

# Smallholder Nursery Practices in Southeast Sulawesi:

## Seedling for Planting and Business

Ujang Susep Irawan & Edi Purwanto

Operasi Wallacea Terpadu Foundation, Taman Cimanggu,

Jl. Akasia III Blok P VI No 4 Bogor Indonesia.

Email: [ujangsi@yahoo.com](mailto:ujangsi@yahoo.com); [purwanto.owt@gmail.com](mailto:purwanto.owt@gmail.com)

James M. Roshetko

International Centre for Research on Agroforestry (ICRAF),

Jl. CIFOR, Situ Gede, Sindang Barang, Bogor. Email: [J.Roshetko@cgiar.org](mailto:J.Roshetko@cgiar.org)

Djoko Iriantono

Forest Tree Seed Center Zone III; Email: [iriantonodj@yahoo.co.id](mailto:iriantonodj@yahoo.co.id)

Fransiskus Harum

National Consultant; Email: [frans.hrm@gmail.com](mailto:frans.hrm@gmail.com)

Søren Moestrup

Department of Geosciences and Natural Resource Management, Faculty of Science,  
University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark.

Received: April 26, 2017

Accepted: June 20, 2017

Published: June 26, 2017

doi:10.5296/jas.v5i2.11405

URL: <https://doi.org/10.5296/jas.v5i2.11450>

## Abstract

Three types of agroforestry land-use systems have been identified in Southeast Sulawesi, these being *monoculture systems* (cacao, patchouli, sago and pepper); *mixed-garden systems* (cacao-patchouli and cacao-coconut, etc.), and *timber-garden systems*. High quality seedlings are a vital input for the establishment of an agroforestry system. The establishment of smallholder tree nurseries can help to meet the demand for seedlings and provide farmers with additional income. This survey was conducted to identify farmers' nursery practices, with specific reference to: (i) identifying the characteristics of community tree nurseries in the survey areas; (ii) identifying indicators of successful tree nurseries; (iii) determining the quality of germplasm; and (iv) determining the status of nursery managers' technical and business capacities. The survey was conducted in 29 villages located in 14 sub-districts in two districts (East Kolaka and Konawe District, Indonesia) on June 2014. Thirty-nine respondents were interviewed. All data were analysed using the statistical program SPSS release 14.0.1. An analysis of the survey found that 80% of nurseries were established on the nursery owners' own land. The nurseries were mostly established on the owner's own initiative (69%), with most respondents stating that they used their own funds to establish the nursery (51%). In addition, 80% of the respondents stated that they operated the nurseries primarily to meet their own needs for seedlings, with 46% stating that they also sold seedlings. In terms of the labor force on these nurseries, 40% are paid part-time employees working less than 20 hrs/week. The most common species produced is *Gmelina arborea*. The most commonly sold species in East Kolaka is *Anthocephalus cadamba*, while in Konawe, the most commonly sold species is *Tectona grandis*. The form of germplasm used for the production of seedlings in both East Kolaka and Konawe are seeds (98%). In East Kolaka, 72% of the seed used in nurseries is collected by respondents from locations around their community. In general, the respondents give little consideration to the quality of the seed when selecting seed sources or producing seedlings. Most respondents (85%) stated that they do not produce as many seedlings as they would like. The main constraint to the production of seedlings is the shortage of germplasm. Most respondents (64%) stated that they had not received formal training and did not have access to technical support. The most common means by which owners accessed technical knowledge were self learning (44%) and reading (36%). Almost all respondents (95%) stated that they had formulated a business plan, but only 41% of respondents had received training in business management, marketing or related topics. The purchasers of seedlings from the nurseries were mostly private individuals. Most respondents (64%) did not have a clear idea of how to expand their business and reach more customers.

Keywords: livelihood, nursery, germplasm, seed quality, business plan

## 1. Introduction

The province of Southeast Sulawesi is located in the South Eastern Peninsula of the island of Sulawesi, one of the four Greater Sunda Islands, situated between Borneo and the Maluku Islands. The mainland of Southeast Sulawesi occupies an area of  $\pm 38,140 \text{ km}^2$  (BPS, 2015). The greatest proportion of this area is constituted by the districts of Konawe, Kolaka, Bombana and the city of Kendari.

In 2014, agricultural sector contributed 78% of value of inter-island trade by land products, with principal crops including cassava, maize, cocoa, coffee, coconut, cloves, cashew nut, pepper and oil palm (BPS Southeast Sulawesi, 2015). Cocoa agroforest systems are prevalent in the province (Janudianto *et al.*, 2012), with the average size of household landholdings standing at approximately 0.5-2.0 ha. The cultivation of cacao commenced in the 1970s, when various government programs encouraged the production of this commodity to increase exports and to contribute to improvements to the gross national product. The area of land under cultivation for cocoa in the province increased from 55,000 ha in 1990 to 230,000 ha in 2010 (Dirjenbun, 1990–2010) and with the level of productivity standing at 213,691 tons in 2014 (BPS Southeast Sulawesi, 2015). In addition to cacao, black pepper (*Piper nigrum*) is also as a significant agricultural commodity. Based on provincial data from 2010, the total area of land utilized for the cultivation of this commodity in the province stands at 12,193 hectares, with more than 60% of pepper plantations located in Konawe and Kolaka (BPS, 2011).

