala. The state needs to redefine what its agriculture sector represents, environmentally and socially. There is a great need to incorporate agroforestry in the national strategy and policy of spatial development, and to promote these farming systems. Public policies should support agroforestry as a comprehensive agrarian system to be maintained and promote its existing ecological and socio-cultural benefits, and should get the support of marginal farmers. In order to help the small farms prosper under increasing globalization, the government should recognize the multifunctionality and socioeconomic adaptability of traditional agroforestry systems (including homegardens) and avoid policies that limit their diversity (e.g., conversion to monocultural systems). There could be an increasing public policy interest in the management of rural landscapes for conservation, both in terms of natural and cultural heritage. Agro-environmental policies could be an important part of an emerging vision for a sustainable countryside, with new support for agroforestry schemes.

**Acknowledgments** This work was carried out with the financial support of the Agence Nationale de la Recherche under the « Programme Agriculture et Développement Durable », project ANR-06-PADD-014, POPULAR, the Indo-French Cultural Exchange Program of FMSH—Paris, and the International Cooperation Projects of CNRS.

## References

- Bourdillon TF (1893) Report on the forests of Travancore, Travancore Government Press, Thiruvananthapuram, Kerala, India
- Department of Economics and Statistics (DES) (2006) Agricultural statistics 2005–2006, Kerala. Government of Kerala. Available at <http://www.ecostatkerala.org/agristat/agristat.htm>, accessed 20 December 2009
- Dhanya B, Viswanath S, Purushothman S (2010) Sandal (*Santalum album* L.) conservation in southern India: a review of policies and their impacts. *Journal of Tropical Agriculture* 48(1–2):1–10
- FSI (2005) Land Use Statistics, Ministry of Agriculture, Government of India (available at <http://www.fsi.nic.in/sfr2005/Chapter%208/Kerala.pdf>; accessed 6 November 2010)
- George KT, Haridasan V, Sreekumar B (1988) Role of government and structural changes in rubber plantation industry. *Economic and Political Weekly* 26(11):158–166
- Guillaume S (1999) Pratiques agroforestières et stratégies paysannes au Kérala (Inde du Sud) dynamique rurale en contexte de forte pression démographique. Thèse de Doctorat de l'Université Paris I-Panthéon-Sorbonne, France
- Jose D, Shanmugaratnam N (1993) Traditional homegardens of Kerala: a sustainable human ecosystem. *Agroforestry Systems* 24:203–213
- KFRI (2005) State Biodiversity strategy and action plan (SBSAP) for Kerala. Kerala Forest Research Institute, Peechi, Kerala, India
- Kjosavik DJ, Shanmugaratnam N (2007) Property rights dynamics and indigenous communities in highland Kerala, South India: an institutional-historical perspective. *Modern Asian Studies* 41(6): 1183–1260
- Kumar BM (2006) Carbon sequestration potential of tropical homegardens. In: Kumar BM, Nair PKR (eds) *Tropical homegardens: a time-tested example of sustainable agroforestry*. Springer Science, The Netherlands, pp 185–204
- Kumar BM (2007) Agroforestry systems and practices of Kerala. In: Puri S, Panwar Pankaj (eds) *Agroforestry systems and practices of India*. New India Publishing Agency, New Delhi, India, pp 459–483
- Kumar BM, Nair PKR (2004) The enigma of tropical homegardens. *Agroforestry Systems* 61:135–152
- Kumar BM, Peter KV (2002) Woody perennials in the farmlands of Kerala: policy and legal aspects. In: Mohanan C, Chacko KC, Seethalakshmi KK, Sankar S, Renuka C, Muralidharan EM, Sharma JK (eds) *Proceedings of the national workshop on policy and legal issues in cultivation and utilization of bamboo, rattan and forest trees in private and community lands*. Kerala Forest Research Institute, Peechi, Kerala, India, pp 166–170
- Kumar BM, Takeuchi K (2009) Agroforestry in the Western Ghats of peninsular India and the Satoyama landscapes of Japan: a comparison of two sustainable land use systems. *Sustainability Science* 4:215–232
- Kumar BM, Babu KVS, Sasidharan NK, Mathew T (1992) Agroforestry practices of central Kerala in a socio-economic milieu. In: Bhasha SC, Muraliedharan PK, Seethalakshmy KK, Sankaran KV, Nair KKN (eds) *Proceedings of the seminar on socio-economic research in forestry*. Kerala Forest Research Institute, Peechi, India, pp 209–220
- Kumar BM, George SJ, Chinnamani S (1994) Diversity, structure and standing stock of wood in the homegardens of Kerala in peninsular India. *Agroforestry Systems* 25:243–262
- Lambin EF, Turner BL, Geist HJ, Agbola SB, Angelson A, Bruce JW, Coomes OT, Dirzo R, Fischer G, Folke C, George PS, Homewood K, Imbernon J, Leemans R, Li X, Moran EF, Mortimer M, Ramakrishnan PS, Richards JF, Skanes H, Steffen W, Stone GD, Svedin U, Veldkamp TA, Vogel C, Xu J (2001) The causes of land- use and land- cover change: moving beyond the myths. *Global Environmental Change* 11:261–269
- Menon AS (1962) Kerala District Gazetteers, Kozhikode, India. Government of Kerala, Thiruvananthapuram, Kerala, India
- Ministry of Agriculture (MoA) (2000) Land use statistics at a glance 1996–97. MoA, Government of India, New Delhi, India
- Ministry of Agriculture (MoA) (2001) Agricultural census 2000–2001. Available at <http://agcensus.nic.in/cendata/StateT1table2.aspx>, accessed 19 October 2009
- Mohanan C, Chacko KC, Seethalakshmi KK, Sankar S, Renuka C, Muralidharan EM, Sharma JK (eds) (2002) *Proceedings of the National Workshop on policy and legal issues in cultivation and*



- utilization of bamboo, rattan and forest trees in private and community lands. Kerala Forest Research Institute, Peechi, Kerala, India
- Nair GC (1911) Wynad, its peoples and traditions. Higginbotham & Co. Services, Madras, India
- Nair PKR (2008) Agroecosystem management in the 21st century: it is time for a paradigm shift. *Journal of Tropical Agriculture* 46(1–2):1–12
- Olivier de Sardan JP (1995) La politique du terrain. *Enquête* 1:71–112 (Fr)
- Ouseph KP (2002) Why farmers do not grow agroforestry trees? An analysis of timber and fuel wood market in Kerala. Research Report—Part B (Unpublished), Institute of Forest Genetics and Tree Breeding, Coimbatore, India
- Peyre A, Guidal A, Wiersum KF, Bongers F (2006) Homegarden Dynamics in Kerala, India. In: Kumar BM, Nair PKR (eds) *Tropical homegardens: a time-tested example of sustainable agroforestry*. Springer, The Netherlands, pp 87–103
- Randhawa MS (1980) A history of India agriculture, vol 2 eighth to eighteenth century. Indian Council of Agricultural Research, New Delhi, India
- Seabrook L, McAlpine C, Fensham RJ (2008) What influences farmers to keep trees? A case study from the Brigalow Belt Queensland Australia. *Landscape and Urban Planning* 84:266–281
- Ward BS, Conner CE (1863, reprint 1994) Memoir of the survey of the Travancore and Cochin states, vol 1. Kerala Gazetteers Department, Government of Kerala, reprinted with biographical sketch of Lts. Ward and Conner, Thiruvananthapuram, Kerala, India