Adoption of Tree Farming by Smallholders in Pati and Bulukumba, Indonesia

Prepared by

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Research Report for Project on

Enhancing Community-Based Commercial Forestry in Indonesia

(ACIAR FST/2015/040)

29 July 2020

Australian Government
Australian Centre for International Agricultural Research

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KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

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Preface

This report was a component of the ACIAR-funded project 'Enhancing community-based commercial forestry in Indonesia' (FST/2015/040), conducted from July 2016 to December 2020. The report was part of the studies under objective 1: 'To enhance the commercial benefits from community-based commercial forestry (CBCF) for smallholders by strengthening their business networks'

Acknowledgements

The authors are grateful for the willingness of the many smallholders and local governments in both Pati and Bulukumba who contributed to this research by sharing their experiences and technical knowledge. The authors also thank the field assistants (Surya Amrian, Lina Utami Ningsih, Erikkayani, and Asatika Ligar Hadiyanti) and research colleagues who contributed to the research. This article draws on research conducted with financial support from the Australian Government's Australian Centre for International Agricultural Research (ACIAR) via project FST/2015/040.

Citation

Permadi, D.B., Muin, N., Bisjoe, A.R., Purwanti, R., Hayati, N., Hapsari, E., Silvia, D., Darisman, A., Oktalina, S.N., Hardiyanto, E.B., and Race, R. (2020). *Adoption of Tree Farming by Smallholders in Pati and Bulukumba, Indonesia*. ACIAR Project FST/2015/040 – Enhancing community-based commercial forestry in Indonesia. Canberra: Australian Centre for International Agricultural Research

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Contents

Abstract

The focus of this study is the adoption of commercial tree farming by smallholders and the land use changes they have engaged in since their first investment in trees. This report describes the characteristics of smallholders who grow trees, their farmland and the selected tree species (i.e. teak (*Tectona grandis*), sengon (*Paraseriantes moluccana*) and gmelina (*Gmelina arborea*). A survey of smallholders was conducted in two study sites – in the districts of Pati district (Central Java) and Bulukumba (South Sulawesi), Indonesia. The results revealed the adoption of tree farming by smallholders has resulted in a significant transition from agricultural crops to more forested landscapes. Informal sources of information (i.e. farmers, friends and relatives) had a profound impact on the adoption of tree growing, especially for tree species that had been established in the districts for more than 50 years (i.e. teak). Also, fast-growing trees (i.e. sengon and gmelina) have become widely adopted due to strong market, government and non-government incentives and support. However, recommended silviculture (i.e. fertilizing, pruning and thinning) was still not fully practiced by all smallholders. The motivation to grow commercial trees was a combination of short- and long-term economic, social and environmental reasons, but the economic objectives were typically unfulfilled. This resulted in the cessation of tree growing by some farmers. There is a need for further investigation of the rate of cessation of smallholder tree farming so accurate projections can be made about likely timber yields and concerns held by smallholders growing trees commercially can be addressed.

Keywords: adoption and diffusion; forest transition; gmelina; land use change; sengon; teak; tree farming.

Introduction

This research focuses on the need to better understand the adoption of tree farming by smallholders in Indonesia to improve understanding of how best to integrate smallholder forestry into the wider expansion of forests on farmland, also referred to as the forest transition (FT), occurring particularly in Java, but also elsewhere in Indonesia. 'Improving the utility of adoption' refers to changes in current adoption patterns, either increasing the area of plantation, reducing the number of trees, changing the plantation species, or any combinations of land uses that reflect strategic behaviors of smallholders. The 'emerging forest transition' refers to an era when a country or region is experiencing changing land use patterns, from reducing deforestation to increasing forest cover (Mather 1992, 2004, 2007).

The Government of Indonesia has designated a forest area of 124 Mha, or 65% of the national land base, as permanent forests (MOEF, 2014). The gross designated area is spatially divided into production forests (23.3%), limited production forests (22.3%), convertible forests (12.5%), protected forests (24.1%) and conservation forests (17.7%). However, Indonesia is categorized as a non-FT country because of its negative net deforestation rate at the national level (Mather, 2007; Meyfroidt et al., 2010). The main drivers of the forest losses include resettlement programs linked to tree crops (palm oil) and labour for the timber industry, fires, and forest clearance by smallholders for tree crops (Margono et al., 2012). According to Mather (2007), government policy is imperative to accelerate a FT, as indicated by the cases of India, China and Vietnam, which are categorized as developing countries experiencing FT over the last three decades. Mather indicates that the governments of these countries have launched radical forest policy changes during the FT period; the National Forest Conservation Program (NFCP) in China, the Joint Forest Management (JFM) program in India, and the devolution of management of state forests in Vietnam. These policy changes have created access for the rural community to engage in the establishment and management of plantation forests.

To balance the rate of deforestation in Indonesia, several forest rehabilitation programs have been launched by the central government. The programs had firstly granted concession permits to 100 timber corporations to establish industrial forest plantations on 6 Mha of 'unproductive' forest areas between 1990 and 2000. This has included 1 Mha for teak (*Tectona grandis*) plantations in Java. Recently, the Government has shifted the focus of the program to include smallholder forestry schemes for the management of state forestland and farm forestry under a social forestry program. Between 2006 and 2014, the Indonesian government allocated 5.5 Mha of forest to the smallholder forestry schemes and between 2015 and 2019, it aimed to increase the allocation to 12.7 Mha to supply 100 million m^3 of timber to the market over that period. This policy has three major aims, to:

- increase the rehabilitation of degraded forests,
- empower local communities and alleviate poverty in rural areas, and
- increase timber supply for the forest industry.

There are currently six social forestry schemes to support smallholder forestry systems in Indonesia. These include community forestry (CF or HKm), village forest (VF or HD), smallholder timber plantations (STP or HTR), forestry partnerships (FP), and farm forestry (private forests or *hutan rakyat*, HR) (Table 1, below). Each can be described based on their land tenure, main actors, and management purposes. The aims of each system may differ. For example, the HKm and HD schemes aim to empower local communities and alleviate poverty for forest dependent people, while the HTR and FP schemes aim to increase timber supply for industry through more commercial-oriented smallholder timber plantations (Suhirman et al., 2012). These differences in aims or goals may have different consequences for implementation processes. However, all the smallholder forestry systems highlight environmental concerns, such as improving degraded land and sequestering carbon.

Table 1: **Smallholder forestry schemes in Indonesia** (modified from Obidzinski & Dermawan, 2010)

Types of smallholder forestry	Land tenure		Main actors using the rights	Management purposes	Duration of the scheme
	Ownership	Rights of user/manager			
Community forest (CF) or Hutan Kemasyarakatan (HKm)	State	Access, use & manage	Community groups	Production & Conservation	Management rights for 35 years
Smallholder timber plantation (STP) or *Hutan Tanaman Rakyat* (HTR)	State	Access, use & manage	Community groups, private companies (contract agreement)	Production	Management rights for 35 years
Village forests (VF) or *Hutan Desa* (HD)	State	Access, use & manage	Community groups, village government (Licence)	Production & Conservation	Management rights for 35 years
Company-community partnership (CCP, *Kemitraan*)	State, managed by State owned company	Access, use & manage	State forest company, Community groups (contractual agreement)	Production & Protection	Collaborative management for 5 – 10 years
Company-community partnership (CCP, *Kemitraan*)	State, managed by Private forest industry	Access, use & manage	Private forest company, Community groups (contractual agreement)	Production	Collaborative management for 5 – 10 years
Community-government agency partnership	State	Access, use & manage	National Park, provincial government/KPH Community groups, (contractual agreement)	Conservation, Production & Protection	Collaborative management for 5 – 10 years
Farm Forestry/Private forests or *Hutan Rakyat* (HR)	Private	Access, use, manage & transfer	Individuals	Production	NA

Farm forestry, or *hutan rakyat* (HR), is one of the social forestry schemes applied on private land. Compared to other schemes operating in state forests, HR allows smallholder individuals to fully manage their land, control and select any tree species. Thus, the smallholders' decisions about their farm forests are not restricted by complex regulations. As noted elsewhere (Djuwadi, 2008), this type of smallholder forestry has the following unique features:

1) it is established on the basis of clearly-defined private property rights,
2) the woodlots do not form a contiguous area, instead being spread throughout the landscape based on tenure and planting pattern, planting area and variations in the vegetation structure and composition,
3) family decisions determine how the woodlot is managed,
4) the harvesting period is based on family needs,
5) well-organized collective decision-making does not always happen, and
6) no deliberate working plan is prepared, meaning industry certainty surrounding sustainable timber production is difficult to maintain.