There are three main forms of smallholder land-use systems in the province, these being *monoculture systems* (cacao, patchouli, sago and pepper); *mixed-garden systems* (cacao-patchouli and cacao-coconut, etc.); and *timber-garden systems* (Rahmanulloh *et al.*, 2012). These systems of land use enable households to generate significant incomes from the cultivation and sale of commodities. Based on annual equity measures, the most profitable system of land use is timber gardens (for the cultivation of teak), followed by pepper monoculture and patchouli monoculture. Timber gardens generate a higher return on labor inputs than do other land uses, while the cacao monoculture system generates the lowest return (Rahmanulloh *et al.*, 2012).

When planning agroforestry systems, the availability of high quality seedlings for planting is a vital consideration. A large number of farmers state that they would like to cultivate timber, but that they cannot readily obtain high quality tree seedlings. Although commercial nurseries may stock a limited range of tree species, the seedlings are often expensive and limited in availability. An option to address this may involve the production of trees in smallholder nurseries. While establishing tree nurseries is a significant undertaking, it has many advantages for farmers compared to buying seedlings from commercial nurseries. During a five-year period (2009-2013) about 5,200,000 seedlings were produced in smallholders nursery in East Kolaka and Konawe.

There is significant potential to increase the productivity of agroforestry systems by improving the supply of seeds for smallholder tree planters and by providing support for the development of small-scale, decentralised enterprise models to increase the availability of tree seed and seedlings (Lillesø *et al.*, 2011).

To facilitate the production of healthy, hardy seedlings, it is necessary that nurseries carefully control moisture, light, soil and predators. If these conditions can be met, the establishment of a smallholder tree nursery can help to meet the demand for seedlings and to enable farmers to generate additional income. To understand how farmers operate tree nurseries, a survey was

conducted: (i) to identify the characteristics of community based tree nurseries<sup>1</sup>; (ii) to identify the characteristics of successful tree nurseries (number of seedlings produced, sale, and self-use); (iii) to determine the quality of germplasm; and (iv) to determine the status of nursery managers' technical and business capacity. This paper reports the results of this survey and present an analysis of the data.

## 2. Materials and Methods

The survey was conducted in two districts (East Kolaka and Konawe), Southeast Sulawesi Province, Indonesia. East Kolaka District lies on the southeast peninsula of Sulawesi with a land area of 6,981.38 square kilometres. Geographically, it is located in the western part of Southeast Sulawesi Province, between 2°00' and 5°00' south latitude, and between 120°45' and 124°06' east longitude. Topographically, East Kolaka has a mountainous and undulated soil surface. Among the mountains and hills, there are stretches of plains potential for the development of agricultural sector (East Kolaka in Figures, 2015). Konawe District is located south of equator, from north to south between 02°45' and 04°15' south latitude, and from west to east between 121°15' and 123°30' east longitude. Konawe is located in southeast peninsula of Sulawesi island with a land area of 5,798.94 square kilometres. The structure of the land surface in Konawe is generally hilly. Among the mountains and hills, plains stretch as a potential area for development of agriculture (Konawe in Figures, 2016).

In East Kolaka and Konawe tree cultivation has been the main livelihood of the people. In these districts, many smallholder nurseries produce and supply tree seedlings and therefore a survey on smallholder nurseries practice was conducted in the period from June through August 2014. The survey was conducted through a semi-structured questionnaire implemented by trained enumerators. The number of respondents equals the number of existing smallholder nurseries in each district in total 39 respondents who still operated smallholder nurseries in East Kolaka and Konawe in 29 villages (Andowengga, Anggaber, Anggalosi, Asaki, Asolu, Atula, Galu, Hakambololi, Iwoimea Jaya, Iwoitombo, Lambuya, Ladongi Jaya, Lambotua, Lasada, Lasoso, Lawonua, Matanggarai, Mandoke, Penanggo Jaya, Poli-polia, Rawua, Simbune, Tanggobu, Tanisandi, Taosu, Tasahea, Tawaro Tebota, Wonuahoa, and Wunduuongo). These villagers were located in 14 sub-districts (Abuki, Aere, Anggaber, Besulutu, Ladongi,

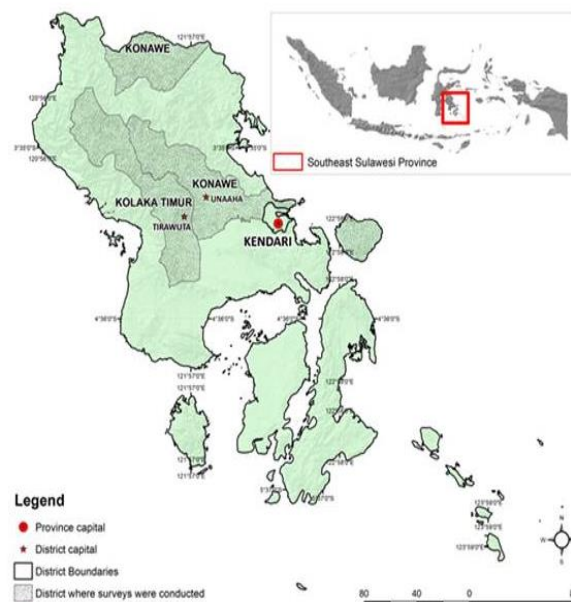


Figure 1. Map of Survey Site

<sup>1</sup> A community nursery usually produces a minimum of 500 to 10,000 seedlings, is made of local material and operated on a small budget provided by group members.

Lambandia, Lambuya, Mowewe, Poli-polia, Sampara, Saupar, Tirawuta, Uepai, and Unaha), in two districts (East Kolaka and Konawe Districts). One substantial questionnaire, holding 38 questions related to the nurseries, indicators of success, quality of germplasm, technical-and business capacity of the operators, was used in the survey.

Data from the survey and related observations is presented in this paper in a tabulated form and analysed according to the *Quantitative Descriptive Analysis Method*, with the frequency distribution tabulation. Data processing (editing, coding, transformation, and tabulation), presenting, description and size of data was analysed using the statistical program of SPSS Release 14.0.1 (*Statistical Product and Service Solution*). The results of the data analysis have been interpreted and presented in a descriptive form.

### 3. Results and Discussions

#### 3.1 Characteristic of Respondents and Nurseries

Of the 39 respondents, 97% of respondents were male and 3% were female. In terms of age distribution, the respondents were categorised in three groups: 20-40 years old (33%); 40-60 years old (54%); and 60 years or older (13%). Most respondents (69%) were the owners of nurseries. Most of the nurseries (92%) were owned by either individuals or families (in equal proportions); 5% were operated as community nurseries under the government nursery program (*Kebun Bibit Rakyat*, KBR); and 3% were owned and operated by schools.

Most of the nurseries (80%) were located on the owner's land, with the remainder located on borrowed land. Of nurseries covered by the survey, only 3% had been certified by either the provincial-level Forest Tree Seed Centre (BPTH) or the district-level forest agency. The nurseries were mostly established on the initiative of the respondents (69%), although some were established on the initiative of friend/neighbours (13%); government agencies (10%); or non-government organizations (NGOs, 5%).

Most respondents stated that they used their own funds to establish the nurseries (51%), with a smaller portion stating that they used funds provided by government agencies (28%). The smallest proportion were established with financial support provided by NGOs, community groups, donor projects, and other sources, with less than 10% of the nurseries established with support of this kind from each of these sources.

The survey found that approximately 41% of respondents stated that the reason for establishing nursery was both 'to meet their own need for seedlings' and 'to cultivate seedlings for sale'; 39% stated the reason was exclusively to meet their own need for seedlings, while 15% of respondents gave other reasons. On the basis of this data, it can be concluded that approximately 80% of the respondents established nurseries either partly or exclusively to meet their own need for seedlings, while around 46% of respondents also established the nurseries to cultivate seedlings for sales.

In terms of the labor force utilized by these nurseries, the greatest proportion (40%) consisted of paid part-time workers (less than 20 hrs/week), followed by labor provided by owners of family members (28%); labor provided by farmer group members (17%); labor provided by

paid full-time workers (more than 20 hrs/week) (15%).

The low number of certified smallholder nurseries indicating lack of awareness about what constitutes quality tree germplasm is alarming and few policy regulations are in place to ensure that only quality germplasm enters the market. This low quality planting material ultimately affects the survival of trees and the effectiveness of agroforestry and tree planting initiatives. Establishment of farmer nurseries, for example, could be facilitated by GOs and NGOs and support smallholder farmers play a pivotal role in tree germplasm supplies (Böhringer *et al.*, 2003). Shift of policy to support such nurseries will bring in income generation with increased supply of quality tree seedlings. This will free government resources to address tree germplasm quality control and supply of species that are difficult for community-based nurseries to handle (Jaenicke 1999; Roshetko *et al.*, 2010; Nyoka *et al.*, 2015). It is assumed that seedling production methods could have influence on seedling quality. Thus, seedlings produced by NGO-supported project nurseries can be expected to be of high quality since most of them are potted, while seedlings produced by farmer and government-owned nurseries can be expected to be of low quality as most of them are bare-rooted (Dedefo *et al.*, 2016).

### 3.2 Tree Nurseries: Tree Seedlings Produced and Sold

Based on the intended use of the seedlings produced, the nurseries can be classified in three categories: (i) those producing seedlings for the rehabilitation of forest and land under government programs; (ii) those producing seedlings for sale; and (iii) those producing seedlings for use by the owners. Based on the survey data, in the period from 2009 to 2013, a total of 5,171,138 seedlings were produced in the two districts of East Kolaka and Konawe, with the former accounting for 196,288 seedlings and the latter accounting for 4,974,850 seedlings. Over the same time period, the total number of seedlings sold in the two districts stood at 330,758, with East Kolaka accounting for 47,158 and Konawe for 283,600. A breakdown in terms of the species of the seedlings produced from all smallholder nurseries in each district is presented in Figure 2, and with a breakdown in terms of the species of seedlings sold in Figure 3.