The development of HR in different parts of Indonesia reflects that smallholder tree growing can help offset the deforestation rate in other parts of the country. Thus, a FT, in terms of changing agricultural landscapes towards more forested landscapes, may happen under varying situations.

The objective of this study was to describe changes in land use options in the districts of Pati and Bulukumba, Indonesia. Both of these districts have a significant proportion of HR compared to state forests. In Pati, the private farm forests cover an area of 34,638 ha or 23% of the total district area, while state forests cover only 15% of the total area (BPS Jateng, 2016)[1]. In Bulukumba, the private farm forests cover an area of 22,500 ha or about 19% of the total area, while state forests cover only 7.3% of the total area[2]. Better understanding the adoption of tree farming by smallholders in these two districts can increase knowledge of a form of local-level FT

[1] https://jateng.bps.go.id/statictable/2017/10/27/1553/luas-penggunaan-lahan-dan-luas-kawasan-hutan-menurut-kabupaten-kota-di-jawa-tengah-2016-ha-.html Accessed 29 May 2020
[2] https://scf.or.id/mfp/sekilas-kajian-pengelolaan-hutan-hak-di-bulukumba/ Accessed 29 May 2020

occurring in Indonesia. In addition, this study aimed to describe the characteristics of the smallholders adopting selected commercial tree species (i.e. teak, sengon and gmelina), the characteristics of their plantings and opportunities for sustainable management of these plantings into the future.

The report is structured as follows: the research method is presented next, followed by the results. The results are divided into two sections – firstly, the land use change occurring in Pati and the adoption of tree farming by smallholders, and secondly, a similar analysis for Bulukumba. The final section of the report presents a summary of the study and its conclusions.

Method

Data collection involved surveys of smallholders in both Pati and Bulukumba districts. Pati is located in Central Java in western Indonesia. This site is located about 2 hours by car from Semarang, the capital city of Central Java. The selection of this site was based on a database of tree growers who have collaborated with the Trees4Trees foundation, a non-governmental organization[3], in a certification program for sustainable community forest management. At those locations, sengon and teak plantations of various ages were measured by the farmers in 2015. In this year, the number of farmers participating in the forestry partnership with the Trees4Trees foundation and working in the community timber chain of custody activities was 193 members who live in 9 villages and 3 sub-distiricts in Pati. The survey in this district was conducted during the 11-15 April 2019. For survey implementation, we selected the sub-districts of Gunungwungkal, Kayen and Tambakromo, then selected the following villages: Bancak, Cabak, Milled, Gajihan, Gulangpongge and Jrahi (Gunungwungkal sub-district), Beketel Village (Kayen subdistrict) and in Sinomwidodo (Tambakromo sub-district). In this study, 42 of the participating farmers (21.8% of the total 193 members) were selected as respondents. About 26% of the respondents had adopted both sengon and teak plantations, while 42.9% and 30.9% had adopted only sengon or teak, respectively.

[3] https://trees4trees.org/

Figure 1: **The location of the Pati and Bulukumba study sites in Indonesia**.

The second study location is the district of Bulukumba, located in South Sulawesi in the middle part of Indonesia. It is located approximately 164-180 km from Makassar, the capital city of South Sulawesi, and can be reached within 4–5 hours driving by car. Bulukumba is well-known as the origin of Indonesia's Phinisi ship industry that has operated for many hundred years. However, there is now much less timber available for this important industry. The survey of smallholders in Bulukumba was conducted during the 25-30 April 2019. Four villages were selected, namely Malleleng and Tana Toa (both in Kajang sub-district), Benjala and Tana Lemo (both in Bonto Bahari sub-district) and Bonto Kamase (in Herlang sub-district).

The survey respondents in both Pati and Bulukumba districts were randomly selected using accidental sampling. Smallholder farmers that were easily located and were willing to be interviewed in the field at the time of the study were the only ones selected to participate. The respondents were asked to participate in a face-to-face interview for approximately 60-90 minutes to answer a structured questionnaire. The questions collected information about the respondents' socio-demographic characteristics, land ownership, land use practices, changes

that they have made to their land use, and details about their adoption of selected commercial timber trees. The data were descriptively analyzed and are presented below in several tables and graphs.

Study 1: Changes in land use patterns and tree farming in Pati District

Respondent socio-demographic characteristics and land ownership

The average age of respondents in Pati was 53 years, dominated by men and the majority had completed a senior high school level. Most of the respondents were farmers. Other main forms of employment were entrepreneurs and civil servants (PNS). A total of 28 respondents did not have side jobs, while the rest had side jobs such as middlemen, village officials and entrepreneurs. The respondents worked an average of 6 hours per day. The respondents' landholding areas varied according to their numbers of parcels and total areas (Table 2). All 42 respondents had at least one parcel, of which 27 respondents (63%) had more than one parcel, and six respondents owned up to five parcels. The respondents' average landholding was 0.69 ha, with a minimum of 0.08 ha and a maximum of 3.9 ha.

Changes in land use patterns and tree adoption in Pati

The total number of parcels observed based on the interview of 42 farmers was 96 covering a total area of 37.2 ha. The majority of respondents owned either 1 or 2 parcels (Table 2). The land use pattern at the study sites in Pati District at the time of the interviews can be described as either private forests (HR) or agricultural crops. The HR is private land used for tree farming, while the agricultural crops include household food and cash crops. HR was found on 55 of the 96 parcels (or 58% of the area) and the rests were used for agricultural crops (Table 3).

Table 2: **Socio-demographic characteristics of the respondents in Pati**

Characteristics	**Number of respondents (%)**
Age (year)	
• Average (St. Deviation)	52.3 (5.87)
• Min – max	44 – 70
Sexual identity: Male	38 (90.5)
Education level	
• Preliminary	6 (14.3)
• Junior high school	5 (11.9)
• Senior high school	28 (66.7)
• University graduates	3 (7)
Main occupation	
• Farmer	31 (73.8)
• Civil servant	3 (7.1)
• Entrepreneur	4 (9.5)
• Other	4 (9.5)
Landholding size (ha)	
• Average (St. deviation)	0.967 (1.334)
• Min – max	0.125 – 5.978
Number of land parcels owned by each respondent	
• 1	15
• 2	16
• 3	1
• 4	5
• 5	3
• >5	2

Approximately 67% of the parcels were previously used for agricultural crops, while the remaining land was used for private forests (33%). The current use data indicates that there is now more private land allocated to growing trees. Information about the exact year the change of land use took place was not available from the respondents. There is an indication, however, that the change could be traced back to 1994, as this is the longest time the respondents could remember, but the majority of respondents mentioned 2018 as the year the change in their current land use pattern occurred. Thus, the land use pattern at the study site has evolved over time between 1994 and 2018. We present further details of the timing of tree farming adoption by the smallholder farmers in the next section.

Table 3: **Land use pattern and changes in Pati since 1994**

No	Characteristics	Number	
		Current uses (%)	Past uses (%)
1	**Land Use Pattern (by number of parcels)**		
	Private Forests (HR)	55 (58)	31 (33)
	Agricultural crops	41 (42)	65 (67)
	Total	96 (100)	96 (100)
	Land Use Pattern (by size, ha)		
	Private Forest	23.8 (64)	15.2 (41)
	Agricultural crops	13.4 (36)	22 (59)
	Total	37.2 (100)	37.2 (100)
2	**Dominant trees/crops (by number of parcels)**		
	Clove	1 (1.0)	0 (0)
	Teak	20 (20.8)	19 (19.7)
	Cassava	26 (27.1)	40 (41,7)
	Coffee	1 (1.0)	0 (0)
	Rice	7 (7.3)	9 (9.4)
	Watermelon	3 (3.1)	3 (3.1)
	Sengon	33 (34.4)	14 (14.6)
	Lemon grass	1 (1.0)	1 (1.0)
	Sugarcane	3 (3.1)	7 (7.3)
	Citroen	0 (0)	1 (1.0)
	No information	1 (1.0)	2 (2.1)
	Total	96 (100)	96 (100)
	Dominant trees/crops (by size, ha)		
	Clove	0.9 (2)	0
	Teak	4.14 (11)	4.08 (11)
	Cassava	9.7 (26)	17.7 (47)
	Coffee	0.05 (0.1)	0 (0)
	Rice	1.6 (4)	1.9 (5)
	Watermelon	0.59 (2)	0.59 (2)
	Sengon	17.8 (47.7)	6.8 (18)
	Lemon grass	0.02 (0.1)	0.02 (0.1
	Sugarcane	2.2 (6)	5.3 (14)
	Citroen	0 (0)	0.38 (1)
	No information	0.22 (1)	0.45 (1)
	Total	37.24 (100)	37.24 (100)

We also compared the types of trees and crops currently planted with those planted in the past and found that they have changed dramatically. In the past, the proportion of parcels used to grow cassava was the largest (41.7%), followed by teak (19.7%), sengon (14.6%) and rice (9.4%). More parcels are now planted with sengon trees, which increased significantly from 14 parcels to 33 parcels (34.4%), followed by cassava (decreased to 27.1%), teak (stable at 20.8%) and rice (decreased to 7.3%). It is clear that the area of cassava plantings has sharply declined from 40 parcels to 26 parcels, while rice fields declined from 9 to 7 parcels (Table 3).

There is also a clear indication that many parcels previously used to grow agricultural crops have been converted into private forests. Table 4 shows, for example, that of 55 parcels currently used to grow private forests, 26 were originally agricultural crops. Far fewer parcels have changed from private forests to agricultural crops.

Table 4: **Number of parcels that changed from the past land use to the current land use in Pati**

Land Use Pattern	**Past pattern**		**Total parcels of current pattern**
	Private forest	Agricultural crops	
Private forest	29	26	**55**
Agricultural crops	2	39	**41**
Total parcels of past pattern	**31**	**65**	**96**

Adoption of teak in Pati

This section describes the adoption of teak trees for tree farming by smallholder farmers in Pati District, especially the initial adoption of community teak forest. Twenty six of the 42 respondents (61.9%) were familiar with teak, but only 24 respondents (57.1%) had planted the species on their own land. One respondent had known about teak since 1945, but had not begun planting the species until 1950. Between 1950 and 1975, there were only 4 respondents (2.4%) that had planted teak in a community forest. This number increase slightly to 7.1%

between 1976 and 1980. The highest rate of uptake of teak planting (16.7%) took place between 1996 and 2000. There was no new uptake of teak planting after 2005. There were 24respondents who planted teak between the years of 1950 and 2005. Most of these respondents (62.5%) undertook their teak planting in the years from 1991 to 2005 (Figure 2).

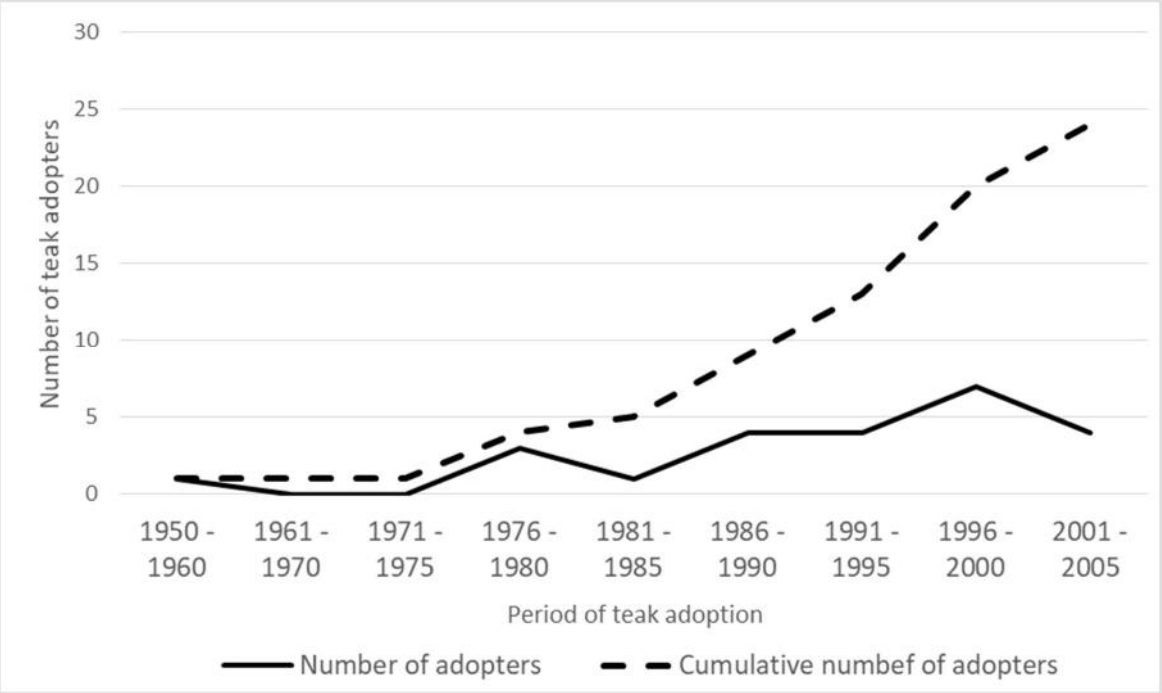

Figure 2: **The cumulative number of teak adopters in Pati between 1950 and 2005**

Respondents' knowledge about teak was mainly obtained from their social networks, mainly from their neighbors, parents or relatives, and colleagues, but also from extension workers. The reasons the respondents planted teak were varied, such as wanting to have timber for the construction of their own houses, to sell the timber for profit, to provide savings in old age or as a long-term investment, following the trend of the timber market or the adoption of teak by neighbors, and to help pay for children's school fees. Being influenced by social trends, such as following the lead of neighbors, was quite high (29%). Planting teak as a profitable and long-term investment/for savings both accounted for 25% of the responses, while a safety net or subsistence need, such as to build a house in the future, for children's tuition fees, and emergency needs accounted for 21% of the responses (Table 5). The smallholder farmers were

generally not concerned about any significant risk when planting teak. Nevertheless, a small number of respondents (12.5%) considered the long harvest period and seasonal caterpillar attacks were risks associated with growing teak. In growing teak, the farmers' establishment capital was generally sourced from family income that was set aside (savings), although some borrowed from cooperatives or from their parents' inheritance, but the amount was considerably small.

Table 5: **Reasons for smallholder farmers in Pati to grow teak for the first time**

Reasons	Number of Respondents (%)
Profitable investment	6 (25)
Long-term investment/saving	6 (25)
Social trend	7 (29)
Safety net/subsistence need	5 (21)
Total	24 (100)

Teak seedlings were generally purchased from traders or farmer groups, raised by the farmers themselves, or a small portion came from subsidies or distributions from the government and *Perhutani* (a State Forest Company). The seedling price ranged from Rp 500 to Rp 3000[4]/seedling. The genetic quality of seedlings was generally unknown, including whether it originated from a seed orchard or poor-quality stands. The initial tree spacing applied was generally 3 m x 3 m or 2 m x 3 m, or 1000 - 1300 trees per ha. Some of the respondents grew teak at a wider or narrower spacing (i.e. 4 m x 3 m or 2 m x 2 m). Respondents applied manure and chemical fertilizers (e.g. ammonium sulphate or urea) by purchasing through farmer groups or cooperatives. But most farmers did not fertilize their teak trees. In the process of adoption, several respondents found that their teak plants died, ranging from 2 to 100 seedlings.