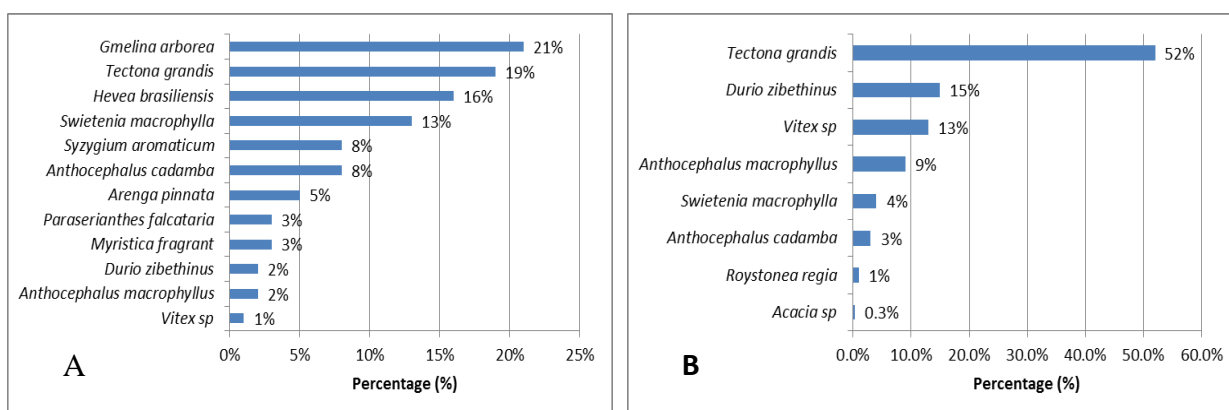


Figure 2. Proportion of tree species seedlings produced in East Kolaka (A) and Konawe District (B)

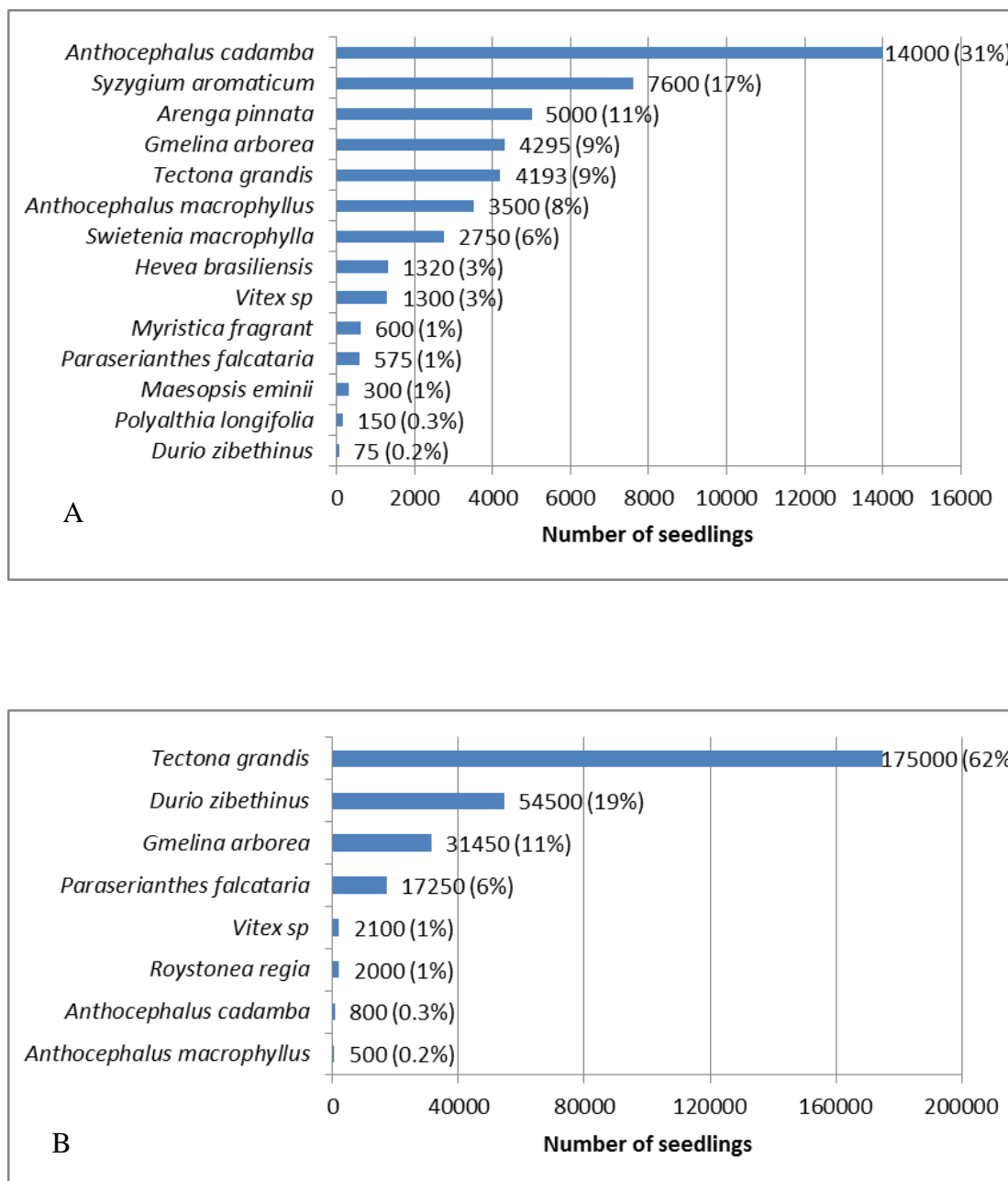


Figure 3. Proportion of tree species seedlings sold during 2009-2013 in East Kolaka (A) and Konawe District (B)