Fifteen of the 24 teak growers (62.5%) did not thin their teak stands. Teak harvesting was done through selective cutting (harvesting individual trees based on a particular need, including a subsistence need). A total of 12 respondents (50%) had never cut down their trees, while 12 others (50%) had felled several teak trees as needed. These farmers mostly sold the harvested

[4] 1 AUD=Rp 10,000

log to middlemen (61.5%), some sold directly to the factories (15.4%) and the remainder used the timber themselves.

Most teak growers (91%) considered that the perceived economic benefits did not change their livelihood, with only 9% reporting an increase in family income. The reasons given for the lack of increase in family income were the long harvest period for teak, that the timber was only used for subsistence needs, or that the planting was considered an investment or savings to be inherited by their children. In terms of social impact, 50% of the teak growers believed in general there were other neighbors finally imitated to participate in growing teak in their own farmland, but only 29% of the teak growers considered there were no social changes due to someone in the community growing teak. Moreover, most respondents (83%) perceived that there was no change in the quality of the local environment due to teak planting. Only 13% of the teak growers considered that teak planting had a positive impact on the environment, including improved soils and reduced erosion (Table 6).

Table 6: **Pati teak growers' perceptions of the impacts of growing teak**

Impact of growing teak	**Number of respondents (%)**
Economic impact	
• Increased household income	2 (9)
• No economic change	21 (91)
Total	23 (100)
Social impact	
• Many people choosing to grow teak	12 (50)
• Few people choosing to grow teak	5 (21)
• No social impact	7 (29)
Total	24 (100)
Environmental impact	
• Improving the environment	3 (13)
• Worse for the environment	1 (4)
• No change in environmental quality	20 (83)
Total	24 (100)

Seven of the 24 teak growers (29.2%) were no longer growing teak after harvesting the first rotation of their plantation. This was mainly due to the long harvest rotation. In these cases, the teak trees were replaced with shorter rotation trees, such as sengon, other crops such as cassava, or a mixture of cassava and sengon.

Adoption of sengon in Pati

Most respondents (29 of 42, 67.4%) were familiar with sengon and had planted the species since 1982, while 13 respondents (32.6%) knew little about the species and had never planted it. Similar to the adoption of teak, most sengon adopters (69%) knew about the species through their neighbors and friends. The remaining respondents mentioned the Trees4trees foundation, the village committee and extension services as their source of information about sengon. The earliest introduction of sengon to the study area was in 1982, during the New Order Era (Orde Baru), particularly through the Regreening program. There were no additional growers until 1995 when there was a slight increase in adoption. Sengon adoption then began to increase in 2000 and 2002. Most of the sengon plantations in the study area were established between2002 and 2016 (Figure 3).

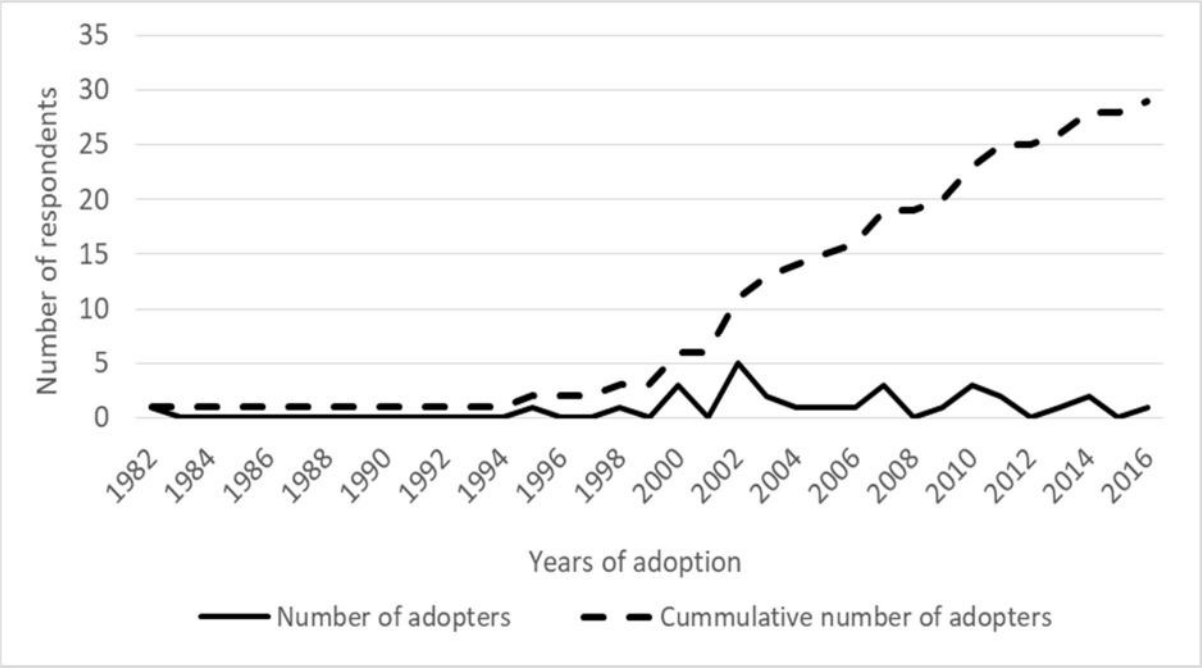

Figure 3: **Number of respondents and cumulative number of respondents that adopted sengon for the first time in Pati between 1982 and 2016**

The reasons for growing sengon were varied, with most relating to economic reasons, such as its profitability (44.8%), its high wood price (17.2%), available markets and mills (6.9%) and for future income (6.9%). There were also social factors that contributed to the growing of sengon, namely joining people in their social networks who had planted sengon (13.8%) and the perceived beneficial characteristics of sengon including its fast growth (3.4%) and use for regreening and environmental improvements (6.9%) (Table 7). When planting sengon for the first time, the farmers were not concerned with any risk. They planted sengon with varying capital inputs, ranging from Rp. 500 thousand to Rp. 5 million[5] depending on the area planted and inputs used. This capital was generally sourced from savings. Approximately 75.9% of the sengon growers obtained seedlings at a price ranging from Rp 1000 to 2500 / seedling. Only one sixth of the growers (14.3%) purchased their seedlings with support from a government subsidy. The sources of the seedlings were farmer groups, traders and the Trees4Trees foundation. Seedling quality was largely unknown.

[5] 1 AUD= Rp 10,000

Table 7. **Reasons for smallholder farmers in Pati to grow sengon for the first time** (Source: processed from primary data)

Reason for growing sengon	Number of respondents (%)
Profitable investment	13 (44.8)
Increased wood price	5 (17.2)
Social trend	4 (13.8)
Saving in the future	2 (6.9)
Available market and mill	2 (6.9)
Regreening/better environment	2 (6.9)
Fast growing	1 (3.4)
Total	29 (100)

Farmers generally grew sengon at a 3 m x 3 m spacing, but there were also variations in spacing including 2 m x 2 m, 2 m x 3 m and 2.5 m x 2.5 m. Approximately 68.9% of sengon growers thinned their trees, while the rest did not. Only 34.5% of sengon growers reported that they had harvested sengon, while 19 people had never harvested sengon wood. They generally sold the timber through timber collectors (middlemen), with only 31% selling it directly to the mill. All sengon growers applied fertilizers to their sengon trees, with ZA, urea and Ponska (NPK) being commonly applied. These fertilizers were procured from farmers groups. The sengon growers reported the presence of pests, mostly bag worm, which defoliates sengon trees. In dealing with this pest attack, the growers applied pesticide spraying or injection techniques which were considered quite effective in controlling the pest.

Around 65% of the sengon growers reported that their adoption of the sengon tree had increased their family income. The marked increase in the price of sengon wood, which used to be low, was the main reason for the adoption. However, 34.5% of sengon growers stated that their growing of the tree had resulted in no change in household income, especially when compared to growing cassava which was more profitable. The adoption of sengon was also considered to have driven changes in cropping patterns in the regions, as many other farmers started to copy their neighbours and grow sengon trees on their farmland. This social impact

was perceived by 89.7% of growers, with only 10.3% stating there was no social change. The trend in planting sengon was also supported by social institutions such as the Trees4Trees foundation, which had facilitated the distribution of seeds and training, and helped with marketing the sengon timber. In addition, 82.1% of the sengon growers considered there were positive impacts on the local environment from the planting of sengon trees. These positive impacts included improvements in soil fertility, less erosion and increased cassava production when it was intercropped with sengon (Table 8).

Table 8. **Pati sengon growers' perceptions of the economic, social and environmental impacts of sengon adoption**

Impact of sengon adoption	**Number of respondents (%)**
Economic impact	
• Increased household income	19 (65.5)
• No economic change	10 (34.5)
Total	29 (100)
Social impact	
• Many people started to adopt sengon	26 (89.7)
• No social impact	3 (10.3)
Total	29 (100)
Environmental impact	
• Better environment	23 (82.1)
• No environmental change	2 (7.1)
• Worse environment	3 (10.7)
Total	28

Despite the positive impacts of growing sengon, 20.7% of the adopters had ceased growing sengon. These farmers had replaced the sengon trees with cash crops, such as oranges, cassava and rice, or they substantially reduced the planting density of sengon by intercropping with cassava. The reason for this was the longer harvest period than the more profitable agricultural or cash crops.

Study 2: Changes in land use patterns and tree farming in Bulukumba

Respondent socio-demographic characteristics and land ownership

A total of 80 respondents were interviewed to complete the survey in Bulukumba, including 64 males and 16 females. The average age of respondents was 46.3 years (Table 9). The youngest was 26 years of age, while the oldest was 78. More than half of the respondents had a good education, with 38.8% having graduated from senior high school and 7.5% having graduated from university. However, about 12.5% of the respondents had never attended school. The majority of respondents (69.8%) worked in farming or fisheries, including working in rice fields, plantations, fishing, animal breeding, and rubber tapping. The remaining respondents were employed in non-farming activities, such as a civil servants, entrepreneurs, laborers, and company workers. The number of family members ranged from one to seven people, with the average household numbering 4.4 people. The respondents held an average of 1.49 ha of land, and only one person had no land. The maximum land area owned by the respondents was 11 ha. On average, the respondents owned 2 – 3 parcels of land.

Table 9: **Socio-demographic characteristics of the respondents in Bulukumba**

Characteristics	**Number of respondents (%)**
Age (year)	
• Average (St. Deviation)	46.3 (11.75)
• Min-Max	26 – 78
Education level	
• No education	10 (12.5)
• Primary school	22 (27.5)
• Junior high school	11 (13.8)
• Senior high school	31 (38.8)
• University	6 (7.5)
Occupation	
• On-farm	55 (68.8)
• Non-farming	25 (21.2)
Landholding size (ha)	
• Average (St. Deviation)	1.5 (1.75)
• Min-Max	0 – 11

Bulukumba's traditional Phinisi ship building industry is now are facing difficulties in procuring suitable timbers for ship building. Using a 10 point likert scale (1 = know nothing, 10 = greatly knows) to evaluate the level of knowledge of respondents about the local Phinisi ship industry, most had a low level knowledge (4.8 scale). However, the majority of respondents (79%) believed that Phinisi ships were made mainly from wood, while the rest had no idea. Those with deep knowledge about the ships also believed that the industry has become a world heritage industry. They remembered visiting the industry and all agreed to plant more trees in order to secure raw materials to supply the Phinisi ship industry in the future.

Adoption of select commercial tree species in Bulukumba

In this section, analysis of the adoption of commercial forestry by smallholders in Bulukumba is limited to four timber species, namely teak, gmelina, sengon and bitti (*Vitex cofassus*). These four species are used for local timber production and have recently been introduced into the region. The popularity of gmelina was evident, with 96.2 % of respondents stating they knew this species, while 85% had planted gmelina on their private land (Table 10). The second most popular tree was teak, with 93.8% of the respondents being familiar with this species and 70% having planted it. Bitti was the third most popular commercial tree species followed by sengon.

Table 10: **Popularity of the selected commercial trees among the respondents in Bulukumba**

Commercial trees	**Number of respondents** (%)			
	Knowledge of the species		Planting the species	
	No	Yes	No	Yes
Teak	5 (6.2)	75 (93.8)	24 (30)	56 (70)
Gmelina	3 (3.8)	77 (96.2)	10 (12.5)	68 (85)
Bitti	10 (12.5)	68 (85)	32 (40)	45 (56.3)
Sengon	52 (65)	25 (31.2)	66 (82.5)	11 (13.8)

The majority of respondents reported that the previous land use of their commercial tree growing area was agricultural crops such as corn, beans and rice, and/or fruit and nut trees

such as cocoa, coffee and cashew. For example, 82% of respondents grew teak on land that was previously used to grow food crops, while the remaining respondents converted other tree plantations, such as coconut, acacia and bamboo. Likewise, the proportion of land converted from that of agricultural crops to gmelina, bitti and sengon was 66%, 73% and 36%, respectively. This indicates that at the study sites in Bulukumba, considerable private land previously designated for agricultural crops has been converted to private or community forests.

The adoption of the different commercial tree plantations took place at different periods of time. Teak was first introduced and planted on private land in Bulukumba in 1956, while bitti, sengon and gmelina were introduced in 1969, 1991 and 1992, respectively (Figure 4). The area of teak plantations has gradually increased since the 1970s and has continued to increase over the last 10 years. Bitti has been a popular species since the 1970s, but its adoption rate has leveled off over the last 10 years. Gmelina was the latest tree species introduced at the study site and its rate of adoption increased dramatically between 2000 and 2008 before levelling off over the last 10 years. In contrast to the other species, the adoption of sengon only steadily increased since its first introduction around 1991 and has levelled off since 2008. The following sections describe the adoption of two of the four selected commercial species – teak, representing a slow growing species, and gmelina, representing a fast growing species.