In East Kolaka, in terms the total number of seedlings produced, white teak (*Gmelina arborea*) was the most significant species. In terms of the number of seedlings sold, white jaban (*Anthocephalus cadamba*) was the most significant species. In Konawe, in terms of both of these factors, teak (*Tectona grandis*) was the most significant species.

### 3.3 Quality of Germplasm

In terms of the form of germplasm used by nurseries, in both East Kolaka and Konawe, the most significant form by far (98%) was germplasm in the form of seed, followed by wildings

(2%). The use of vegetative propagation technique (cutting, grafting, or air layering) was not commonly used, being used only for the production of fruit trees and some multi-purposes tree species (MPTS). The seed stock used in nurseries in East Kolaka was mostly collected from farmland (72%). There were no vegetative propagule source for the propagation of seedlings in either East Kolaka or Konawe. In the case of two species, sengon and rubber, seeds were collected from improved seed stands. The survey also found that white teak seeds were mostly collected from local farms, with no recorded cases of the collection of these seeds from improved seed stands or seed trees. In contrast to the case of East Kolaka, in Konawe, 35% of seeds were collected from improved stands (mostly for teak, gmelina, sengon, white jabon, and biti), while 30% of seeds were collected from local farms. Teak seeds were collected from a range of sources (forests, own farm/respondents farms, plantations, improved stands, and seed trees). A breakdown in terms of the sources of the collected seeds in East Kolaka and Konawe is presented in Figure 4.

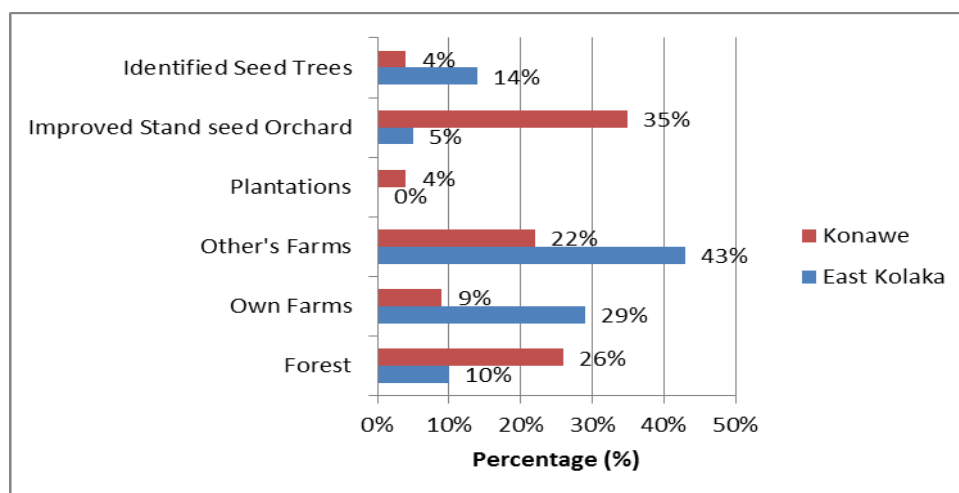


Figure 4. Percentage of seed collection in each seed source class in East Kolaka and Konawe District

In both East Kolaka and Konawe, the production of seedlings of nine trees species was prioritized, as follows: *Gmelina arborea*, *Tectona grandis*, *Anthocephalus macrophyllus*, *Anthocephalus cadamba*, *Swietenia macrophylla*, *Paraserianthes falcataria*, *Maesopisi eminii*, *Vitex cofassus*, and *Albizia saman*. The survey found that 56% of respondents stated that access was the major reason for selecting the specific source of seeds. It seems that in general, the respondents did not give a high level of consideration to the quality of the seeds when selecting the sources, with only 26% of the respondents stating that the quality of the seeds was a factor in their selection of sources. The survey found that easy access to seeds was an important reason for the selection of the source (15% of respondents). Most respondents (85%) stated that they had produced less seedlings than they would have liked. Approximately 72% of respondents stated that the lack of availability of germplasm is the major limiting factor in the production of seedlings. This finding is in line with the most commonly stated reason for not producing prioritized seedlings, with 82% of respondents stating that the lack of seeds limited their production of prioritized species. Limited capital



(18%); technical production difficulties (3%); limited time/labor (5%); and lack of customers (3%) were the other factors cited by respondents as reasons for their limited production of seedlings.