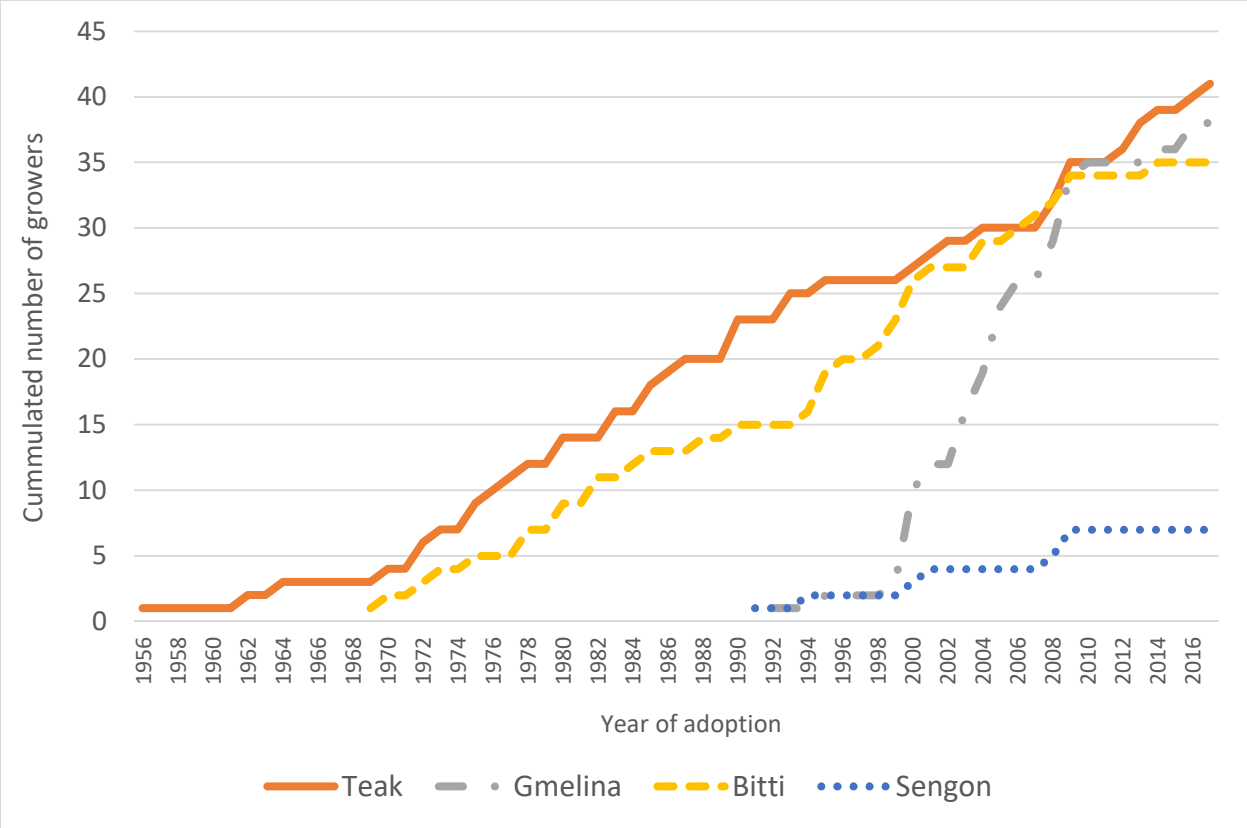

Figure 4: **Comparison of the adoption rates of four commercial tree species by smallholders in Bulkumba**

Adoption of teak in Bulukumba

Almost all respondents (93.8%) in Malleleng and Benjala were familiar with local teak, as teak timber has long been used for building traditional "Panggung" (elevated) houses. Whereas, around 5% of the respondents knew nothing about teak as they had never planted the species or used its timber. This study found that respondents with knowledge of teak have different backgrounds. Most of the respondents (46%) reported they knew some things about teak, some (35%) knew a lot, while the rest (19%) had little knowledge about teak. This indicates that the respondents' knowledge about local teak was only moderate and could be greatly improved, especially given the advances in information and technology relating to growing teak.

Teak is known by the community through several sources of information. Family was the main source of information about local teak (61.3%), followed by neighbors (11.2%) and the government including local and district governments and extension workers (8.06%) (Figure 5). Information was also obtained from community leaders (1.6%), and training programs (3.23%). This suggests that the role of informal sources of information is important for promoting the adoption of teak.

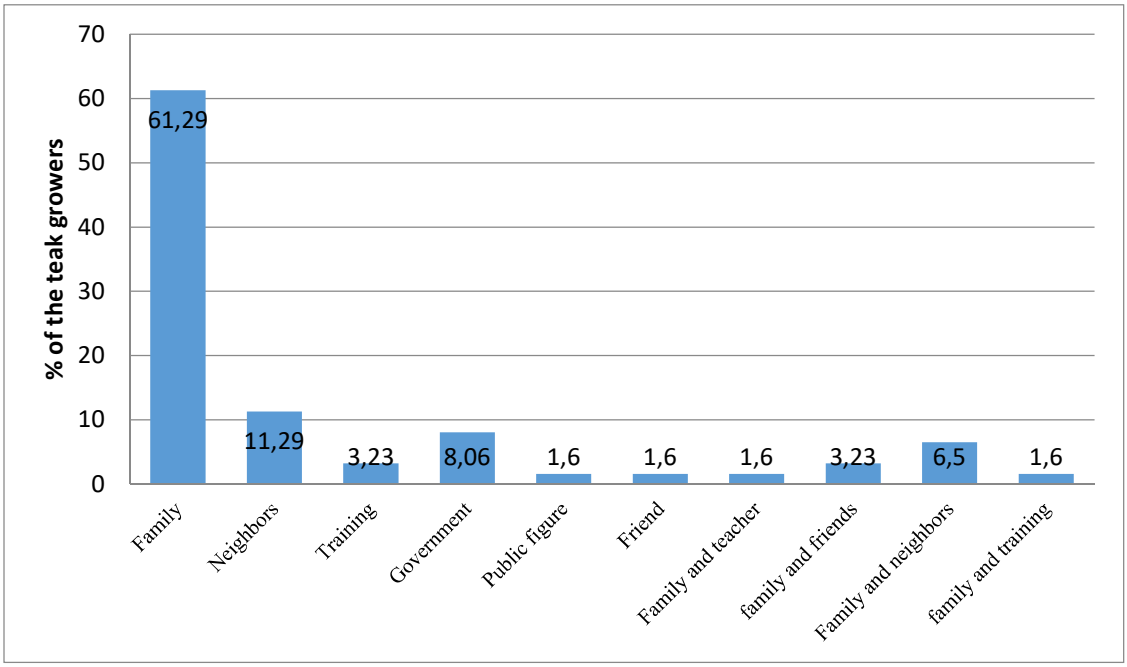

Figure 5: **Sources of information used by smallholders in Bulukumba before planting teak on their farmland**

The distance between farmland and houses can have a significant impact on cropping patterns applied by farmers. Before growing teak, 58.5% of the land was allocated for agricultural commodities, namely: corn, soybean, rice and bananas; 20.75% of the land was used to grow mixed crops, about 13.22% was planted with cash crops such as cashew, cacao and coconut, and the remaining 7.5% of land was planted with trees other than teak, such as bitti, acacia and bamboo (Figure 6). This shows that the conversion from agricultural land to tree cover, especially teak, has been happening in Bulukumba since the 1950s (see Figure 4).

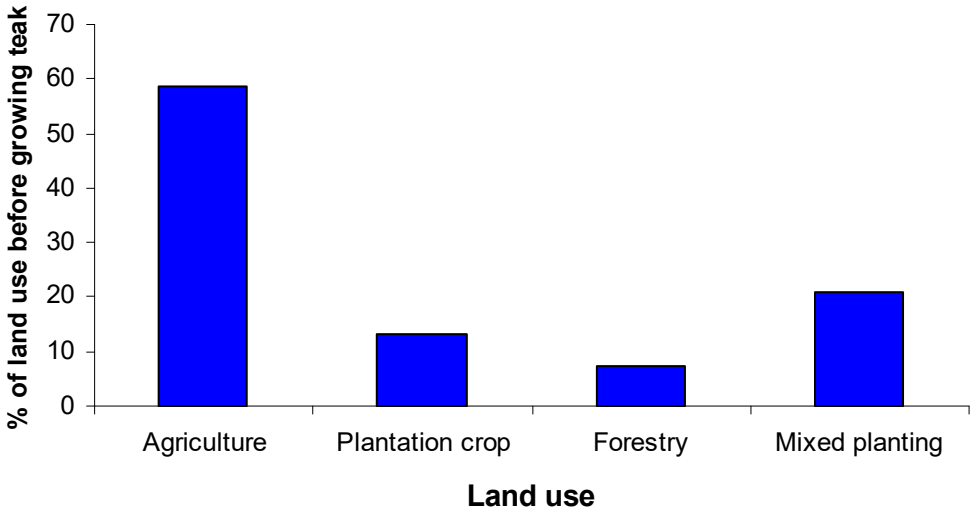

Figure 6: **Dominant land uses replaced by teak trees in Bulukumba**

Respondent motivations for converting their agricultural land to teak plantations was varied, but mostly dominated by technical-economic reasons. The majority of respondents were motivated by their judgments that the quality of teak timber is excellent for construction for their own needs, such as for building houses and making furniture, and the high price for teak timber which they expect will increase alongside an increasing market demand. Another economic motivation was to increase household income in the future, especially to cover children's school fees and marriage expenses. Respondents also experienced difficulties in controlling pests (e.g. wild boar), which destroyed their food crops and made them consider converting the crops to teak. Teak also requires less labour compared to food crops. The shortage of family labour is emerging problem for many smallholder farmers, due to migration, which has reduced the number of family members available to provide farm labour. A drop in prices received for agricultural products had also motivated some respondents to change their existing plantations to teak. A few respondents were triggered to grow teak on their farmland by social influences, such as information from neighbors and forest extension workers, or government subsidies, such as free teak seedlings. Few respondents reported ecological reasons as their motivation to grow teak (Table 11).