The survey made it clear that private nurseries want to expand their production capacities. However, access to high quality germplasm is a necessary precondition for this expansion to occur in an optimal manner. (Graudal and Lillesø, 2007). In Southeast Asia, the quality of tree seed is most often affected by factors under the control of the formal seed sector (research organizations, government agencies, and the forestry industry), to which smallholders have little access (Harwood et al., 1999). Efforts must be made to establish linkages between smallholders and the sources of high-quality germplasm and to expand smallholder access to a wider range of species that are suited to the biophysical and socioeconomic context in which they operate. This should include developing farmers' tree propagation and tree nursery management skills. Participatory training and nursery development have been proven to be effective methods of building farmers' level of awareness, leadership and technical skills; and to ensure their autonomy in the areas of germplasm quality, production and management capacity (Koffa and Roshetko, 1999; Koffa and Garrity, 2001; Carandang et al., 2006).

### *3.4 Technical Capacity*

The survey found that 64% of respondents stated that they had never participated in training in nursery operations and did not have access to technical support related to such operations. Most respondents (72%) stated that they had no prior experience in nursery work before establishing their own nursery. Almost all respondents (95%) expressed a desire for support or training to enable them to develop their nurseries. A significant proportion (23%) of respondents said that their lack of technical knowledge was a major constraint on the operation of their nurseries.

Most respondents stated that they had learnt management skills and the skills related to nursery production through a process of self-learning (44%) or learning from written sources (36%). Discussions with respondents indicated that training manuals and other agricultural extension materials related to nursery operations are in high demand by members of local communities.

The survey also found that respondents in East Kolaka had participated in training to a greater extent than respondents in Konawe. Of the respondents who had participated in training, the subjects covered by this training included the following: (i) the cultivation of cacao, clove, coffee, pepper, rubber tree and durian; (ii) community nurseries; (iii) forest timber; (iv) pest and disease management; (v) the procurement of high quality tree seed; (vi) forest tree seeds; and (vii) the propagation of forest tree seedlings. The providers of training in both East Kolaka and Konawe fell into one of two categories: (i) *Government training*: This included training provided by watershed management units/BPDAS, provincial-level forest agencies, district-level forest agencies, district-level plantation agencies, district-level agricultural agencies; and (ii) *Project training*: this included training provided through projects operated by institution such as ICRAF, Operasi Wallacea Terpadu Foundation (OWT), AgFor

SE Sulawesi, and University of Copenhagen (UCHP). A list of the topics covered in this training on the providers of the training is presented in Table 1, while the types of technical support related to the operation of nurseries is presented in Table 2.

Table 1. List of training topics, subject, and providers in surveyed area

No	Trainings Topics	Training Subject	Training Provider
East Kolaka			
1	Cacao cultivation	Nursery, seedlings propagation, plant maintenance, cutting	Project (ICRAF, OWT AgFor) and Government (Plantation District Agency, extension worker)
2	Clove cultivation	Nursery and plant maintenance	Project (OWT AgFor)
3	Coffee cultivation	Coffee cultivation	Project (AgFor SE Sulawesi)
4	Pepper cultivation	Propagation, planting, maintenance, pest and disease management,	Project (ICRAF, AgFor SE Sulawesi)
5	Rubber tree cultivation	Nursery and plant maintenance	Project (OWT AgFor)
6	Durian cultivation	Nursery, propagation, and maintenance	Project (ICRAF, OWT AgFor)
7	Community nursery	Nursery establishment, propagation	Government (Watershed Management Unit (BPDAS) and Forest district agency)
8	Pest and Disease	Pest and disease management	Government (Agriculture District Agency)
9	Procurement of good quality tree seed	Identification of seed source, nursery establishment, generative and vegetative propagation	Project (OWT AgFor, IGN)
10	Forest Tree Seed	The important of tree plantation, certification, red jabol seed	Government (Forest District Agency)
Konawe			
11	Seedlings Propagation	Seedlings propagation, maintenance, nursery establishment	Government (Forest Province Agency, Watershed Management Unit)

Table 2. Type of technical support available on nursery operation

No.	Technical Support	Technical Support Provider
East Kolaka		
1	Cultivation, fertilizing, maintenance of plant	Plantation extension worker
2	Germination technique of jabol	Forest district agency
3	Forest tree seed	OWT - University of

		Copenhagen
4	Cover plastic of pepper	OWT AgFor
5	Fertilizing, planting, and marketing	Forest District Agency
6	Seedlings propagation	OWT AgFor
Konawe		
1	Seedlings transplanting	Forestry extension worker
2	Palm tree cultivation	Forest District Agency
3	Tree seedlings propagation	Extension worker / OWT

### 3.4 Business Capacity

Almost all of the survey's respondents (95%) stated that they had formulated a business plan. However, 59% stated that they had not participated in any form of training in business management, marketing, or related topics. Most of the respondents (80%) also stated no training support agents for nursery business operations were available to them. Of the respondents who stated that they had received business-related training, 63% stated that they had received the training from an NGO; 25% from a government agency; and 13% from a formal educational institution.

This survey also found that most respondents (95%) maintained a single site for the production and sale of seedlings. More than half of the respondents (59%) stated that their nurseries were located at their homes. Most of the nurseries were located around 5-50 meters from the nearest main road (56%), with 26% being located on the roadside.

Most respondents (95%) stated that their customers consisted predominantly of private individuals, with only a limited number of purchases from government agencies or companies. Most respondents (64%) were not able to identify the constraints they faced in reaching customers; with 5% stating that they didn't face any constraints of this sort. The main identified constraints in this area related to: poor transportation infrastructure (8%); lack of vehicle (5%); lack of information and communication (5%); lack of marketing knowledge (3%); limited communication and infrastructure (3%); limited species diversity and seedling stock (3%); limited access to the nursery (3%); and limited familiarity with the customers (3%). Only 13% of respondents belong to a formal network or association of nurseries intended to facilitate the sharing of information on matters related to seedling markets and customers.

The respondents maintained proactive links with their customers through a number of means. Media campaigns and promotions were regarded as the best means of maintaining proactive links with customers by the majority of respondents (67%). The respondents used a number of sources to obtain information related to the marketing of nurseries/seedlings. Organs of the mass media (television, newspapers, radio, etc.) were regarded as the most important source of information related to marketing of nurseries/seedlings by the majority of respondents (74%).

The survey found that 39% of respondents stated that they used mobile telephones to support their nursery operations, with these respondents stating that they considered mobile phones as

a vital tool for ensuring the success of nursery business. The reasons given for the importance of telephones included the following: (i) the ability to easily contact customers and business partners; (ii) customers' and business partners' expectations that nursery operators would have mobile telephones; (iii) mobile phones enable operators to communicate at all hours; to confirm and check details quickly; and to make and to keep bookings and appointments; (iv) mobile telephones facilitate ready access to email.

Smallholders generally have weak market linkages and poor access to market information (Arocena-Fransico *et al.*, 1999). Commercial opportunities exist for smallholder nurseries to transform their traditional nursery systems by intensified market orientation. To achieve this transformation, smallholder farmers need to develop intensive management systems designed to produce quality seedlings for priority species that meet market specifications (Roshetko *et al.*, 2007; Roshetko *et al.*, 2013). A replicable and efficient extension approach is needed to meet the needs of farmers by increasing their production and improving their access to markets for their agroforestry products. This approach should include three components: i) market studies and analysis; ii) farmer group extension; and iii) farmer enterprise development. Training and activities undertaken in the farmer group extension and enterprise development components are based on market opportunities identified by the market survey (Roshetko *et al.*, 2007).

## 5. Conclusions and Recommendations

Smallholder nurseries in East Kolaka and Konawe District, Southeast Sulawesi Province have been established primarily on land belonging to the nursery owners. The nurseries were established as a result of the owners own initiative and through the use of their own funds. To operate their nurseries, most owners employ paid part-time workers, who work on average less than 20 hours per week. The nurseries gave priority to production of nine tree species: *Gmelina arborea*, *Tectona grandis*, *Anthocephallus macrophyllus*, *Anthocephalus cadamba*, *Swietenia macrophylla*, *Paraserianthes falcataria*, *Maesopisi eminii*, *Vitex cofassus*, and *Albizia saman*. In East Kolaka, *Gmelina arborea* is the species most extensively produced, while *Anthocephalus cadamba* is the species for which most seedlings are sold. In Konawe, *Tectona grandis* is both the species most extensively produced and for which most seedlings are sold. The limited availability of germplasm is a major limiting factor to the production of seedlings.

This survey found that the predominant form of germplasm utilized for the production of seedlings in the nurseries was *seed*, with most seed being collected from local farms. Seedlings are generally produced to meet the owners own needs, with a small proportion of seedlings being sold. Most nursery owners have not received training in business management, marketing or related topics.

Based on the findings of the survey, a number of recommendations to enhance smallholder nursery operations in Southeast Sulawesi can be given: (i) training opportunities should be made available to nursery operators, particularly on matters related to the establishment of nurseries, the propagation of seedlings, business management, and marketing; (ii) the selection and collection of seed should be conducted in a manner to facilitate the provision of

adequate supplies of seed of priority species; (iii) measures should be implemented to build the awareness of nursery operators and seed collectors regarding the importance of seed quality; and (iv) measures should be taken to promote the sale of seedlings from smallholder nurseries not only to private individuals, but also to government agencies, private companies, and other potential customers.

### Acknowledgements

The research reported in this article was supported through ‘Decentralized Tree Seed Systems in South East Sulawesi Project’, funded by the G.B. Hartmann Foundation in Denmark. We gratefully acknowledge the kind cooperation of the Operasi Wallacea Terpadu Foundation (OWT) field teams for implementing the survey and the Agroforestry and Forestry in Sulawesi: Linking Knowledge to Action project funded by the Government of Canada (Contribution Arrangement no. 7056890).’