Table 11: **Reasons for smallholder farmers in Bulukumba to grow teak for the first time**

Reason for growing teak at the first time	Number of respondents (%)
1. Good timber for subsistence needs and commercial purposes	21 (35.0)
2. Good timber for subsistence needs	18 (30.0)
3. Good timber for commercial purposes	6 (10.0)
4. Labour efficiency, avoid farming risks and losses	6 (10.0)
5. Better income for the future	4 (6.7)
6. Social influences and government incentives	3.5 (0)
7. Ecological and commercial purposes	1 (1.7)
8. Ecological purposes	1 (1.7)

Teak adopters perceived low risks in growing teak. The greatest perceived risk was that the teak would not grow well, followed by the long harvest cycle, timber defects, pests and wildfire. However, 54.9% of respondents stated that growing teak poses no risk, as growing teak requires less intensive maintenance compared to food crops. Most of the respondents (89%) maintained that the establishment costs of teak plantations were paid for from their savings, while the remaining costs (11%) were covered by loans from relatives/family.

There were variations in the number of teak seedlings planted by the smallholder farmers. About 77% of teak growers planted less than 100 seedlings, 18% planted between 100 and 300 seedlings, and only 4.93% planted more than 300 seedlings. The small numbers of seedlings planted by the teak growers seems due to their small landholdings (below 0.5 ha). Generally, the teak growers raised their own seedlings (87%). Others obtained their seedlings through farmers groups or Bulukumba forest services (8.9%), or they bought the seedlings from traders (3.75%).

Around 79% of respondents did not use certified teak seedlings, and 20.93% did not even know that certified seedlings were available. Teak was mostly planted at a spacing of 3 m x 3 m or 5 m x 5 m. The spacing was occasionally denser or the trees were scattered throughout the farmland without any systematic arrangement.

Most of the teak growers (70%) did not fertilize their trees because they thought that woody plants such as teak did not need fertilizer (Table 12). Some respondents grew teak intermixed with crops such as corn. In these cases, the teak benefitted from the fertilizer applied for the corn crop. Pruning was a silvicultural treatment practiced by 58% of the teak growers. Some teak growers neglected pruning, despite this practice being important to improve the quality of teak timber. Thinning was practiced even less than pruning, with only 38% of farmers thinning their tree plantations. About 75% of the teak growers had harvested their trees, while the remaining farmers were waiting for their teak plantations to mature before they would consider harvesting.

Table 12: **Silvicultural treatments practiced by teak growers in Bulukumba**

Silvicultural treatments	Yes (%)	No (%)
Fertilization	18 (30)	42 (70)
Pruning	34 (58)	25 (42)
Thinning	23 (38)	37 (62)
Harvesting	46 (75)	15 (25)

The harvested teak was used to build farmers' own houses or sold to timber collectors. According to some respondents, the timber they sold to collectors was eventually supplied to the local Phinisi ship industry, but mostly the respondent did not have any knowledge about the teak market channels.

As a result of growing teak, 52% of the teak growers admitted that their income increased and they had no need to buy wood for their own use. Nevertheless, 44.26% of the farmers did not experience a change in family income as they had not yet harvested their teak trees, whereas 3.3% believed their revenue had decreased compared to previous income levels. The majority of the teak growers (43.3%) perceived that their decision to grow teak had influenced their neighbours to grow teak, while considerable proportion of growers (31.7%) viewed their decision affected less neighbor to plant teak, and the remainder did not believe there were social impacts. Most respondents (60.4%) considered that the local environment had been improved by planting teak – that is had created a better microclimate and greener landscape.

Other growers considered there had been no marked changes in the local environmental conditions as the teak was being grown at sites close to the dense customary forests. No respondents thought that local environmental conditions had worsened as a result of growing teak.

Around 76% of the teak growers stated they will continue planting teak after harvesting their trees, with the remaining 24% stating they would no longer grow teak. The reasons for not continuing to plant teak following the first harvest were varied and included: the long rotation cycle, limited available land, getting older and not enough family labour. Those planning to replace teak were intending to grow other tree species or crops that yield products in much shorter timeframes and receive better prices, such as gmelina, sengon, rubber (*Hevea brasiliensis*) and mahogany (*Swietenia sp.*). Approximately 33.3% of the teak growers will replace teak with plantation crops such as cacao, cloves, cashew and pepper. Around a quarter (25%) of the teak growers will replace the teak trees with fruit crops, including rambutan, durian and banana, especially for their own consumption. They also believed these crops will result in better income while also maintaining a vegetated local environment.

Adoption of gmelina in Bulukumba

Gmelina is a popular tree among smallholders in Bulukumba. The majority of the respondents (96.25%) were familiar with gmelina. Most respondents knew about gmelina through a government tree plantation program. About half of the respondents first became aware of gmelina between 2001 and 2009, less than one third became aware of it before 2000, and about one-fifth only became aware of the species in the last ten years. Regarding the introduction of gmelina to smallholder famers, the role of forestry extension workers is of high importance for increasing farmers' understanding of the potential for gmelina cultivation and increasing the scale of plantings. About 30% of the gmelina growers first obtained their knowledge of gmelina as a plantation option from their family members (e.g. parents, relatives), and about 30% first obtained their knowledge of the species from government

extension officers. For the remaining growers, the leaders of farmer group, and neigbours, friends and traders of tree seedlings were the most important sources of information (Table 13).

Table 13: **Respondents' sources of information about gmelina in Bulukumba**

Source of information	**Number of respondents (%)**
Government officers	23 (30)
Family	23 (30)
Group leaders	16 (21)
Neighbors	9 (12)
Friends	5 (6)
Seedling traders	1 (1)

The majority of respondents (83.8%) planted gmelina on less than 0.5 ha of their land, and only 6.7% planted gmelina on an area of more than 1 ha. On such small areas of land, the gmelina was intercropped with cash crops. Most of the land used to grow gmelina (90.79%) was located close to the farmers homes (< 5 km). Only 7.89% and 1.32% of the land used to grow gmelina was located between 5-10 km and > 10 km from the farmers homes, respectively.

Before the introduction of gmelina in Bulukumba, the dominant cultivated plants were agricultural crops (69%) and other trees (31%). The main planted agricultural crops were corn and fruit trees such as cacao, cashew and banana, while the main trees were teak, acacia, coconut and bitti. This suggests that the land previously designated for crops and other tree species had been converted to either gmelina plantation or gmelina intercropping systems.

The gmelina growers were primarily motivated to grow the species due to its growth rate being faster than other woody trees. Another important motivation was that the government provided free gmelina seedlings to the villagers. Farmers also believed that the gmelina logs were suitable for construction, either for building their own houses or making furniture, and that these logs could also fetch a good price if sold into the market (Table 14). These factors

may explain the more rapid adoption of gmelina by the smallholder farmers compared to other tree species (see Figure 4).