### References

- Arocena-Francisco, H., de Jong, W., Le Quoc Doanh, de Guzman, R.S., Koffa, S. Kuswanda, M., Lawrence, A., Pagulon, A., Rantan, D. and Widawati, E.: (1999). ‘Working Group 1 – External factors affecting the domestication of agroforestry trees (economics and policy)’, in J.M. Roshetko and D.O. Evans (eds.). *Domestication of agroforestry trees in Southeast Asia. Forest, Farm, and Community Tree Research Reports, special issue*, 212–213.
- Badan Pusat Statistik Provinsi Sulawesi Tenggara. Sulawesi Tenggara in Figures (2008).
- Badan Pusat Statistik Provinsi Sulawesi Tenggara. Sulawesi Tenggara in Figures (2015).
- Badan Pusat Statistik Kabupaten Konawe. Konawe Regency in Figures (2011). Badan Pusat Statistik.
- Badan Pusat Statistik Kabupaten Kolaka. Kolaka Regency in Figures (2011). Badan Pusat Statistik.
- Badan Pusat Statistik Kabupaten Kolaka Timur. East Kolaka Regency in Figures (2015). Badan Pusat Statistik.
- Badan Pusat Statistik Kabupaten Konawe. Konawe Regency in Figures (2016). Badan Pusat Statistik.
- Bähringer A, Ayuk EA, Katanga R, Ruvuga S. (2003). Farmer nurseries as a catalyst for developing sustainable land use systems in southern Africa. Part A: nursery productivity and organization. *Agric Syst.*, 77, 187–201.
- Carandang WM, EL Tolentino Jr, JM Roshetko. (2006). Smallholder tree nursery operations in southern Philippines - supporting mechanisms for timber tree domestication. *Forests, Trees and Livelihoods*, 16, 71-83.
- Dedefo K, Abayneh Derero, Yemiru Tesfaye & Jonathan Muriuki. (2017). Tree nursery and seed procurement characteristics influence on seedling quality in Oromia, Ethiopia. *Forests, Trees and Livelihoods*, 26(2), 96–110

<http://dx.doi.org/10.1080/14728028.2016.1221365>

Graudal, L, Lillesø JPB. (2007). Experiences and future prospects for tree seed supply in agricultural development support: based on lessons learnt in Danida supported programs 1965-2005. Danida

Harwood C, JM Roshetko, RT Cadiz, et al., (1999). Working Group 3 – Domestication strategies and process. In: *JM Roshetko, DO Evans (eds) Domestication of agroforestry trees in Southeast Asia. Forest, Farm, and Community Tree Research Reports Special Issue*, 217-225.

Jaenicke H. (1999). Good tree nursery practices: practical guidelines for research nurseries. Nairobi: World Agroforestry (ICRAF).

Koffa SN, DP Garrity. (2001). Grassroots empowerment and sustainability in the management of critical natural resources: The Agroforestry Tree Seed Association of Lantapan. In *I Coxhead, G Buenavista (eds) Seeking Sustainability: Challenges of Agricultural Development and Environmental Management in a Philippine Watershed Los Banos Laguna Philippines. Philippine Council for Agriculture, Forestry and Natural Resources Research*, 197-217

Koffa SN, JM Roshetko. (1999). Farmer-managed germplasm production-diffusion pathways in Lantapan Philippines. In: *JM Roshetko, DO Evans (eds) Domestication of agroforestry trees in Southeast Asia. Forest, Farm, and Community Tree Research Reports Special Issue*, 142-150

Komisi Pengawasan dan Persaingan Usaha. (2009). Study of industry and trade of cacao. KPPU, Jakarta

Janudianto, N Khususiyah et al., (2012). Working paper no. 156: agroforestry and forestry in Sulawesi series: livelihood strategies and land use system dynamics in Southeast Sulawesi. ICRAF.

Lillesø JPB, Moestrup, S. et al., (2011). Innovation in input supply systems in smallholder agroforestry: seed sources, supply chains and support systems. *Agroforestry Systems* 83:347-359. <https://doi.org/10.1007/s10457-011-9412-5>.

Nyoka BI, Roshetko J, Jamnadass R, Muriuki J, Kalinganire A, Lillesø J-PB, Beedy T, Cornelius J. (2015). Tree seed and seedling supply systems: a review of the Asia, Africa and Latin America models. *Small-Scale*, 14, 171–191.

Rahmanulloh A, M Sofiyudin, Suyanto. (2012). Working paper no. 157: agroforestry and forestry in Sulawesi series: profitability and land-use systems in South and Southeast Sulawesi. ICRAF.

Roshetko JM, E Nugraha, JCM Tukan et al., (2007). Agroforestry for livelihood enhancement and enterprise development. In: *S. Djoeroemana, B. Myers, J. Russell-Smith et al (eds) Integrated Rural Development in East Nusa Tenggara Indonesia Proceedings of a workshop to Identify Sustainable Rural Livelihoods held in Kupang Indonesia 5–7 April 2006. ACIAR*,

Canberra.

Roshetko JM, Tolentino EL, Carandang WM, Bertomeu M, Tabbada A, Manurung GES, Yao CE. (2010). *Tree nursery source book*. Options in support of sustainable development. Bogor: World Agroforestry Centre-ICRAF and Winrock International.

Roshetko JM, N Idris, P Purnomosidhi et al., (2013). Farmer extension approach to rehabilitate smallholder fruit agroforestry systems: the “Nurseries of excellence (NOEL)” program in Aceh Indonesia. *Acta Horticulturae*, 975, 649-656.  
<https://doi.org/10.17660/ActaHortic.2013.975.81>

### **Copyright Disclaimer**

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).