Table 14: **Reasons for smallholders in Bulukumba to grow gmelina for the first time**

Reason for growing gmelina at the first time	**Number of growers (%)**
1. Fast growing	13 (31)
2. Government subsidy	10 (24)
3. Subsistence needs and commercial sales	8 (19)
4. Good price	3 (7)
5. Market demands	3 (7)
6. Avoid risks of corn price volatility	2 (5)
7. Social influences and good price	2 (5)
8. Subsistence needs	1 (2)

When planting gmelina, the growers were concerned that the gmelina trees would suppress the growth and production of any intercropped agricultural crops. This would eventually reduce their income from food crops. Pest and disease attacks on the seedlings were another concern for some growers. About 79.45% of growers planted gmelina without incurring any cost for seedlings as they were obtained for free from the government. But some growers had to spend money to buy seedlings from traders. The number of seedlings planted by respondents mostly ranged from 100 to 200 seedlings. Sources of seedlings were reported from the government (50%), farmers raising their own seedlings (40.28%), and purchasing seedlings from seedling traders (9.72%). Tree spacings mostly ranged from 3 m x 3 m to 5 m x 5 m, while some growers planted at narrower and/or irregular spacings.

At nutrient deficient sites, the use of fertilizer is important for improving soil quality and supporting optimal tree growth. However, not all smallholder farmers fertilized their trees, mostly because of the cost of the fertilizer. About 64.38% of respondents did not fertilize their gmelina trees. Most of the growers also pruned and thinned their gmelina trees. The majority of the growers had experience with harvesting gmelina trees (Table 15). A total of 72.97% of the respondents had harvested some gmelina trees, while the remainder (27%) had not yet

harvested their gmelina trees as they were still immature. The majority of growers stated that after harvesting their gmelina trees they would not replace them with other tree species. The gmelina growers mostly used their harvested wood for their own consumption as building materials (53.7%), while 22.2% of the harvested logs were sold to industry, mostly through middlemen who collected wood on site and bore for the harvesting cost. The price received by smallholder famers was the standing value of the trees. The cost of felling trees and hauling logs from the harvest site to the roadside was borne by the middlemen. The stumpage value was apparently determined by the middlemen.

Table 15: Silvicultural practices applied by gmelina growers in Bulukumba

Silvicultural treatments	Yes (%)	No (%)
Fertilizer	26 (36.6)	47 (63.4)
Pruning	42 (57.5)	31 (42.5)
Thinning	38 (52.1)	35 (47.9)
Harvesting	54 (72.8)	20 (27.2)

The majority of the respondents had yet not received any economic benefit from growing gmelina as their trees were still immature. However, about 44.6% of the respondents had increased their income from selling gmelina timber. Following the introduction of gmelina into the district, more than half of the growers reported seeing positive social impacts of growing gmelina as people started to plant the gmelina, but some other growers reported not seeing any positive social impacts of this species introduction. Almost all growers agreed that there were positive impacts for the local environment from growing gmelina, including improvements in air and soil quality, greening of the local landscape, flood prevention, and improved water availability in the dry season. About 72.9% of the growers stated they would continue to grow gmelina, but the remainder (27.1%) would not plant the species in the future. The main reasons for not replanting gmelina were limited availability of suitable land, interests in other fast-growing tree species that could fetch a higher market price, and avoiding livestock disturbances.

Discussion and Conclusions

This study examined the adoption of tree farming by smallholders in the districts of Pati and Bulukumba, Indonesia. Some key findings of the study are further discussed here. First, the transition from farmers growing agricultural crops to tree crops, especially outside of existing forestland, is occurring on a noticeable scale at the village and/or district levels. There has been considerable land use change among smallholders in Pati during the period 1950 – 2018, with cultivated agricultural land shifting to private forests and, to a lesser extent, forest land to cultivated farm land. The change in land use during this period (i.e. nearly 70 years) has resulted in a net increase in the District's net forest cover from 33% to 58%. Similarly, in Bulukumba, about half of the change in land use during the period of 1956-2016 (i.e. about 60 years) involved the conversion of cultivated agricultural land (mostly growing corn) to family-based commercial tree plantations – mainly teak and gmelina. This shows the evidence of forest transition from deforested areas into reforested areas at very local level.

Secondly, the practice of private forestry has increased significantly in Pati, with the two main species grown being sengon and teak. Teak plantations have been adopted by the District's smallholders since the 1950s, while sengon plantings commenced and have increased in scale more recently since the 1990s. The adoption of teak began to increase significantly in the 1980s, and the adoption of sengon increased markedly in 2000s. In Bulukumba, the four main commercial tree species that have mostly contributed to the land use change are teak, gmelina, bitti and sengon. In this District, the earliest teak plantation was established in the 1950s and plantings of this species increased significantly 20 years later. Bitti was introduced to the District in the 1960s and its adoption by smallholders also gradually increased alongside teak. Sengon and gmelina were first introduced almost at the same time in 1990s, but gmelina has proven to be the more popular species, with an adoption rate far higher than sengon. In both Pati and Bulukumba, there has been a time lag between the first introduction of the tree species for commercial timber production and their adoption peak which requires further study.

Thirdly, in Pati, the adoption of tree plantations by farmers was generally diffused through informal sources, i.e.: neighbours, friends and family (in the case of teak) and formal sources, i.e.: extension services, especially non-governmental organizations (in the case of sengon). In Bulukumba, the adoption of tree farming was triggered by both family members and the government extension officers –at both the village and district levels. This supports that farmer-to-farmer learning and collaborating with extension services could lead to increased effective adoption in any future innovation program (Muktasam et al, 2020).

Fourthly, in Pati, the economic benefits due to increasing demand of the local timber market and the availability of mills (external factors) had encouraged farmers to adopt tree farming, especially using fast growing tree species. In the case of teak, the main motivation for farmers to plant the species was for a long-term investment and subsistence uses, while for sengon the main motivation was the rising price of sengon timber and the potential for this species to be more profitable during a relatively short period of time (e.g. 5-8 years). In Bulukumba, gmelina has been gaining in popularity over the last two decades due to its faster growth compared to teak and bitti, and because its timber is good for house construction and commercial sales, although its market potential has been uncertain in recent years. The internal factors, such as land availability and farmer occupation also influence the selected trees being adopted; if the farmers has larger land size, they tend to plant teak, otherwise fast growing species is preferred (Siarudin et al, 2017).

Fifthly, implementation of appropriate silvicultural practices (fertilizing, pruning, thinning) by smallholder tree growers in both Pati and Bulukumba was limited. Increased technical assistance from the government and non-government extension officers could increase the farmers' awareness, knowledge and skill for using the recommended silvicultural practices. However, the costs of intensive silviculture may be a major constraint for some smallholders. Stewart *et al* (2020) indicate that conducting pruning and thinning of teak and sengon will result in high financial return at the end. Thus incentives, such as a government subsidy to provide simple tools to conduct pruning, for example, may be required to boost the rate of tree

farming adoption among smallholder farmers. Further research about the effectiveness of low-cost silvicultural options appropriate for smallholders should also be pursued.

Lastly, the economic returns of tree farming was still below what was anticipated by many smallholders contacted for this study, mainly due to the long harvesting cycle and the low prices received for timber at the farm level. Consequently, there is a strong possibility that many current teak growers will replace their long-rotation teak with shorter-rotation tree species (e.g. sengon) or cash crops, reducing future supplies of teak from smallholders. However, some smallholders also reported that they were considering converting their sengon plantations to cash crops, such as cassava and oranges, which are currently thought to be more profitable. The quest for short-term profits is considered the chief reason for smallholders changing their commodity production. Nonetheless, most farmers still retain some areas of forested land of either teak, sengon or gmelina. These farmers could be those who have more land and or larger areas so that they could keep the land for future investments by planting the trees. There is a need for further investigation of the rate of cessation of smallholder tree farming, so that we can more accurately compare the probability of adoption or rejection of tree farming and the primary factors affecting farmers' decisions.

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